

# SCR'18 SWISS CONGRESS OF RADIOLOGY

# MAY 10-12, 2018 | LAUSANNE

SCHWEIZERISCHER RADIOLOGIEKONGRESS CONGRÈS SUISSE DE RADIOLOGIE

ONLINE ABSTRACT BOOK of the Swiss Congress of Radiology

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Preface **3** Committees and Important Addresses **4** Abstract Reviewer Committees and SGR-SSR Poster Jury **5** 

# **SGR-SSR ORAL PRESENTATIONS 6**

Breast, Chest and Radiation dose Cardiovascular imaging Musculoskeletal I: Joints Abdomen and Pelvis Neuroradiology Musculoskeletal II: Spine and technological advances Interventional radiology Joint session SGR-SSR & SGNM-SSMN: Understanding Cancer Paediatric imaging

# SGNM-SSMN ORAL PRESENTATIONS 32

Cardiovascular and Neuroimaging **32** Radiopharmacy / Therapy **34** Varia **36** Oncology **38** 

# SVMTRA-ASTRM ORAL PRESENTATIONS 40

Le TRM et la sécurité des patients / MTRA und Patientensicherheit Diversité dans le développement de l'imagerie par coupes / Diversität in der Entwicklung der Schnittbildverfahren IRM, quelles nouveautés ? / MRI, was gibt es Neues? Politique professionnelle et horizon du monde TRM / Berufspolitik und der Horizont der Welt der MTRA Plenary Session 5

# SGR-SSR POSTER PRESENTATIONS 47

Abdominal and Pelvic Imaging Brain, Head and Neck Cardiovascular Imaging Medical Physics and Basic Science Ethics, Economics and Quality Improvement Chest and Lung Musculoskeletal Imaging Women's Imaging including Breast Paediatric Radiology

# SGNM-SSMN POSTER PRESENTATIONS 69

# **SVMTRA-ASTRM POSTER PRESENTATIONS 72**

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# Dear Delegates and Visitors of the Swiss Congress of Radiology 2018, Dear Colleagues!

The Swiss Society of Radiology (SGR-SSR), the Swiss Society of Nuclear Medicine (SGNM-SSMN) and the Swiss Association of Radiographers (SVMTRA-ASTRM) are delighted about the high quality and the great amount of abstracts which were submitted for presentation at the annual Swiss Congress of Radiology.

The continuous excellent work of all authors is highly appreciated as it makes the congress a very prestigious scientific meeting.

This "Online Abstract Book of the Swiss Congress of Radiology" is the 8<sup>th</sup> issue which is solely published online. It represents a cost efficient, durable and platform independent documentation of scientific abstracts, integration of the abstract data into either the Society's or Congress' web page as well as permanent accessibility all over the world.

The "Online Abstract Book of the Swiss Congress of Radiology" will permanently be accessible on either the Society's or Congress' web page at www.radiologiekongress.ch. It includes all the abstracts of the scientific talks and posters presented at the annual Swiss Congress of Radiology in Lausanne.

Proper citation of scientific abstracts is however important, especially in case of online-only web publications. The Swiss Society of Radiology thereof recommends the use of the following structure to cite abstracts from the new "Online Abstract Book of the Swiss Congress of Radiology":

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# We look forward to welcoming you to the Swiss Congress of Radiology 2018 in Lausanne

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SS101

SS102

# Clustered Ring Enhancement versus other internal enhancement patterns in prediction of malignancy of Non-Mass Enhancement in Breast MRI

<u>M. Lunkiewicz</u>, S. Forte, B. Freiwald, G. Singer, R. A. Kubik-Huch; Baden/CH

**Purpose:** The purpose of this study was to estimate the risk of malignancy for the clustered ring enhancement pattern, as a newly introduced descriptor in the revised BI-RADS Atlas (5th Edition).

**Methods and Materials:** Breast MRIs of all patients performed with subsequent MRI-guided VAB-Biopsy between January 2012 and January 2016 were re-evaluated. Two independent radiologists, blinded to the histopathological results, classified the findings according to the 5th edition of BI-RADS Atlas. A third independent radiologist was involved to achieve consensus, in case of discrepancy.

With special focus on the clustered ring internal enhancement pattern, the findings have been correlated with the histopathological results.

**Results:** There were a total of 142 women included. 72 biopsied lesions were classified as NME. Among all internal enhancement patterns, clustered ring enhancement was evident in 14 cases (19.4%).

Clustered ring enhancement was associated with the highest malignancy rate (7/14, PPV 50%), followed by clumped enhancement (7/30, PPV 23.3 %). **Conclusion:** The highest PPV for malignancy was associated with clustered ring internal enhancement pattern when using the revised 5th edition of BI-RADS Atlas.

### Ultrasound contrast agent in phase contrast X-ray mammography: Small bubbles may solve diagnostic troubles

<u>K. Lång</u><sup>1</sup>, C. Arboleda Clavijo<sup>2</sup>, S. Forte<sup>3</sup>, Z. Wang<sup>1</sup>, R. A. Kubik-Huch<sup>3</sup>, M. Stampanoni<sup>2</sup>; <sup>1</sup>Villigen/CH, <sup>2</sup>Zurich/CH, <sup>3</sup>Baden/CH

**Purpose:** Breast imaging with phase contrast X-ray mammography (PCM) is progressing towards clinical implementation. PCM captures X-ray refraction and scattering characteristics of breast tissue, resulting in differential-phase-contrast (DPC) and dark-field (DF) images in addition to a standard attenuation image. Microbubble ultrasound contrast agents have strong scattering properties and should be visible in DF images. Here, we present an ex-vivo pilot study using commercial microbubble agent and animal tissue.

**Methods and Materials:** Two ex-vivo phantoms were used representing a dense (chicken breast) and non-dense breast (cow udder). Eggshells and plastic tubes, simulating microcalcifications and vessels, were inserted into the phantoms. Native and post contrast images were acquired using a clinically compatible grating-interferometry-based mammography setup (a modified Philips MicroDose Mammography system), operated at 38 kvP, 14 sec acquisition time, with an air kerma of 4 mGy. 2 mL of sulphur hexafluo-ride microbubbles (SonoVue 8 µL/mL, Bracco) was injected into the phantoms. The visibility of the contrast agents in the absorption, DPC and DF images were analysed and the contrast-to-noise-ratio (CNR) between the contrast agent and surrounding tissue was calculated.

**Results:** The microbubbles were clearly visible in the DF image in the dense as well as the non-dense breast phantom, with the lowest contrast observed in the dense phantom (CNR=2.5). As expected the microbubbles were not visible in the absorption or DPC images.

**Conclusion:** The result of this study indicates that ultrasound contrast agents could be used in X-ray based breast imaging. Subsequent in-vivo studies are needed to investigate their potential to replace Iodine for contrast-enhanced PCM.

#### Automatic Classification of Breast Lesions in Ultrasound, using a Deep Convolutional Neural Network

### A. Ciritsis, C. Rossi, A. S. Becker, M. Marcon, M. Eberhard, A. Boss; Zurich/CH

**Purpose:** To evaluate whether a deep convolutional neural network (dCNN) trained with ultrasound images of breast lesions, labeled according to histopathological results and the ACR BI-RADS catalogue, allows for classification and objective suggestion for additional biopsies.

**Methods and Materials:** 1019 ultrasound images from 582 different patients with an average age of 56.3±11.5 were successfully linked to the ACR BI-RADS classification from the corresponding radiological report. All lesions were subdivided into the classes: BI- RADS 2, BI-RADS 3 and BI-RADS 4-6 Preprocessing and data augmentation was applied on all images. A dCNN consiting of thirteen convolutional layers was implemented and trainend to classify BI-RADS 2, BI-RADS 3 and BI-RADS 4-6 lesions. To test the performance of the dCNN, a unknown data set with 100 images was evaluated by the dCNN and two independent readers and compared to the radiological reports and corresponding histopathological results and follow up examinations which served as reference.

**Results:** The dCNN classified 70.2% of all lesions correctly as BI-RADS 2 and 85.1% and 90.5% correctly as BI-RADS 3 and BI-RADS 4-6. Reader one and reader two classified 45.4%(57.6%) as BIRADS 2 lesions, 91.5%(70.2%) as BI-RADS 3 and 98.2%(95.2%) as BIRADS 4-6.

**Conclusion:** In conclusion we applied a dCNN, which allows for accurate observer independent classification of lesions in breast ultrasound according to the ACR BI-RADS catalogue. The implementation of dCNN into the clinical workflow may help to improve the accuracy and reliability in the clinical routine and allows for accurate, standardized classification and objective suggestion if additional biopsies are necessary.

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SS104
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#### How does the stand-alone performance of a deep-learning based computer system for detecting breast cancer in mammography compare to the performance of experienced breast radiologists?

A. Rodriguez-Ruiz<sup>1</sup>, A. Gubern-Merida<sup>1</sup>, S. Zackrisson<sup>2</sup>, G. Gennaro<sup>3</sup>, M. Chevalier<sup>4</sup>, <u>N. Karssemeijer<sup>1</sup></u>, R. Mann<sup>1</sup>, I. Sechopoulos<sup>1</sup>; <sup>1</sup>Nijmegen/NL, <sup>2</sup>Malmö/SE, <sup>3</sup>Padua/IT, <sup>4</sup>Madrid/ES

**Purpose:** To compare the stand-alone performance of a deep learning based computer system to the performance of radiologists in the detection of breast cancer in digital mammography (DM) images.

**Methods and Materials:** Five datasets from previously performed fully-crossed multi-reader multi-case (MRMC) studies, in five countries, and using mammograms acquired with systems from three vendors were collected. Each dataset consisted of DM exams, radiologists score per case (BI-RADS or level of suspiciousness), and ground truth (histopathology and/or follow-up). This resulted in a total of 1675 exams (436 malignant) and readings by 31 certified radiologists. A deep learning based computer system (Transpara™ 1.3, Screenpoint Medical, Nijmegen, The Netherlands) automatically analyzed each exam providing a cancer suspiciousness score (1-100). For each dataset, receiver operating characteristic (ROC) curves (smoothed to avoid discrepancies due to different scaling) and their area under the curve (AUC) were computed and compared between the system and radiologists.

**Results:** The computer system had a higher AUC than 16/31 radiologists (range 1-9%, only significantly different for two, P<0.05), lower AUC than 12/31 radiologists (range 1-7%, only significantly different for two, P<0.05), and equivalent AUC for 3/31 radiologists. Its performance was also similar to that of the average radiologist in each dataset (differences in AUC ranged between -2% and +5%, P>0.05).

**Conclusion:** A computer system for detecting breast cancer in DM based on deep learning is as good as radiologists. It could therefore be used in a screening setting as an independent second reader or for decision support.

### SS105

# Automatic identification of malignant breast lesions in semi-quantitative Hybrid PET/MRI

#### <u>C. Rossi</u>, A. Ciritsis, I. A. Burger, A. S. Becker, P. Veit-Haibach, A. Boss; Zurich/ CH

**Purpose:** Location, size, and structure of malignant breast lesions are elements of main importance in the surgical management of breast tumor patients. A gradient boosting machine learning algorithm is proposed for standardized classification of malignant breast tissue based on estimations of vascular permeability, neoangiogenesis, and glucose metabolism inferred from hybrid PET/MRI examinations.

**Methods and Materials:** Hybrid FDG-PET/MRI was performed in 23 consenting patients. T1-weighted 3D GRE sequences were acquired before and after intravenous administration of gadolinium. Six post-contrast series were acquired with a time interval of 71 s. Semi-quantitative indexes of MR contrast agent dynamic as well as the FDG uptake were used as features to train the algorithm for tumor, gland tissue, and fat tissue classification. Regions of interested were manually drawn over the different tissue types for labeling of the training data. A confusion matrix was generated for quantitative assessment of classification accuracy over a testing dataset. Feature importance was computed as well.

**Results:** Breast tissue classification was achieved with an accuracy of 90.0%. Tumor was correctly identified in 89% of the cases (false positive rate = 4%). Gadolinium-induced maximum contrast enhancement and contrast agent first uptake rate were the most important MR-based features (with a weight of 28.0% and of 16.1%, respectively). FDG uptake contributed to over 34% to the classification decision.

**Conclusion:** Automatic classification of breast tissue types is feasible using a machine learning algorithm trained with semi-quantitative PET/MRI data. Standardized detection of malignant breast lesion may be clinically relevant in planning of breast-conserving surgery.

SS106

#### Artificial Intelligence and Machine Learning in Radiology -A Legal Framework with a Focus on Medical Aspects

<u>K. N. Vokinger</u>', U. J. Mühlematter<sup>2</sup>, A. S. Becker<sup>2</sup>, A. Boss<sup>2</sup>, M. Reutter<sup>2</sup>, T. Szucs<sup>3</sup>; <sup>1</sup>Boston/Zurich/CH, <sup>2</sup>Zurich/CH, <sup>3</sup>Basel/CH

**Purpose:** Artificial Intelligence (AI) and machine learning (ML) play an increasing role in radiology. However, the medical and legal implications are not yet well established. The goal is to answer the following questions: What are current and future a) possibilities that ML offers in radiology, b) legal prerequisites that such intelligent medical software (IMS) needs to fulfill in order to be approved for clinical practice, and c) who is liable for patient damage caused by using IMS (manufacturer, admission office or physician)? **Methods and Materials**: This interdisciplinary study was a cooperation between lawyers and radiologists. After evaluating the potential of AI and ML in radiology, we analyzed the current law and developed proposals for the future law based on their potential in clinical practice.

**Results:** IMS is considered as medical device. By contrast to drugs, they are not strictly regulated because traditional medical devices do not bear great risks (e.g., bandages). However, IMS has severe risks for the patient. The legislator plans to increase the prerequisites that need to be met for IMS to be placed on the market (e.g., stricter prerequisites will apply to clinical trials). Furthermore, regarding liability the physician carries a lot of responsibility under the current law.

**Conclusion:** While AI and ML play an evolving role in radiology, the current law is inadequate, especially regarding the approval of IMS and liability. Among other things, we suggest a revision of the current law in order to increase the responsibility of the software manufacturer and to disburden the radiologist regarding liability.

# An artificial intelligence approach to improve workflow efficiency in chest radiography

<u>I. Hofmeister</u>, S. Burgermeister, S. P. Martin, T. de Perrot, C. D. Becker, X. Montet; Geneva/CH

**Purpose**: Chest radiography is a central tool in current medical practice, both for radiologists and other physicians, readily available for diagnosing or following a wide range of diseases. With the increase in diagnostic procedure, the workload in radiology increases every year, requiring substantial expert human resources for images interpretation. Here, we leverage recent advances in artificial intelligence (AI) to help radiologist rapidly and accurately interpret chest radiographies.

**Methods and Materials:** We developed a deep learning algorithm that can automatically detect 14 widespread diseases on chest radiography. Our algorithm, a deep convolutional neural network (CNN), was trained on a large dataset of 112'120 frontal-view chest radiographies. Then, we assessed the ability of our algorithm to reduce time and error rate in radiologic interpretation of an external dataset of 300 chest radiographies.

**Results**: Our CNN algorithm alone achieved a performance at similar level as senior radiologist on multi-disease classification (i.e. detecting one or more of the 14 diseases of interest). When used as help for human interpretation, we found that chest radiography reviewing by radiologist assisted by our AI algorithm is both faster (p<0.05) and more accurate (p<0.05) than the same interpretation by radiologist alone.

**Conclusion:** Our results suggest that deep learning algorithms can help radiologists in their daily practice, by reducing time and improving quality of chest radiography interpretation.

#### SS108

### Annotation to Improve Staging Accuracy: An NSCLC Case Study

K. Mader<sup>1</sup>, A. Sauter<sup>2</sup>, G. Sommer<sup>2</sup>, <u>T. J. Weikert<sup>2</sup></u>, J. Cyriac<sup>2</sup>, B. Stieltjes<sup>2</sup>; <sup>1</sup>Zurich/CH, <sup>2</sup>Basel/CH

**Purpose**: For staging NSCLC patients, radiologists and nuclear medicine physicians, create free-style text reports that do not necessarily contain all staging-relevant information. This may lead to misstaging and subsequently erroneous treatment planning. Therefore, we extracted the TNM staging formula from previous free-style PET/CT reports (RIS Stage) and compared these with an ROI annotation approach.

**Methods and Materials**: Patients were selected by screening the reports (RIS) from 383 patients who underwent FDG-PET/CT for primary staging of NSCLC at the University Hospital Basel. From these reports, TNM (7th edition) stage was determined by an experienced radiology and nuclear medicine physician. For each patient the full PET-CT image dataset was downloaded from the PACS and transferred to an in-house annotation software that supports manual segmentation of lesions using a set of labels including location information and morphological TNM features.

**Results:** In a substantial number of patients, not enough information was provided by the report to extract a distinct TNM stage: T: 25.0% (96/383); N: 4.7% (18/383). TNM information could be extracted in all patients with the segmentation-based approach. This led to upstaging and downstaging in 51 and 24 cases respectively.

**Conclusion:** We found that for roughly 30% of cases a proper full TNM stage could not be derived from an expert interpretation of unstructured PET/CT reports. This commonly affects the T-stage because of missing diameter measurements. Our approach with annotations allows for a clear definition of cancerous lesions in a standardized and reproducible manner and saves time going back to images in order to evaluate a patient.

# SS109

### Computed Tomography Angiography for Suspected Pulmonary Embolism in Pregnancy: Diagnostic Yield and Alternate Diagnoses

<u>D. C. Rotzinger</u>, V. Dunet, V. Ilic, O. Hugli, R. A. Meuli, S. Schmidt; Lausanne/CH

**Purpose:** The diagnosis of pulmonary embolism (PE) in childbearing women is often suspected and remains challenging as pregnancy may induce physiologic changes that mimic PE symptoms. Our aim was to assess the prevalence of PE and alternate diagnoses in a large, consecutive group of pregnant women requiring computed tomography pulmonary angiography (CTPA) for clinically suspected PE.

**Methods and Materials:** We retrospectively enrolled all pregnant women referred to CTPA for suspected PE over a 17-year period, from January 2000 to September 2017. One radiologist retrieved demographic data and D-dimer levels from medical records. Two radiologists reviewed all CTPA examinations in consensus, in order to assess the technical quality of acquisition, the presence and anatomic location of PE, signs of pneumonia, pulmonary infiltrates, basal atelectasis and pleural effusion.

**Results:** A total of 210 (mean age 32±6 years) pregnant women with a mean gestational age of 28±7 weeks were included. Seven examinations (3.3%) were inconclusive due to inadequate image quality. Of the 203 analyzed patients, 13 (6.4%) had PE. Of those with no PE detected (n=190), alternate diagnoses were found in 63 (33.2%) patients, of which 14 had pneumonia, 33 had pulmonary infiltrates, 39 had basal atelectasis and 27 had pleural effusion. D-dimer levels were not significantly different between PE-positive (median 1225, IQR=1095) and negative (median 683, IQR=351) groups (p=0.188).

**Conclusion:** In pregnant patients with suspected PE, CTPA yields a low rate of positive studies, indicating that it mainly allows for excluding PE. However, CTPA demonstrates alternate diagnoses in one third of patients without PE.

#### SS110

#### Online platform for fast and accurate calculation of fetus dose in CT

N. N. Saltybaeva, H. Alkadhi; Zurich/CH

**Purpose:** CT examination of pregnant patients is always a challenging task because of the concern about the radiation risk to the fetus (embryo). The methods estimating radiation dose to the fetus are either limited in their accuracy or require complex measurements and calculations. The purpose of our study was to create an online platform for fast and accurate fetal dose assessment.

**Methods and Materials:** The online tool for fetal dose assessment was based on precalculated data from Monte Carlo simulations (MCS). These simulations were performed on standard phantoms, representing 3-, 6- and 9-month of pregnancy, using generic x-ray spectrum, filtration and scanner geometry.

In order to validate the tool we compared the dose values calculated by the algorithm on standard phantoms against those calculated for the real patients. For this purpose MCS were also performed on 11 pregnant patients (gestational ages 7- 35 weeks) previously underwent clinically indicated abdominal CT, using individual kVp, mAs curves, collimation and scanner geometry.

**Results:** The algorithm proposed in the study allows estimating dose to the fetus with an accuracy of 32% (STD~17%). The study has shown strong correlation (p<0.05) between the accuracy of calculated dose and patient's size. The algorithm tends to overestimate fetus dose by up to 41% in overweight patients, however this effect can be corrected (23±11% of accuracy) if patient effective diameter is used as an input parameter.

**Conclusion:** The proposed algorithm allows for fast and sufficiently accurate assessment of radiation dose to the fetus in CT. The prototype is available online.

# Update of the Diagnostic Reference Levels for CT in Switzerland with Dose Management Software

C. Aberle<sup>1</sup>, <u>T. V. M. Lima<sup>2</sup></u>, R. Treier<sup>3</sup>, S. T. Schindera<sup>2</sup>; <sup>1</sup>Basel/CH, <sup>2</sup>Aarau/CH, <sup>3</sup>Liebefeld/CH

**Purpose:** The existing Swiss national diagnostic reference levels (DRLs) for CT were updated by acquiring big data on CT radiation doses with dose management software.

**Methods and Materials:** The CT dose data from 11 radiological institutions in Switzerland with a total of 35 scanners were collected with dose management software solutions between 2014 and 2017. The collected dose data of 123'432 CT examinations were analyzed and the 75th percentiles of median CTDI<sub>vol</sub> and DLP values per scanner were calculated. The data were subdivided in 15 different CT protocols and results were compared to the existing national DRLs published in 2010.

**Results:** The updated DRLs of all protocols were lower compared to the existing DRLs. The CTDI<sub>vol</sub> decreased between 18 and 53% and the DLP between 13 and 48%. The largest decrease in CTDI<sub>vol</sub> was seen in CT of the neck (14 vs 30 mGy; -53%) and the smallest in CT of the head (53 vs 65 mGy; -18%). In the chest, the CTDI<sub>vol</sub> decreased by 30% for the standard protocol (7 vs 10 mGy) and by 47% for the protocol to rule out pulmonary embolism (8 vs 15 mGy). The standard protocol of the abdomen presented a 27% decrease in CTDI<sub>vol</sub> (11 vs 15 mGy) and 18% decrease in DLP (530 vs 650 mGycm).

**Conclusion:** The updated national DRLs for CT are substantially lower compared to the existing DRLs demonstrating the efforts of the radiological community to lower CT radiation exposure in order to increase patient safety.

### MR-compatible Ultrasound and Predictive Slice Tracking -Moving Towards Ultrasound-driven Cardiovascular MRI

L. A. Crowe<sup>1</sup>, F. Santini<sup>2</sup>, L. Gui<sup>1</sup>, P. Guillemin<sup>1</sup>, O. Lorton<sup>1</sup>, P. Bernou<sup>3</sup>, M. Roth<sup>1</sup>, G. Manasseh<sup>1</sup>, P. O. Bieri<sup>2</sup>, J.-P. Vallee<sup>1</sup>, R. Salomir<sup>1</sup>; <sup>1</sup>Geneva/CH, <sup>2</sup>Basel/CH, <sup>3</sup>Strasbourg/FR

**Purpose:** MRI depicts cardiac valve function, but out-of-plane motion limits utility of 2D acquisitions. Ultrasound is a well-accepted clinical tool for surgical planning, but quality is patient dependent. We suggest hybrid imaging using in-bore ultrasound for direct motion tracking and on-the-fly adaptation of MR slice position to improve MRI for valve morphology.

**Methods and Materials:** US images from a clinical Siemens ACUSON-Antares, with modified, MR-compatible, linear-array probe, were sent to an external PC. The extracted average motion vector (optical-flow-based tracking of user-defined ROIs, OpenCV2.3.1) was communicated to the MR on-the-fly. A non-parametric algorithm predicted the future position (+60ms). A cardiac-triggered segmented balanced-SSFP sequence was modified to adapt slice positioning according to the tracking information. Real-time balanced-SSFP determined the optimum algorithm for high-resolution 'cine' (>1min).

Quantification of cine image improvement required a gold-standard static image. A gel-filled bottle, attached to an Innomotion robot simulating respiratory motion (amplitude 20mm), was imaged in a Siemens 3T PRISMA scanner.

**Results:** There were no confounding US-based artifacts on MRI nor on US during MRI. Phantom residual motion for real-time acquisition had a standard deviation of 8.86mm uncorrected, 0.68mm on-the-fly, 0.53mm predictive. Cine image quality was significantly improved with predictive correction and edge sharpness increased, becoming almost identical to the static gold-standard.

**Conclusion:** This multimodal method has the potential to correct all movements combined (respiration, contraction, valves) as anatomy of interest would be directly observed by ultrasonography inside the MR magnet bore. Dynamic MRI motion correction was quantified with a moving phantom. The future-predicting algorithms yielded dramatically improved "cine" images.

#### SS113

#### Texture Analysis and Machine Learning for Detecting Myocardial Infarction in Non-Contrast Low Dose CT: Unveiling the Invisible

<u>M. Mannil</u>, J. von Spiczak, R. Manka, H. Alkadhi; Zurich/CH

**Purpose:** To test whether texture analysis (TA) and machine learning enable the detection of myocardial infarction (MI) on non-contrast enhanced low radiation dose cardiac computed tomography (CCT) images.

**Methods and Materials:** We included non-contrast enhanced electrocardiography-gated low radiation dose CCT image data (effective dose 0.5mSv) acquired for the purpose of calcium scoring of 27 patients with acute MI (9 female, mean age 60±12 years), 30 patients with chronic MI (8 female, mean age 68±13 years), and in 30 subjects (9 female, mean age 44±6 years) without cardiac abnormality. TA of the left ventricle was performed using freehand regions-of-interest and texture features were classified twice. Model I: controls vs. acute MI vs. chronic MI; Model II: controls vs. acute/chronic MI. For both classifications, commonly used machine learning classifiers were used: decision tree C4.5, k-nearest-neighbors (k-NN), locally-weighted-learning (LWL), RandomForest, sequential-minimal-optimization (SMO), and an artificial neural network employing deep learning. Additionally, two blinded, independent readers visually assessed non-contrast CCT images for the presence of MI.

**Results:** In model I, best classification results were obtained using the k-NN classifier (sensitivity 69%, specificity 85%). In model II, best classification results were found with the LWL classification (sensitivity 86%, specificity 81%) with an area-under-the-curve from receiver operating characteristics analysis of 0.78. In comparison, both readers were not able to identify MI in any of the non-contrast, low radiation dose CCT images.

**Conclusion:** This study indicates the ability of TA and machine learning for detecting MI on non-contrast low radiation dose CCT images being not visible for the radiologists' eye.

SS114

### Deep Learning for Automated Medical Image Quality Assessment: Application to Whole-Heart Magnetic Resonance Imaging

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**Purpose:** We aim at developing a fully automated algorithm, which quantitatively gauges the quality of medical images by using deep learning to mimic human perception.

**Methods and Materials:** A clinical database of N=424 whole-heart MRI scans was graded by two expert readers on a quality scale from 0 (non-diagnostic) to 4 (excellent diagnostic value). An automated image quality assessment algorithm based on a deep convolutional neural regression network (DCNN) was designed, optimized, trained ( $N_{tr}$ =324), validated and tested ( $N_{te}$ =100) on such database. Two-dimensional patches extracted from the 3D volumes were given as input to the network, which outputs one quality grade per each patch. The average of all patch grades within each volume was taken as final grade. Regression accuracy on  $N_{te}$  is reported and compared with the intra- and inter-observer agreement using Bland-Altman analysis. Furthermore, the algorithm was used to assess the evolution of image quality during iterative compressed sensing reconstruction.

**Results:** The DCNN yielded a regression performance versus the human graders in the range of the intra- and inter-observer agreement with  $r^2 = 0.78$  and kappa = 0.67. Bland-Altman analyses of the DCNN vs expert readers showed an almost un-existing bias (<0.01) and a standard deviation of about half a grade. Image quality evolution as assessed by the DCNN during compressed sensing reconstruction highly correlated with the objective cost function.

**Conclusion:** These results suggest that deep learning may play an important role in automated image quality analysis and reconstruction for 3D cardiac MRI, and can possibly be extended to other applications.

SS115

#### Associations between MRI derived global right ventricle diastolic strains and mPAP in CTEPH patients

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**Purpose:** To investigate the modification of the right ventricle diastolic function in patients with Chronic Thromboembolic Pulmonary Hypertension (CTEPH) using the feature tracking MRI technique.

**Methods and Materials:** Thirteen patients with suspected CTEPH were assessed by right heart catheterization (RHC) and cardiac MRI, including standard cine acquisitions during breath-hold. 4-chamber, right and left 2-chamber and short-axis views were used restrospectively for feature tracking analysis (CVI42, Circle Cardiovascular Imaging Inc., Galgary, Canada) after approval of the ethical committee. Global right ventricular (RV) longitudinal, circumferential and radial strain and strain rates were correlated with the pulmonary artery mean pression (mPAP) measured during the RHC. In addition, systolic, E and A decelerations (corresponding respectively to the early diastolic filling and to the atrial contraction) were measured from the descending slopes of the global longitudinal strain rates (in %.ms<sup>-2</sup>).

**Results:** CTEPH was confirmed in 11 / 13 patients. The mPAP was 30.3 ± 15.2 mmHg (11-66 mmHg). Feature tracking was successful in all the patients, but in 2 patients (further excluded from the analysis) it was not possible to separate the E and A waves. Peak diastolic circumferential strain rate (R2=0.58, p = 0.01) and the E deceleration (R2=0.48, p=0.03), but not systolic strain indices, were significantly correlated with mPAP.

**Conclusion:** The correlation between the RV diastolic function and the mPAP in CTEPH patients could reflect subclinical compensatory hypertrophy of the RV wall following chronic pressure overload. This study suggests a strong potential of feature tracking cardiovascular MRI to diagnose and monitor patients with pulmonary hypertension.

# SS116

# Motion-Resolved 5D MR Imaging of the Heart: A Simple Correction for Radial Trajectory Imperfections

#### L. Di Sopra, M. Stuber, J. Heerfordt, D. Piccini, J. Yerly; Lausanne/CH

**Purpose:** To develop a simple and flexible post-processing technique to correct for trajectory imperfections in 5D cardiac MRI without requiring any pre-scan calibration or pulse sequence modification.

Methods and Materials: Three-dimensional radial trajectories are particularly well-suited for motion-resolved multidimensional cardiac MRI, but are also sensitive to trajectory imperfections, usually caused by eddy currents and gradient timing delays, which can induce significant artifacts in the reconstructed images. The deviation of a generic k-space radial readout from its theoretical path can be modeled as a direction-dependent parallel shift. The algorithm considers the shape of k-space readouts (strongest signal carried by DC-component) and angular uniformity (readouts with similar directions show comparable k-space shifts) to individually correct each readout. The suggested correction was first tested in vitro, where a spherical phantom was acquired on a 1.5T clinical MRI scanner. Three indicators were analyzed: background noise, signal phase homogeneity and interface sharpness were compared before and after correction. Cardiac images of N=10 volunteers were continuously acquired without cardiac- or respiratory-gating (free-running). Physiological signals for binning were extracted from the k-space data, and fully self-gated 5D respiratory- and cardiac-motion-resolved reconstruction was performed. Before and after-correction images were visually compared based on streaking artifact and interface definition.

**Results:** *In vitro*: After correction, all indicators significantly improved (p<0.0001): background noise -24%, phase homogeneity +154%, interface sharpness +19%. In vivo: streaking artifacts were visibly reduced and myo-cardium-lung interface definition improved.

**Conclusion:** The proposed correction has shown to reduce trajectory imperfection artifacts in vitro and promising image quality enhancement was obtained preliminarily in 5D cardiac imaging.

# SS117

# A T2 preparation module for simultaneous robust fat suppression and tissue contrast enhancement for cardiac MRI at 3T

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**Purpose:** To develop an adiabatic T2 preparation (T2-prep) module for simultaneous enhancement of blood-muscle contrast and robust fat saturation for cardiac magnetic resonance imaging (MRI).

**Methods and Materials**: This prospective study was conducted from October to December 2017. It had institutional ethics approval and written informed consent was obtained from all subjects. A novel adiabatic T<sub>2</sub>-prep with fat saturation capabilities (FSA-T<sub>2</sub>-prep) was tested against a conventional adiabatic T<sub>2</sub>-prep (CA-T2-prep). ECG-triggered 2D breath-held cardiac MRI was performed on healthy volunteers (N=5, age=27.84y, range 26-35y) on a 3T MR scanner (Prisma, Siemens) using an 18 (6x3) channel chest coil. Sequence parameters: 1.1x1.1mm2 resolution, 14 k-space lines acquired per T<sub>2</sub>-prep (duration of 40 ms), RF excitation angle 15°, TE 3.71ms, TR 8.07ms, bandwidth 200Hz/px, slice thickness 5mm.

The signal-to-noise ratio (SNR) was computed in signal compartments containing blood, myocardium, chest fat, and epicardial fat. Additionally, blood-myocardium contrast-to-noise ratio (CNR) was computed. Differences were tested via a Student's t-test for paired data, with a p-value < 0.05 considered as significant.

**Results:** Compared to the CA-T<sub>2</sub>-prep, the FSA-T<sub>2</sub>-prep reduced chest and epicardial fat SNR by 89.3% (p=0.0005) and 65.9% (p=0.0007) respectively. No significant difference of blood SNR (p=0.18), myocardium SNR (p=0.78) and blood-myocardium CNR (p=0.24) was observed when using FSA-T<sub>2</sub>-prep compared to the CA-T<sub>2</sub>-prep. The reduction of fat signal enhanced the visualization of the right coronary artery.

**Conclusion:** A novel adiabatic  $T_2$  preparation module was developed that enabled efficient  $T_2$  preparation while simultaneously providing robust fat suppression.

#### SKRATCH: An Accelerated and High Spatial-Resolution T2 Mapping Technique for the Quantification of Edema at 3T

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**Purpose:** To develop and characterize a novel cardiac T2 mapping MRI technique for the visualization and quantification of myocardial edema, which allows for higher spatial resolution and shorter acquisition time while maintaining high precision.

**Methods and Materials:** The developed technique was named SKRATCH (Shared k-space RAdial T2 Characterization of the Heart), and consisted of a radial golden-angle GRE acquisition with spatial resolution 1.2×1.2mm<sup>2</sup>. After calibration in phantoms, the sequence was acquired in 19 healthy volunteers (age 28±4years, weight 69±12kg, eight women) and was compared to a reference acquisition. The sequence was also acquired on three patients after reperfusion of a myocardial infarction (age 64±7years, weight 70±7kg, one woman). The mean T2 value of each segment of the myocardium was calculated and tested for significant differences. Variability studies were performed, and the myocardial areas of the segmented T2 maps were calculated.

**Results:** The SKRATCH acquisitions were successfully performed in all healthy volunteers and patients. In the healthy volunteer study, the average T2 values were similar to those of the reference (T2=39.9±3.4ms vs. 39.5±3.4ms, P>0.20) and SKRATCH T2 maps presented low variability (95% confidence interval ≤±1.4ms). In the patient study, the higher spatial resolution of the SKRATCH T2 maps resulted in more than twice the number of pixels inside the segmented myocardium compared to the reference (averaged 1021±114pixels and 471±44pixels, respectively), enabling a more detailed visualization of the infarct area.

**Conclusion:** A high-spatial-resolution T2 mapping technique was successfully tested and validated in healthy volunteers and showed promising preliminary results in patients.

#### SS119

#### Navigator-Gated Cartesian Versus Self-Navigated Radial Free-Breathing 3D bSSFP Coronary MRA: A Quantitative Comparison in Healthy Volunteers

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**Purpose:** To fill a gap in the literature by comparing standard Cartesian Navigator-Gated (CNG) and more recent Radial Self-Navigated (RSN) coronary magnetic resonance angiography using quantitative vessel metrics.

**Methods and Materials:** Protocols were adopted from large-scale patient studies (CNG: Sakuma, Radiology 2005, 237(1):316-321, RSN: Monney, JCMR 2015, 17:55). Healthy volunteers (N=14, age=27.6±4.7 years, age range=21-40 years, 12 male) were examined during July-November 2017 on a 1.5T clinical scanner (MAGNETOM Aera, Siemens Healthcare) after informed consent and institutional review board approval. Acquisition times were recorded and quantitative measurements of visible vessel length and sharpness of the Right Coronary Artery (RCA) and Left Main (LM) + Left Anterior Descending (LAD) coronary arteries obtained (Etienne, MRM 2002, 48(4):658-666). Two-sided paired t-tests with p<0.05 considered statistically significant were used for comparisons.

**Results:** Image acquisition completed without intervention in 13/14 subjects. In one CNG scan, respiratory drift occurred and the subject was asked to move slightly to allow the acquisition to finish. The RSN acquisition time was on average 5:39±0:27 minutes being significantly faster (p=1.35e-6) than CNG, which lasted 17:26±5:18 minutes. However, CNG provided significantly sharper full LM+LAD (CNG:48.8±7.1%;RSN:38.2±8.6%;p=2.8e-3), proximal RCA (CNG:50.6±6.6%;RSN:43.5±7.7%;p=0.026) and full RCA (CNG:48.1±5.9%;RSN: 39.3±8.4%;p=0.019). No significant differences were found in visible vessel length and proximal LM+LAD sharpness.

**Conclusion:** CNG provides sharper coronaries but is associated with long and unpredictable acquisition times while RSN allows clinically feasible scan times at the expense of vessel sharpness. For examination of stenoses or congenital heart disease, the robustness and simplicity of RSN has to be weighed against the superior vessel conspicuity of CNG.

# SS120

#### A multimodality quantification of the influence of cardiac allograft vasculopathy on the coronary arteries and the myocardium

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**Purpose:** To investigate whether X-ray coronary angiography (XRCA) based cardiac allograft vasculopathy (CAV) is linked with the coronary intima thickness as assessed by optical coherence tomography (OCT), the myocardial T1 relaxation time and extracellular volume (ECV) as determined by magnetic resonance imaging (MRI), or interstitial fibrosis in the endomyocardial biopsy (EMB).

**Methods and Materials:** Heart transplant recipients  $\geq 6$  months after operation (n=26, age=54±13, 8 women) underwent MRI and OCT in addition to protocol XRCA and EMB. The intima-media thickness ratio (IMTR) was calculated on the OCT images. On the MR maps, the T<sub>1</sub> and ECV of the myocardium were computed.

A Student's t-test was used to establish whether the presence of CAV on XRCA is linked to differences in IMTR, fibrosis, T1 value, or ECV. A Pearson correlation was calculated to ascertain whether there is a link between the IMTR or fibrosis on the one hand, and the T<sub>1</sub> or ECV values on the other hand. **Results:** CAV was detected by XRCA in 4/26 patients. IMTR and fibrosis did not significantly differ between the groups with and without CAV (P>0.11). Both T1 and ECV were significantly higher in CAV patients (P<0.03). Interstitial fibrosis correlated with the ECV (P=0.02) and showed a trend with the T1 relaxation time (P=0.06). IMTR correlated neither with the T1 relaxation time nor ECV (P>0.8).

**Conclusion:** This pilot study shows that T1 values and ECV increase in patients with CAV, suggesting that MRI-based non-invasive detection of CAV has the potential to play a diagnostic role for the detection of CAV.

SS121

### Photon Counting CT with Dedicated Sharp Convolution Kernels: Tapping the Potential of a New Technology for Stent Imaging

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**Purpose:** To assess the value of sharp convolution kernels for photon-counting-detector (PCD) CT for coronary stent imaging and to evaluate to which extent iterative reconstructions (IR) can compensate for noise increase.

**Methods and Materials:** A phantom simulating coronary artery stenting was prepared including 18 coronary stents expanded in plastic tubes (3mm diameter). Tubes were filled with diluted contrast agent, sealed, and immersed in oil (calibrated to -100HU). The phantom was scanned in a 128-slice research dual-source CT scanner equipped with a PCD detector. Images were reconstructed using a conventional stent imaging kernel with filtered back projection (B46) and IR at SAFIRE-level 3 (1463). For comparison, a sharp kernel with filtered back projection (D70) and IR at SAFIRE-level 3 and 5 (Q70<sub>3</sub>/Q70<sub>5</sub>) was used. Two readers evaluated image quality (scale 0–3), in-stent diameter, in-stent attenuation, mathematical image sharpness, and noise. Interreader reliability was calculated using intraclass correlation coefficients (ICC). Imaging parameter differences were evaluated using a Wilcoxon signed-rank test and paired sample t-tests.

**Results:** Interreader reliability was excellent (ICCs>0.952). Sharp kernel reconstructions yielded significantly better results regarding image quality, in-stent diameter, and image sharpness (all p<0.001). No significant difference was found for in-stent attenuation (p=0.627). Noise was significantly higher in all sharp convolution kernel images, but could be reduced by 41% and 59% applying SAFIRE-levels 3 and 5, respectively (p<0.001).

**Conclusion:** A dedicated sharp convolution kernel for PCD-CT imaging of coronary stents yields superior imaging characteristics compared to conventional reconstruction kernels. Resulting higher noise levels can be reduced by iterative reconstruction.

### In vivo mouse MRI with Nanomicelles – A new blood pool contrast agent

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**Purpose:** In cardiovascular MRI, extra-vascular contrast agents currently used (e.g. Gd-DOTA) require apnea to avoid respiratory artifacts. In children, this means intubation or propofol apnea, which is not well tolerated or leads to a shortened protocol. Blood pool agents would allow angiography acquisition during free breathing with light anesthesia and would also be highly advantageous in 3D cine MRI applications to provide blood/myocardial contrast over longer acquisition times with relatively low dose.

**Methods and Materials:** DOTA-bearing amphiphilic building blocks were synthesized by binding lipophilic chains and a polyethylene moiety on a center tyrosine amino acid. Nanomicelles were formed by nanoprecipitation and fully characterized. Mice were injected intravenously with either Gd-DOTA (n=4) or nanomicelles (n=4). MRI used a cryogen-free Mediso nanoscan small animal 3T. 3D T1-weighted images were acquired every 30 min for 3 hours, in addition to a 3D cine acquisition.

**Results:** Micelles (mean size 10±3 nm) remained stable and did not alter cell viability. A phantom showed micelles gave 20% higher signal than Gd-DOTA due to a higher relaxivity (27mM<sup>-1</sup>s<sup>-1</sup>@20MHz).

In mice Gd-DOTA was rapidly eliminated via kidneys, whereas micelles remained in the blood pool over 3 hours, significantly enhancing blood in vessels on T1 (five-fold) and blood/myocardium contrast on cine MRI. Quantification of normalized signal intensity showed the different uptake and elimination pathways and timecourse.

**Conclusion:** Our new contrast agent has a longer blood persistence due to size, but without protein interaction. Higher relaxivity is due to increased concentration of gadolinium per micelle. Micelles also open the potential for functionalization for theranostics.

# SS123

# The sagittal-oblique Y-view shoulder CT image underestimates the overall fatty infiltration of the supraspinatus muscle

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**Purpose:** Knowing the condition of rotator cuff muscles is critical in various shoulder disorders. We developed and compared 2D and 3D semiautomated quantitative CT methods to assess whether supraspinatus muscle degeneration measured on the classic sagittal-oblique ("Y view") CT image accurately predicts the condition of the entire muscle.

**Methods and Materials:** We selected 30 patients who underwent standardized nonarthrographic CT scans prior to shoulder arthroplasty. Datasets were reconstructed semiautomatedly to generate the sagittal-oblique Y-view CT image. Two radiologists independently delineated the presumed contours of the healthy supraspinatus muscle on consecutive 1-mm-thick CT sections, from the myotendinous junction laterally to the medial border of the scapula. Muscle degeneration ratios, consisting of atrophy, fatty infiltration, and secondary bone formation, were then automatically calculated, and compared between the Y-view, 3 (1cm medially and laterally), 10 (at 1cm intervals), and all (>100) CT images covering the supraspinatus muscle. Interobserver reliability was assessed.

**Results:** Atrophy (0.48±0.20) was the main determinant of supraspinatus muscle degeneration (0.64±0.18) on the Y-view CT image. Fatty infiltration was significantly higher when measured on ≥10 CT images than on the Y-view (p≤0.005). In contrast, there were no significant differences between 1, 3, 10, and all CT images for atrophy, secondary bone formation, and degeneration (p≥0.383). Interobserver reliability was excellent for all parameters (p≥0.912).

**Conclusion:** The classic sagittal-oblique Y-view shoulder CT image underestimates the overall fatty infiltration of the supraspinatus muscle, and at least 10 images at 1cm intervals are required to accurately assess this parameter. A fully automatized 3D quantitative CT method would help address this issue.

### SS124

#### A statistical shape model to predict the premorbid glenoid cavity

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**Purpose:** We propose a method for inferring the premorbid glenoid cavity shape and orientation to inform restorative surgery.

**Methods and Materials:** We developed a statistical shape model (SSM) from 64 healthy scapulae. The premorbid glenoid shape was predicted from the surrounding normal scapular body using a SSM-based reconstruction method. First, we validated the method on 64 healthy scapulae by quantifying the accuracy of the predicted scapular surface in terms of surface distance, as well as glenoid version and inclination. After validation, the SSM-based reconstruction was applied to 30 scapulae with OA glenoids. Glenoid version and inclination were measured fully automatedly and compared between the original OA glenoids, reconstructed predicted glenoid shapes, and healthy scapulae.

**Results:** The validation on healthy scapulae showed a root mean square surface distance between original and predicted glenoid cavities of 0.98mm±0.23mm. The prediction error was 2.11°±1.62° for glenoid version and 2.10°±1.81° for inclination. Differences between original and predicted glenoid measurements were not statistically significant (p≥0.42). When applied to OA datasets, SSM-based reconstructions restored the glenoid version and inclination to values similar to the healthy group. No differences were observed between the reconstructed OA glenoids and healthy scapulae (p≥0.44), while the reconstructed predicted glenoid shapes significantly differed from the original scapulae with OA glenoids (p≤0.03).

**Conclusion:** The proposed local SSM can accurately predict the premorbid glenoid cavity of healthy scapulae from anatomic features unaffected by degeneration. Therefore, this technique has the potential to reconstruct the premorbid glenoid cavity as it was prior to degenerative or traumatic disorders, and thus guide restorative surgery.

# Radiocarpal plicae: Prevalence, MR arthrographic features and association with radial-sided wrist pain

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**Purpose:** We aimed to assess the prevalence and MR arthrographic features of radiocarpal plicae, and evaluate their association with radial-sided wrist pain.

**Methods and Materials:** We retrospectively reviewed 616 consecutive wrist MR arthrographies performed over a 10-year period. After exclusion of patients with previous wrist surgery or insufficient image quality (artifacts, no 3D submillimetric isotropic images), two radiologists independently assessed 407 wrist MR arthrograms (244 men, mean age 37 years) for the presence of radiocarpal plicae and radioscaphoid cartilage lesions. The anatomic and signal intensity characteristics of plicae (origin, orientation, maximum length, thickness, cross-sectional area, and subjective thickening) were evaluated. The patients' medical records were reviewed for causes of radial-sided wrist pain and surgical correlations. Radiologic-anatomic correlation was further performed on 10 cadaveric wrists.

**Results:** The prevalence of radiocarpal plicae on wrist MR arthrography and cadavers was 32% (142/407) and 30% (3/10), respectively. Interobserver agreement was substantial (weighted kappa=0.79). Surgical confirmation was available for 4 patients. The mean length, thickness, and cross-sectional area of plicae were 5.3±1.3mm, 0.73±0.14mm, and 4.1±2.2mm<sup>2</sup>, respectively. Plicae most commonly originated from the dorsal aspect of the radiocarpal joint, and were proximally and volarly oriented. 9% (13/142) of plicae were observed in association with radioscaphoid cartilage lesions. The prevalence of plicae in patients with radial-sided wrist pain (27%, 47/173) vs. those with other symptoms (41%, 95/234) was statistically comparable (p=0.81).

**Conclusion:** Radiocarpal plicae are common anatomic variants found on wrist MR arthrography. They are rarely associated with radioscaphoid cartilage lesions and may be observed with or without association with radial-sided wrist pain.

SS126

#### 3D X-ray-tomography compared to conventional computed tomography in patients with wrist and ankle fractures

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**Purpose:** Accuracy of 3D-tomography using a twin robotic X-ray unit for extremity fractures is unclear. Thus, our purpose was to evaluate fracture detection, image quality and radiation dose in patients with wrist or ankle trauma using 3D-tomography and conventional CT.

**Methods and Materials:** IRB approval and written informed consent was given. 44 patients (27 male; 17 female; mean age, 53±20 years) with acute fractures of the wrist (28) and ankle (18) were prospectively enrolled from the emergency department and scanned using 3D-tomography (Multitom Rax, Siemens Healthineers) and conventional CT (Somatom AS+, Siemens Healthineers). Morphological fracture characteristics, visibility of bone and soft tissue structures, and image quality at both imaging modalities were assessed independently and randomly by two readers on a 5-point Likert scale. Dose-length-product (DLP) adapted to scan range was compared between both modalities. Descriptive statistics, Wilcoxon signed rank test (P<0.05) and interreader reliability were calculated.

**Results:** 86 of 92 fractures, visible on CT, were diagnosed with 3D-tomography. No false positive finding occurred at 3D-tomography. Interreader agreement for fracture characterization was substantial to almost perfect ( $\kappa$ =0.76-0.96). Visibility of bone and soft tissue structures, and image quality were inferior using 3D-tomography (P<0.001-0.046). DLP was significantly lower for 3D-tomography compared to CT (mean, 21±9 vs. 276±86 mGy\*cm); even the highest 3D-tomography DLP was <30% of the CT dose.

Limitations: Readers were technically not blinded to CT and 3D-tomography images. All included patients had fractures.

**Conclusion:** Fracture assessment of peripheral extremities is reliable utilizing a low dose 3D-tomography X-ray system, despite impaired image quality.

#### MRI characteristics of onychomatricoma

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**Purpose:** To describe MRI characteristics of onychomatricoma, a rare and begnin fibroepithelial nail tumor with these two different components a proximal core in the nail matrix and a distal component with filamentous expansions in the nail matrix and to determine the presence of subgroups in imaging.

**Methods and Materials:** 24 patients and 26 fingers or toes were analysed and compared with MRI. The morphologic characteristics were reported in two subgroups according to the location of the tumoral matrix (central or lateral) regarding to the nail matrix and tested statistically. Following data were reported in these two subroups with tumoral matrix size, filamentous expansions size, number of filamentous expansions and aspect of diameter filamentous expansions (similar size between extension or not).

**Results:** Patients with a central matrix tumor are more frequent (65%). The tumoral matrix size is more high for the patients with lateral matrix tumor (3.6mm versus 2.3mm in the central matrix subgroup;p= 0.011). The filamentous expansions size are shorter with the lateral matrix tumor (6.6mm versus 7.3mm in the central matrix subgroup;p=0.016), the number of extensions are more numerous for the lateral matrix lesion(9.7 of mean number versus 7.6 in the central matrix subgroup;p=0.025) and the aspect of extensions are more frequent with similar diameter extension(82% versus 33% for the central matrix subgroup;p=0.014).

**Conclusion:** This study allows improvement in the knowledge of MRI characteristic of onychomatricoma with two specific subgroups according to the location of the matrix tumor (central or lateral) and the possibility to have diagnosis by imaging, without surgery.

#### SS128

#### MRI evaluation of pincer-morphology in asymptomatic volunteers – Comparison to patients with pincer-type femoroacetabular impingement (FAI)

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**Purpose:** To assess pincer FAI MRI findings in asymptomatic volunteers with negative impingement test versus patients with clinically confirmed FAI.

**Methods and Materials:** We included 63 asymptomatic volunteers and 63 patients with FAI. The asymptomatic volunteers underwent unenhanced MR imaging of the hip. The patients underwent MR arthrography of the symptomatic hip with the same MR sequences. Analysis of all MR images was done independently by two fellowship-trained musculoskeletal radiologists. Acetabular version, acetabular depth and lateral center-edge angle were measured.

**Results:** The asymptomatic volunteers consisted of 31 female and 32 male individuals. The patient group consisted of 29 women and 34 men. 16% of patients with FAI had a pincer FAI. The acetabular version was 4.0°±7.2 for reader 1 and 2.1°±7.9 for reader 2 in pincer FAI patients, and 6.2°±6.4 for reader 1 and 3.2°±4.9 for reader 2 in asymptomatic volunteers. The acetabular depth was 3.7mm±2.4 for reader 1 and 4.2mm±2.5 for reader 2 in pincer FAI, and 5.2mm±2.6 for reader 1 and 5.7mm±2.2 for reader 2 in asymptomatic volunteers. The lateral center-edge angle was 33.8°±10.2 for reader 1 and 33.6°±7.5 for reader 2 in pincer FAI patients, and 31.0°±6.2 for reader 1 and 30.7°±5.7 for reader 2 in asymptomatic volunteers.

**Conclusion:** There is a large overlap in pincer-type MRI findings between patients with symptomatic pincer FAI and clinically proven asymptomatic volunteers.

#### SS127 Are acetabular labrum size and

Are acetabular labrum size and tear pattern associated with decreased or increased femoral torsion in patients with femoroacetabular impingement?

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**Purpose:** In patients with FAI decreased and increased femoral torsion (FT) contribute to an unknown degree to the bony conflict. Hence the role of de-/rotational osteotomies is to be defined. While labral lesions in dysplasia, cam and pincer FAI have well been descriped, the impact of FT on the labrum is unknown. Our aim was to compare labral size and tear pattern between hips with decreased and increased FT.

**Methods and Materials:** After IRB approval for this retrospective study, the institutional MR database (2011-2016;620 hips) was reviewed for direct MR arthrographies in hips with degecreased FT (<5° FT, 58 hips) and increased FT (>30° FT, 71 hips). Groups were comparable for age, acetabular version, LCE and alpha-angle. Additionally to standard-protocol, axial images of distal femoral condyles for measurement of FT and 2D-radial-PD-w-TSE-images without FS using the femoral neck axis as the center of rotation, were obtained. On each half o'clock position labral cross sectional area (CSA) was measured in mm<sup>2</sup> and labral tear pattern were graded corresponding to our classification. Unpaired t-tests was used to compare CSA, chi-square test to compare tear pattern between both groups.

**Results:** Labral CSA was significantly elevated (19/20 clock-face-positions) in the increased FT group. Prevalence of intrasubstance tears was significantly higher anteriorly in hips with increased FT.

**Conclusion:** Hypothrophic labrum without obvious tear may indicate an anterior FAI due to decreased FT. Labral hypertrophy and intrasubstance tear may reflect labral adaption to a mechanical overload due to an anterior subluxation consequent to a posterior ischio-femoral impingement in hips with increased FT.

#### SS130

#### MRI assessment of supra- and infratrochanteric femoral torsion: Association with femoroacetabular impingement and hip dysplasia

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**Purpose:** To evaluate a novel measurement technique for assessing the supra- and infratrochanteric component of femoral torsion, to establish reference values in healthy volunteers, and to compare supra- and infratrochanteric torsion in patients with hip dysplasia and femoroacetabular impingement (FAI) with healthy volunteers.

**Methods and Materials:** This retrospective study was approved by our local ethics committee. Femoral torsion was assessed in 380 patients and 61 healthy volunteers by MRI. For assessing supra- and infratrochanteric torsion three measurement techniques (Kim-, simplified Kim-, and Centroid-method) were evaluated by two readers on 100 patients. The technique with the highest inter-reader reliability was selected to perform measurements on all patients and volunteers. Patients' supra- and infratrochanteric torsions were stratified to hip disorders diagnosed by specialized hip surgeons, and compared to reference values of healthy volunteers. Statistical analysis included the independent t-test, Mann-Whitney-U-test and intraclass correlation coefficient (ICC).

**Results:** The Centroid-method showed the highest inter-reader reliability for measuring supra-/infratrochanteric torsion with an ICC of 0.979. The supra-/infratrochanteric torsion of the volunteers was  $31.5^{\circ}\pm7.4^{\circ}$  and  $-18.3^{\circ}\pm9.9^{\circ}$ , respectively. In comparison to volunteers, patients with hip dysplasia had significantly higher supra-/infratrochanteric torsion with  $37.5^{\circ}\pm10.3^{\circ}$  (p=0.001) and  $-9.6^{\circ}\pm11.7^{\circ}$  (p<0.001), respectively, and patients with pincer-type FAI had significantly higher supratrochanteric torsion of  $37.8^{\circ}\pm8.0^{\circ}$  (p=0.002).

**Conclusion:** The supra- and infratrochanteric component of femoral torsion differs substantially between hip disorders: Patients with hip dysplasia have predominantly increased infratrochanteric torsion, while patients with pincer-type FAI have increased supratrochanteric torsion. Separate quantification of supra- and infratrochanteric torsion allows a more detailed analysis of hip disorders and may influence treatment planning.

SS129

SGR-SSR ORALS

# SS131

#### 3D-printed models of the knee for evaluation of trochlear dysplasia in comparison to standard radiographs and computed tomography

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Purpose: To test the hypothesis that 3D-printed specimens improve diagnosis of trochlear dysplasia and Dejour's classification in comparison to radiographs and computed tomography (Rx/CT).

Methods and Materials: This retrospective study was approved by the local ethics committee. 50 patients were included. 3D-models of the distal femur were printed after segmentation of CT-datasets. An expert panel consisting of a senior musculoskeletal radiologist and a senior knee surgeon classified the knees into normal or Dejour grade A-D, which served as the standard of reference. Therefore, the experts reviewed radiographs, CT, the 3D-specimens and patients' clinical history. The 3D-specimens and Rx/CT were evaluated by two readers independently and separately at the interval of 3 weeks for trochlear dysplasia and Dejour A-D. Statistics included general descriptive statistics, ROC-analysis and inter-reader reliability.

Results: The expert panel diagnosed a trochlear dysplasia in 28/50 patients. In comparison to the panel's diagnoses, the diagnostic accuracy for the presence/absence of trochlear dysplasia after evaluation of 3D-specimens and Rx/CT was for reader1 0.937 and 0.823 (p=0.029) and for reader2 0.982 and 0.946 (p=0.147). Inter-reader reliability was excellent for 3D-specimens and substantial for Rx/CT (Kappa: 0.920 and 0.788). For Dejour-classification, the proportion of exact matches for 3D- and Rx/CT-analysis were for reader1 36% and 59% and for reader2 48% and 52%. Inter-reader reliability was poor for 3D-specimens and fair for Rx/CT (Kappa: 0.148 and 0.368).

Conclusion: 3D-models can improve detection of trochlear dysplasia in comparison to radiographs and CT, whereas no additional value for grading into Dejour A-D could be demonstrated.

#### SS132

#### MR imaging predictors of posterolateral corner instability in patients with acute anterior cruciate ligament tear: A decision tree analysis

L. Filli, A. B. Rosskopf, R. Sutter, C. W. Pfirrmann; Zurich/CH

Purpose: To determine the diagnostic performance of MR imaging for predicting posterolateral knee instability in patients with acute anterior cruciate ligament (ACL) tear.

Methods and Materials: After ethical approval, this retrospective study was performed on 162 patients (95 male, 67 female; age, 32.8±10.0 years) who had undergone ACL reconstruction with (N=19) or without (N=143) concomitant posterolateral corner reconstruction. MR images were evaluated by two independent radiologists. Diagnostic performance of MR imaging findings was calculated, with surgery as reference standard. Decision tree analysis was performed to determine the best MR imaging predictor of posterolateral instability.

Results: The lateral collateral ligament (LCL) was completely torn in 10/7 (posterolateral group/control group) patients, the posterior cruciate ligament (PCL) in 2/5 patients, the popliteal tendon in 3/0 patients and the biceps femoris tendon in 4/0 patients. High specificity but low sensitivity for posterolateral instability was found for complete tear of the LCL (specificity/ sensitivity 95.1%/52.6%), PCL (96.5%/10.5%), popliteus tendon (100%/15.8%) and biceps femoris tendon (100%/21.1%). The smaller structures of the posterolateral corner were not consistently visualized (popliteofibular ligament, 53%; fabellofibular ligament, 8%; popliteomeniscal fascicles, 59-71%). Decision tree analysis revealed that a complete tear of the LCL was the best predictor of posterolateral instability, followed by complete tear of the biceps femoris tendon. With this two-step decision tree, posterolateral instability was correctly predicted in 90.7% of cases.

**Conclusion:** Complete tear of the LCL at MR imaging was the best predictor of posterolateral instability.

### Fat-free isotropic 3D T2 mapping of knee cartilage with a novel, fast and robust water excitation technique

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Purpose: To develop and characterize an isotropic 3D lipid-insensitive MRI T2 mapping technique of the knee for improved cartilage delineation and precise and accurate measurement of T, relaxation times.

Methods and Materials: A recently developed isotropic 3D T,-prepared gradient-echo T, mapping technique (Iso3DGRE) for knee cartilage evaluation was combined with the novel binomial off-resonant RF excitation (LIBRE) pulse. Numerical simulations were performed to optimize the LIBRE pulse parameters. Phantom studies were carried out to verify the optimized parameters and to test the accuracy of the technique against reference standard spin-echo (SE) T<sub>2</sub> mapping. In vivo, T<sub>2</sub> maps with normal excitation and with the LIBRE pulse were acquired in knees of healthy volunteers (n=7) and T, values in different compartments were calculated. The precision was defined as the ratio of the standard deviation and the average T, value within a region of interest.

Results: The numerical simulations resulted in an optimal radiofrequency (RF) excitation angle of 35°, which was confirmed in phantom experiments. In the phantoms, a good agreement of the technique with the SE was found (slope 0.93±0.04, intercept 0.11±1.6ms, R2>0.99). Averaged over all volunteers and compartments, the LIBRE-Iso3DGRE T, values (36.5±5.2ms) were slightly higher than those determined with Iso3DGRE (34.1±7.2ms, P=0.003). LIBRE excitation resulted in more precise T<sub>2</sub> estimation than normal excitation (23.7±7.4% vs 30.6±9.9%, P<0.0001).

Conclusion: Homogeneous LIBRE fat signal suppression allowed for the removal of chemical shift artifacts and resulted in improved cartilage delineation and precise T<sub>2</sub> values.

# SS134

### Accuracy of Iodine Quantification in Abdominal Dual-Energy CT: Influence of Dual-Energy Platform, Iodine Concentration, Phantom Size, Radiation Dose, and Reconstruction Algorithm using Single-Source Fast kV-Switching and Dual-Source Dual-Energy MDCT

#### A. Euler, J. Solomon, M. Mazurowski, E. Samei, R. Nelson; Durham/US

**Purpose:** To assess the impact of dual-energy platform, iodine concentration, patient size, radiation dose, and reconstruction algorithm on the accuracy of the quantification of low iodine concentrations using single-source fast kV-switching (SS DECT) and dual-source (DS DECT) dual-energy CT.

**Methods and Materials:** Cylinders of a 3D-printed phantom (diameter 8-20 mm) were filled with eight iodinated solutions (concentrations 0.2-4.0 mg iodine per mL). Fat rings were added around the phantom to simulate medium and large patients. Each combination of concentration and size was repeatedly scanned in dual-energy mode on (1) an SS kVp-switching DECT (Discovery 750HD, GE) and (2) a DS DECT (Definition Flash, Siemens). Radiation doses were 7 and 10 mGy in the medium phantom and 10, 13, and 16 mGy in the large phantom. SS datasets were reconstructed with FBP and ASiR40% and DS datasets with FBP and SAFIRE-3. Measured iodine concentrations were compared to the known concentrations. A linear mixed effects model determined the influencing factors on quantification error within each dual-energy implementation.

**Results:** Error of iodine quantification increased with increasing iodine concentration and phantom size for both SS- and DS-DECT (all P<0.01). Iodine concentration was underestimated using SS (-0.35 mgI/mL) and overestimated using DS DECT (+0.3 mgI/mL). A subanalysis by dual-energy platform revealed that error decreased when increasing radiation dose or by applying iterative reconstruction only for DS DECT (both P<.001).

**Conclusion:** Accuracy of iodine quantification was significantly influenced by dual-energy platform, iodine concentration, and phantom size. The impact of radiation dose and reconstruction algorithm was limited to DS DECT.

#### SS135

#### Benefit of Reduced-Tube-Potential Imaging in Liver CT: Dependence on Lesion Contrast and Phase of Parenchymal Enhancement - A Phantom Study using Realistic Liver Tissue Surrogates

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**Purpose:** To evaluate the effect of reduced-tube-potential (kV) imaging on liver lesion-to-parenchyma contrast ( $C_{LP}$ ) and contrast-to-noise ratio ( $CNR_{LP}$ ).

**Methods and Materials:** A hollow phantom was filled with solutions of liquid tissue surrogate for liver (LTSL) and iodine that were validated to emulate attenuation characteristics of liver parenchyma at 80, 100, 120, and 140 kV. Liver was modeled during the late-arterial phase (LAP,+92 HU) and portal-venous phase (PVP,+112 HU) and 5- to 20-mm-diameter cylinders within the phantom were filled with additional LTSL-iodine solutions to represent hyperattenuating (+5 to +50 HU) and hypoattenuating (-5 to -50 HU) lesions. The phantom was surrounded with fat-equivalent rings to emulate medium and large patients. Each combination of  $C_{LP}$  phase of enhancement, and size was scanned at 80,100,120, and 140 kV at constant radiation dose.  $C_{LP}$  and CNR<sub>LP</sub> were assessed for each lesion. A linear mixed-effects model quantified the influence of kV and enhancement phase on  $C_{LP}$  and CNR<sub>LP</sub>.

**Results:** Tube potential had a significant impact on  $C_{LP}^{-}$  and  $CNR_{LP}^{-}$  (P<0.001); both parameters increased as kV was reduced. Compared to 140 kV,  $CNR_{LP}^{-}$  increased by 86%, 43%, and 14% for 80, 100, and 120 kV, respectively. The increase in  $C_{LP}^{-}$  and  $CNR_{LP}^{-}$  at reduced kV was dependent on  $C_{LP}^{-}$  at 140 kV and independent of the enhancement phase.

**Conclusion:** Phantom results indicate that the benefit of reduced-kV liver imaging depends on lesion-to-parenchyma contrast and is independent of enhancement phase. Low-contrast lesions, which are the most difficult to detect, benefit less than high-contrast lesions from reduced-kV liver imaging.

# Liver MR relaxometry – Basic rules for clinical application and reference values when analyzing T1 and T2\* maps

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**Purpose:** To determine reference values of native T1 mapping of the liver at 3T with respect of hepatic fat, fibrosis and iron content, as well as susceptibility-induced effects of adjacent lung parenchyma.

**Methods and Materials:** 143 patients with contrast enhanced abdominal CT scans, as well as 12 healthy volunteers underwent multiparametric MR imaging on a Siemens Verio 3T magnet including T1- and T2\*-mapping and proton density fat fraction (PDFF) quantification. Five groups were created: 1) main reference group without fibrosis (shear modulus <2.8kPa) and steatosis (PDFF<10%), 2) healthy volunteers, 3-5) positive controls with 3) elevated liver stiffness, 4) steatosis and 5) both. T1 values were compared between liver segments and groups, using Mann-Whitney-U test. Multivariate analysis was then performed.

**Results:** T1 and T2 relaxation times were shorter in lung-adjacent liver segments as compared with non-lung-adjacent segments (average 33ms, p<0.001 for T1). There were no significantly different values between the reference group and healthy volunteers, p=0.358. T2\*-time was a significant confounder for T1-time (p<1^15), while age and sex (p=0.722, 0.687) were not. Normal values in reference patients' non-lung-adjacent segments were: T1 = 780 ± 83 ms for non-corrected, and T1 = 782 ± 102 ms for T2\*-corrected T1. In positive controls, these values were significantly higher (p≤0.011 for uncorrected T1 and p≤0.001 for T2\*-corrected T1).

**Conclusion:** When analyzing T1 maps in the liver, non-lung-adjacent segments should be measured if possible due to susceptibility effects of adjacent lung. Liver iron content as indicated by T2\*-shortening is a major confounder of T1 time.

SS137

# Tumor Growth Rate (TGR) as an indicator of tumor activity in metastatic neuroendocrine tumors (NETs)

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**Purpose:** TGR has been proposed as a novel radiological biomarker with additional insights into tumor response in several tumor types. The aim of our study was to evaluate the value of TGR to predict progression and to assess treatment in patients with metastatic NETs.

**Methods and Materials:** Patients with metastatic intestinal or pancreatic NETs from the CLARINET study received lanreotide (LAN) or placebo (Pbo) every 28 days for 96 wks or until PD/death. TGR (% change in tumor volume/ month) was calculated from the RECIST sum prior to randomization (screening TGR), and then baseline to each visit or between consecutive visits.

**Results:** Median TGR during screening was 2.1 (IQR 0.2, 6.1) in the LAN group and 2.7 (IQR 0.2, 6.8) in the Pbo group. Median TGR at 12 wks' treatment was reduced to 0.2 (–2.1, 3.8) with LAN (p<0.0005) but was 3.0 (0.4, 7.2) with Pbo. This difference between groups was maintained throughout the treatment period. ROC analysis showed that screening TGR≤/>4 was the best cut-off value for predicting risk of progression, independently of treatment. Screening TGR> 4 exposed patients to a 4-fold higher risk of progression than TGR< 4 (HR 4.1; 95%CI 2.5, 6.5; p<0.001).

**Conclusion:** TGR seems to be a more precise marker of tumor progression/ stabilization than RECIST1.0, and thus has potential clinical utility in predicting risk of further progression, and in detecting early signs of antitumor activity with treatment.

### SS138

### Pre-treatment magnetic resonance-based texture features as potential imaging biomarkers for predicting event free survival in anal cancer treated by chemoradiotherapy

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**Purpose:** to assess regular MRI findings and tumour texture features on pre-CRT imaging as potential predictive factors of event-free survival (disease progression or death) after chemoradiotherapy (CRT) for anal squamous cell carcinoma (ASCC) without metastasis.

**Methods and Materials:** We retrospectively included 28 patients treated by CRT for pathological, proven ASCC with a pre-CRT MRI. Texture analysis was carried out with axial T2W images by delineating a 3D-region of interest around the entire tumour volume. First order analysis by quantification of the histogram was carried out. Second order statistical texture features were derived from the calculation of the Gray Level Co-occurrence Matrix using a distance of 1 (d1), 2(d2) and 5(d5) pixels. Prognostic factors were assessed by Cox regression and performance of the model by Harrell C-Index. **Results:** 8 tumour progressions led to 6 tumour specific deaths. After adjusting for age, gender and tumour grade, skewness (HR = 0.131, 95% CI = 0-0.447, P = 0.005) and cluster shade\_d1 (HR=0.601, 95%CI=0-0.861, P=0.027) were associated with event occurrence. The corresponding Harrell C-indices were: 0.846, 95%CI=0.697-0.993, and 0.851, 95%CI=0.708-0.994.

**Conclusion:** ASCC MR texture analysis provides prognostic factors of event occurrence and requires additional studies to assess its potential in "individual dose" strategy for ASCC chemoradiation therapy.

#### SS139

# Detection of active inflammatory bowel disease (IBD) via diffusion weighted imaging (DWI) and magnetization transfer (MT) in mouse model

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**Purpose:** To characterize the inflammatory process of colitis induced in Interleukin-10 knockout mice by diffusion weighted imaging (DWI) and magnetization transfer (MT) in order to validate those MRI techniques as potential biomarkers in inflammatory bowel disease (IBD).

**Methods and Materials:** Interleukin-10 knockout mice were used as an animal model for IBD. At an age of 6 –8 weeks the mice (n=8) were measured with a 4.7 T small animal imager with a DWI echo-planar imaging sequence (b-values 0, 800 s/mm2) and a gradient-echosequences with and without MT pre-pulse. Apparent diffusion coefficient (ADC) values and MT ratios (MTR) were inflammed and healthy bowel wall and statistically tested by ANOVA test. The inflammation of the bowel wall was validated by histology as a reference standard (HE staining)

**Results:** Inflammed bowel tissue of the colon showed lower ADC values (1.24  $\pm$  0.39 10<sup>-3</sup> mm<sup>2</sup>/s) compared to normal bowel wall (1.80 $\pm$ 0.45x10<sup>-3</sup> mm<sup>2</sup>/s, p<0.05). MTR values of inflamed bowel wall (21.5  $\pm$  3.2 %) were lower compared to healthy bowel (MTR 28.9  $\pm$  4.1 %). Inflammated tissue can be validated in histological ex vivo samples of the study group with presence of granulocytes in the submucosa and deep crypt damages.

**Conclusion:** The diffusion restriction observed in DWI of inflamed bowel wall may be attributed to lymphocytic infiltration, whereas a decrease in MRT is mostly likely due to tissue edema. Therefore, both functional MRI technques provide complimentary information for characterization of the degree of bowel wall inflammation.

# Preoperative evaluation of pancreatic fibrosis and steatosis: Correlation of MR findings with histology using magnetization transfer imaging and multi-gradient echo MR imaging

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**Purpose:** To investigate the correlation of magnetization transfer (MT) imaging and multi-gradient-echo magnetic resonance imaging (MRI) with histopathology to preoperatively quantify pancreatic fibrosis and lipomatosis prior to pancreatoduodenectomy.

**Methods and Materials:** 24 patients (68±8years, 16 males) prospectively underwent quantitative MT imaging with a 2D gradient-echo sequence and multi-gradient-echo imaging on a 3T MRI one day prior to pancreatoduodenectomy due to pancreatic adenocarcinoma (n=14), duodenal adenocarcinoma (n=6), neuroendocrine tumor (n=3) or IPMN (n=1). MT-ratio (MTR) and proton density fat fraction (PDFF) were measured in pancreatic tail (PT) and at the resection margin (RM). Pancreatic fibrosis was graded as mild, moderate or severe (F1-3), lipomatosis was graded as 0–10%, 11–30%, and >30% fat deposition (L1-3) on histopathology. Mann-Whitney U test and Spearman's correlation was used.

**Results:** Patients with advanced pancreatic fibrosis (F3) showed a significant higher MTR compared to the F1-group at the RM and PT (38±4 vs. 32.3±1.6, p=.018 and 39.7±5.5 vs.31.2±1.7, 0=.001). Spearman's correlation coefficient of MTR and fibrosis grade was r=.532 (p=.011) and .554 (p=.008), respectively. Pancreatic parenchyma with advanced fat deposition (L2–3) showed significantly higher PDFF compared to lipomatosis grade L1 (RM: p=.002 and PT: p=.001). PDFF of pancreatic parenchyma showed a moderate and significant correlation with histopathological lipomatosis grade (r=.668 and r=.707, p=.000). MTR was significantly higher in pancreatic tumor compared to pancreatic parenchyma (44±5.5 vs. 37.4±5.4, p=.000).

**Conclusion:** Multiparameteric MRI of the pancreas including MTR and PDFF maps may yield quantitative information to preoperatively quantify pancreatic fibrosis and lipomatosis noninvasively.

#### SS141

#### Multivariate Analysis including Biological Biomarkers, Diffusion-Weighted Imaging, T1 and T2 Mapping for Renal Fibrosis Prediction

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**Purpose:** This multiparametric MRI study aimed to externally validate the correlation of cortico-medullary Apparent Diffusion Coefficient difference (ΔADC) with renal fibrosis from biopsy. In addition, a mixed scoring including the combination of laboratory and MRI biomarkers was proposed to improve fibrosis detection.

**Methods and Materials:** 130 chronic kidney diseases (CKD) patients were scanned with readout-segmented diffusion-weighted imaging (RESOLVE), T1 and T2 Mapping. Univariate and multivariate analyses were conducted between laboratory and MRI biomarkers. A model including eGFR, phosphate and proteinuria together with ΔADC and ΔT1 (model 1) was compared to another model excluding eGFR and a third model including only MRI biomarkers, all for fibrosis assessment. External validation of ΔADC and the mixed score of each multivariate model was evaluated with AUC derived from ROC curves.

**Results:** The previously observed strong correlation between  $\Delta$ ADC and fibrosis (Friedli; Scientific Reports 2017) were confirmed (r=-0.57, p<0.001). From multivariate analysis, the highest R<sup>2</sup> was for model 1 with R<sup>2</sup>=0.66 (estimated optimism of 0.065). The  $\Delta$ ADC index threshold at 40% fibrosis was validated in the new and the previous cohort with 0.84 AUC (95%CI: 0.76-0.92) and 0.96 (95%CI: 0.90-1.0) respectively. Model 1 allowed better discrimination of patients (0.93 AUC).

**Conclusion:** The previously defined  $\triangle$ ADC index was externally validated for fibrosis assessment in a larger and mixed population of 130 patients, with various primary diseases. The combination of routinely obtained serologic markers and MR parameters improved renal fibrosis assessment. In both populations,  $\triangle$ ADC alone or in model 1 was able to identify patients with extensive fibrosis with an excellent AUC.

SS143

# Differentiation of urinary stones and phlebolith in unenhanced low-dose CT by artificial intelligence

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**Purpose:** Distinction between urinary stones and phlebolith may constitute a diagnostic challenge in unenhanced low-dose CT (LDCT) for pelvic calcification in low body mass index (BMI) patients. The study aimed to investigate radiomic tools based on texture analysis for their differentiation. **Methods and Materials:** LDCT of 380 consecutive patients were reviewed between August 2015 et March 2017. In each patient, one or two abdomino-pelvic calcifications (n=415) were selected according to its intra- or extra- pyeloureteral position and assigned as an urinary stone (n=214) or a phlebolith (n=201) by a senior radiologist. Segmentation of each lesion allowed radiomic analysis by extraction of 117882 features. After dimension reduction by principal component analysis, classification was performed using a support vector machines (SVM) after splitting dataset in a training set (n=33/415, 80%) and a testing set (n=83/415, accuracy, area under the curve (AUC) and permutation testing.

**Results:** In the testing set, SVM classification led to a sensitivity and specificity at 95.35% and 95.00%. The accuracy and AUC rose to 95.18%. and 0.992, respectively. Classification accuracy was significantly better than permutation scores (p<0.05)

**Conclusion:** Radiomic method derived from textural analysis provides a promising method to discriminate between urinary stones and phlebolith.

#### Prediction of Successful Shock Wave Lithotripsy with CT: A Phantom Study using Texture Analysis and Machine Learning

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**Purpose:** To apply texture analysis (TA) in computed tomography (CT) of urinary stones and to correlate TA findings with the number of required shockwaves for successful shock wave lithotripsy (SWL).

**Methods and Materials:** CT was performed on thirty-four urinary stones in an in-vitro setting. Urinary stones underwent SWL and the number of required shockwaves for disintegration was recorded. TA was performed after postprocessing for pixel spacing and image normalization. Feature selection and dimension reduction were performed according to inter- and intrareader reproducibility and by evaluating the predictive ability of the number of shock waves with the degree of redundancy between TA features. Three regression models were tested: (1) linear regression with elimination of colinear attributes (2), sequential minimal optimization regression (SMOreg) employing machine learning, and (3) simple linear regression model of a single TA feature with lowest squared error.

**Results:** Highest correlations with the absolute number of required SWL shockwaves were found for the linear regression model (r=0.55, p=0.005) using two weighted TA features: Histogram 10<sup>th</sup> Percentile, and Grey-Level Co-Occurrence Matrix (GLCM) S(3, 3) SumAverg. By using the median number of required shockwaves (n=72) as a threshold, receiver operating characteristics analysis showed largest area-under-the-curve values for the SMOreg model (AUC=0.84, r=0.51, p<0.001) using four weighted TA features: Histogram 10<sup>th</sup> Percentile, and GLCM S(1, 1) InvDfMom, S(3, 3) SumAverg, and S(4, -4) SumVarnc.

**Conclusion:** Our in-vitro study illustrates the proof-of-principle of Texture Analysis of urinary stone CT images for predicting the success of stone disintegration with shockwave lithotripsy.

#### SS144

Temporal changes in MRI appearance of the prostate after focal ablation

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**Purpose:** The purpose of our study was to evaluate and categorize temporal changes in MRI appearances of the prostate in patients who underwent focal therapy with MRI follow up.

**Methods and Materials**: The Institutional Review Board approved this retrospective study. Forty-two patients (median age 61; 48-76 years) with low-to-intermediate-risk, clinically organ-confined prostate cancer underwent focal ablation therapy from 2009 through 2014. Two radiologists reviewed post-treatment MRIs (n=88) and categorized imaging features blinded to the time interval between the focal therapy and the follow-up MRI. Inter-reader agreement was assessed (kappa) and generalized linear regression was used to examine associations between imaging feature being present/absent and days between ablation and MRI.

**Results:** Inter-reader agreement on MRI features ranged from fair to substantial. Edema was found present at earlier times after ablation (median 15-22d compared to MRIs without edema, median 244-445d), as was rim enhancement of the ablation zone (18-23d vs 354-553d), a hypointense rim around the ablation zone on T2-weighted images (49-54d vs 256-305d) and the presence of an appreciable ablation cavity (49-55d vs 582-719d; all p<0.05). The formation of a T2-hypointense scar was found to be present on later MRI scans (446-461d vs 28-28d), so was enhancement of the ablation zone/scar (216-610d vs 119-174d) by one reader.

**Conclusion:** The MRI appearance of the prostate after focal ablation changes substantially over time. Identification of temporal patterns in the appearance of imaging features should help radiologists distinguish normal MRI findings from possible recurrence

### SGR-SSR ORALS

# SS145

# Magnetic resonance relaxometry and diffusion imaging of neuronal differentiation

### <u>V. D. Phi van</u>, A. S. Becker, D. Keller, C. Eberhardt, D. Eberli, A. Boss; Zurich/CH

**Purpose:** To characterize neural stem cells (NSC) in neurospheres and their differentiation into neurons applying magnetic resonance (MR) relaxation and diffusion techniques; which may serve as a potential non-invasive diagnostic tool in neural stem cell therapy.

**Methods and Materials:** Rat NSCs were cultured as neurospheres of different sizes (diameters 0.15, 0.25, and 0.5mm). To assess differentiation, neural stem cells were cultured in Matrigel 3D-culture with specific medium for differentiation into neurons. A control group with standard NSC medium was kept undifferentiated. Longitudinal relaxation time T1, transverse relaxation time T2, and apparent diffusion coefficients (ADCs) were measured in a 4.7T small animal imager at days 0, 3, 7 and 12 after initiation of differentiation. Differentiation into neurons was proven by immunofluorescence, Western Blot and PCR.

**Results:** Neurospheres showed similar T1 (mean 2175±146ms) and T2 (209±57ms) times for the different sizes. ADC values differed between the different sizes with the largest (smallest) neurospheres having the lowest (highest) diffusion restriction ( $2.2 \times 10^{-3} \pm 0.2 \text{ mm}^2/\text{s}$  vs.  $1.8 \times 10^{-3} \pm 0.1 \text{mm}^2/\text{s}$ ). Undifferentiated NSC in 3D matrigel culture exhibited long relaxation times and high passive water diffusion: T1 times ( $3138\pm125\text{ms}$ ) and T2 times ( $696\pm72\text{ms}$ ) and ADC value ( $1.9 \times 10^{-3} \pm 0.2 \text{mm}^2/\text{s}$ ). During differentiation relaxation and diffusion parameters gradually decreased: T1 ( $2376\pm180\text{ms}$ ), T2 ( $490\pm58\text{ms}$ ) and ADC value ( $1.6 \times 10^{-3} \pm 0.2 \text{mm}^2/\text{s}$ ) at 12 days after differentiation. The control group showed no change in parameters.

**Conclusion:** Measurement of MR biomarkers allows characterizing NSC in neurospheres and their differentiation into neurons, which may be helpful in neural stem cell therapy.

#### SS146

#### Changes in functional connectivity in the ventral attention system after Prismatic Adaptation

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**Purpose:** Prismatic adaptation (PA) is used in the rehabilitation of spatial neglect, a common disorder following right hemispheric damage, characterized by a tendency to ignore stimuli in the left visual field. Previous task-related fMRI have shown that PA modulates the activity of the inferior parietal lobule (IPL) suggesting that PA changes the right hemispheric dominance within the Ventral Attention System (VAS). We tested this hypothesis with resting-state fMRI connectivity of the VAS, the Dorsal Attention System (DAS) and the Default Mode Network (DMN) before and after a PA session.

**Methods and Materials:** We acquired resting state functional MRI data before and after an adaptation on 14 subjects who wore rightward deviating prisms during adaptation and on 12 control subjects. Using resting state functional connectivity matrices, we calculated for each network separately, the mean correlation coefficient, called total connectivity, between nodes of VAS, DAS and DMN. We compared differences 'before-after adaptation' between groups with bilateral independent-samples t-tests.

**Results:** The total connectivity was lower after PA than before for the prisms group in the VAS, DAS and DMN and for the control group in the DAS; for this latter group it was higher after adaptation in the DMN and VAS. However, the difference between groups was significant only for the VAS (VAS:t(24)=2.49,p=0.02; DMN:t(24)=1.90,p=0.69; DAS:t(24)=0.75,p=0.461).

**Conclusion:** Our results show that PA changes significantly the functional connectivity in the VAS, and provide new insights to select candidates of PA for the rehabilitation of spatial neglect based on a spared VAS.

#### SS147

# Pretherapeutic functional neuroimaging predicts tremor arrest after thalamotomy

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**Purpose:** Essential tremor (ET) represents the most common movement disorder. Drug-resistant ET can benefit from standard stereotactic procedures (deep brain stimulation or radiofrequency thalamotomy) or alternatively minimally invasive high-focused ultrasound or radiosurgery. All aim at same target, thalamic ventro-intermediate nucleus (Vim).

**Methods and Materials:** The study included a cohort of 17 consecutive ET patients treated only with left unilateral SRS-T between September 2014 and August 2015. The mean time to tremor improvement was 3.32 months (standard deviation 2.7, 0.2-10). Neuroimaging data were collected at baseline (n=17). Standard tremor scores, including activities of daily living (ADL) and tremor score on treated hand (TSTH) were completed pretherapeutically and 1 year later. We further correlate these scores with baseline connectivity in twenty major large-scale brain networks.

**Results:** We report as predictive three networks, with the interconnected statistically significant clusters: primary motor cortex interconnected with inferior olivary nucleus1, bilateral thalamus interconnected with motor cerebellum lobule V<sup>2</sup> (ADL) and anterior default-mode network interconnected with Brodmann area 10<sup>3</sup> (TSTH). For all, more positive pretherapeutic interconnectivity correlated with higher drop in points on the respective scores. Age, disease duration, or time-to-response after SRS-T were not statistically correlated with pretherapeutic brain connectivity measures (p>0.05). The same applied to pretherapeutic tremor scores, after using the same methodology described above.

**Conclusion:** Our findings have clinical implications for predicting clinical response after SRS-T. Here, using pretherapeutic magnetic resonance imaging and data processing without prior hypothesis, we show that pretherapeutic network(s) inter-connectivity strength predicts tremor arrest in drug-naïve ET, following stereotactic radiosurgical thalamotomy (SRS-T).

SS148

# Improved non-invasive susceptibility-weighted MR imaging of the thalamic nuclei at 7 Tesla with enhanced contrast and venous vessel exclusion

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**Purpose:** The aim of this work was to optimize the susceptibility-weighted imaging (SWI) technique at 7 Tesla for non-invasive, high-contrast and high-resolution visualization of the thalamic nuclei, by jointly optimizing the SWI contrast and suppressing venous vessels.

**Methods and Materials:** This prospective study was approved by the ethics committee of Canton de Vaud, and included 5 healthy volunteers (72±9yo, 3male/2female), who provided written informed consent. The volunteers were scanned at 7T (Siemens Healthcare) with SWI (0.375×0.375×1mm resolution), and a T1-weighted acquisition (MP2RAGE, 0.6mm isotropic resolution), in March 2017. The raw SWI data were reconstructed offline, and the SWI phase-magnitude combination was modified specifically to enhance intra-thalamic contrast. Venous vessels were automatically segmented on the SWI images and removed by interpolation. The resulting images were then compared to a histological atlas (Schaltenbrand).

**Results:** Standard SWI offered superior intra-thalamic contrast compared to T1-weighted data, in agreement with previous studies. Nevertheless, the optimized SWI contrast consistently surpassed standard SWI, with more clearly delineated borders for several nuclei. Hypo-intense features closely matched the pulvinar, ventro-caudalus, ventro-odalis and parafascicular nucleus. Indirectly, this also allowed more accurate delineation of nuclei such as the centromedian and the ventral intermediate nucleus, an important surgical target for tremor treatment.

**Conclusion:** SWI can be optimized for thalamic nuclei visualization in an effective and fairly straightforward approach, by modifying its phase-magnitude combination and suppressing venous vessels. Together, these modifications offer substantially improved contrast and delineation of thalamic nuclei, and may bring important benefits for their non-invasive imaging in basic neuroscience and clinical applications alike.

# Spatio-temporal pattern of gadolinium-related hyperintensity increase within deep brain nuclei

### P. Pozeg, G. P.-O. Marie, R. A. Meuli, P.-P. Maeder, J. Forget; Lausanne/CH

**Purpose**: To systematically evaluate the spatio-temporal pattern of gadolinium-related changes in T1-weighted SI ratios occurring in the deep brain nuclei of adult patients exposed to at least 10 consecutive doses of gadodiamide.

**Methods and Materials**: In this retrospective study, approved by the cantonal ethics committee, we analyzed the brain MRI images of 30 patients (12 females, mean age: 43 ± 11.6 years) acquired between January 1999 and March 2008. We manually traced the regions of interest (ROIs), including dentate nucleus (DN), globus pallidus (GP), putamen, pulvinar, anterior thalamus (AntTh), superior colliculus (SC), and substantia nigra (SN) on unenhanced T1-weighted sagittal images (spin echo, 1.5T Siemens scanners). The mean signal intensity (SI) of each ROIs was normalized (divided) by the mean SI of the pons. The normalized SIs were measured at the baseline before first gadodiamide administration, and at each of 10 successive MRI exams. We used linear mixed effects models to analyze the data.

**Results:** We observed a significant (all p<.01) and differential increase of SI ratios across 10 successive gadodiamide administrations, suggesting a gradual deposition, with the fastest SI increase observed in DN ( $\beta$ =0.010), followed by GP ( $\beta$ =0.007), pulvinar ( $\beta$ =0.0068), putamen ( $\beta$ =0.0065), SC ( $\beta$ =0.006), AntTh ( $\beta$ =0.0035), and SN ( $\beta$ =0.0032).

**Conclusion:** Gadolinium deposition within deep brain structures occurs gradually following the first injection of gadodiamide. We argue that the different slopes observed in SI ratios may correlate with the inner iron content and subsequently an increased probability of unchelation of gadolinium kation and transmetallation reactions with iron kations.

#### SS150

# <u>A. Klauser</u>, S. Courvoisier, M. Kocher, F. Lazeyras; Geneva/CH

Whole Brain High-Resolution Metabolite Imaging

**Purpose:** We implemented the novel free-induction decay magnetic resonance spectroscopic imaging (FID-MRSI) to 3T clinical MRI to provide high-resolution, whole brain, unrestricted metabolite images in 2D or volumes in 3D.

**Methods and Materials:** FID-MRSI sequence was implemented on a 3T clinical MRI. Sequence optimization was pursued to reach ultra-short 1ms echo time and 400ms repetition time, reducing acquisition time and minimizing effects of relaxation on signal. Skull lipid contamination was removed by a specific post-processing method allowing for acquisition of the whole brain without spatial restriction due to usual volume selection. Weak signal-tonoise due to small voxel-size was improved with denoising constrained model. Eventually, MRSI dataset were quantified using LCModel to estimate spatial concentration distributions of N-AcetylAspartate, total-creatine, choline-containing-compounds, myo-inositol and glutamate+glutamine.

Healthy volunteers were scanned with protocol approved by the ethics review board and written consent was given. Either 2D or 3D FID-MRSI datasets were obtained. 2D-FID-MRSI was acquired on 64x64 matrix over 220x220mm field-of-view resulting in voxel-size of 3.4x3.4x10mm and acquisition duration of 10min. 3D-FID-MRSI was planned on 210x210x105mm field-of-view with 40x40x20 matrix what resulted in 5.3x5.3x5.3mm voxel size and 40min acquisition duration.

**Results:** The efficient lipid-suppression allows for usually challenging visualization of metabolite concentrations in the whole cortex.

2D or 3D metabolite dataset exhibit metabolic specific distribution revealing anatomical contrasts that could not be obtained by standard MRSI acquisition.

**Conclusion:** New FID-MRSI acquisition scheme in combination with reconstruction post-processing enable producing metabolite images and volumes with improved sensitivity and resolution that provide new imaging prospect in clinical system.

#### SS151

# Brain metabolic changes in anorexia nervosa by magnetic resonance multivoxel spectroscopy

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**Purpose:** Anorexia nervosa leads to serious nutritional deficiencies, which also have an impact on the brain with structural and metabolic changes. The aim of this study was to highlight changes in the concentration of common metabolites of different regions in the brain of patients suffering from anorexia nervosa and to relate them to the proportion of gray and white matter.

**Methods and Materials:** In a prospective study, 21 patients suffering from anorexia nervosa with mean body mass index (BMI) of 14,9 Kg/m<sup>2</sup> (range 10-19.5), were compared with 11 control patients with mean BMI of 21,6 Kg/m<sup>2</sup>. A multivoxel (8 x 8) spectroscopy analysis was performed on an axial slice just above the corpus callosum, and including the superior and middle frontal gyri, the cingulate, the superior parietal region, and precuneus. We analysed different metabolite ratios including Myo-inositol/Creatine, Choline/Creatine, and N-acetyl-aspartate/Creatine, as well as lactate and lipids in brain regions with different proportions of white and gray matter. The statistical analysis was performed by a mixed model.

**Results:** We found a significant increase in the Choline/Creatine ratio in the frontal, precentral, postcentral and parietal regions in anorexics (p<0.05). A decrease in lipids at 0.9 ppm in the cingulate was also found in the anorexic group (p<0.01).

**Conclusion:** Anorexics have significantly higher Choline/Creatine ratios in the frontal and parietal regions, suggesting increased cell turnover and catabolism of lipid membranes. Significant lower concentrations of lipids were found in the cingulate, which is known to be dysfunctional in eating disorders.

SS152

# Diagnostic and prognostic value of cerebrovascular reactivity MRI for crossed cerebellar diaschisis after stroke compared to 15(0)-H2O-PET

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**Purpose:** Crossed cerebellar diaschisis (CCD) is defined as the reduction in cerebellar blood flow (CBF) and metabolism contralateral to a supratentorial lesion, and corresponds to poorer clinical outcome. Positron-Emission-Tomography (PET) imaging is typically used to detect CCD, but MRI blood-oxygenation-level-dependent (BOLD) derived cerebrovascular reactivity (CVR) might characterize this disease without the ~1 mSv X-rays dose, at lower cost and higher disponibility. Hence, we tested BOLD-CVR for CCD diagnostic and clinical prognostic.

**Methods and Materials:** Nineteen subjects with symptomatic unilateral cerebrovascular steno-occlusion underwent BOLD-CVR as well as a 15(O)-H2O-PET. CCD and cerebellar asymmetry index (CAI) were determined from PET and compared to BOLD-CVR quantitative values. Clinical status at admission and outcome after 3 months were determined with NIHSS and mRS scores.

**Results**: CAI in CCD(+) subjects was significantly higher (CCD(+) vs. CCD(-) for BOLD-CVR: 14.8 $\pm$ 10.7 vs. 1.4 $\pm$ 5.4, p<0.001; and for PET 7.0 $\pm$ 1.8 vs. 1.8 $\pm$ 3.1, p<0.001). The area under the ROC curve (AUC) for BOLD-CVR was 0.88 (CI: 0.73-1.0) with 0.87 sensitivity and 0.77 specificity to detect CCD. CCD(+) subjects were in poorer clinical condition at baseline (CCD(+) vs. CCD(-): NIHSS: 6 vs. 1, p = 0.004; mRS: 3 vs. 1, p<0.01) and after 3 months follow-up (NIHSS: 2 vs. 0, p=0.03; mRS: 1 vs. 0, p=0.04).

**Conclusion:** BOLD-CVR can accurately detect CCD. Furthermore, CCD subjects identified with BOLD-CVR had a poorer initial clinical status and stroke severity scores at three months compared to the PET indentification, due to the better CCD+ segregation using MRI.

# Cortical atrophy evaluation on MRI scans: A study of inter-rater agreement for visual rating scales

#### H. Fenter, V. Dunet, P. Hagmann, P.-P. Maeder; Lausanne/CH

**Purpose:** MRI has an increasing role for the diagnosis and follow-up of neurodegenerative diseases. We aimed at evaluating the inter-rater reproducibility of visual scales used for the evaluation of brain trophicity as well as to isolate factors that may influence this reproducibility.

**Methods and Materials:** In this study, 103 patients (mean age: 73±14 years, male: 45) referred to our department were retrospectively included. All underwent a brain MRI at 3T including a T1-MPRAGE sequence. Three neuroradiologists assessed the images blinded for patients' characteristics. Lobar (frontal, temporal, occipital and parietal) trophicity and ventricle size, as well as white matter hypertense lesions were evaluated on a 4-point scale (range: 0-3, total maximum: 33). Hippocampic trophicity was evaluated with the Scheltens scale. Inter-rater reproducibility was assessed by calculation of the Cohen's kappa coefficients. Influence of rater's experience, lobar location, gender, and age on the reproducibility was evaluated.

**Results:** Of 103 patients, 93 were assessed by the 3 observers while 10 patients were excluded due to motion artefacts. Overall, inter-rater reproducibility was fair (kappa= 0.35). The more experienced pair was systematically in higher agreement with a global kappa of 0.44. Lobar location influenced reproducibility with kappa values ranging from 0.2 for temporal lobes to 0.53 for parietal lobes. Reproducibility increased with patients' age but was not influenced by gender.

**Conclusion:** Reproducibility of visual scale is only fair to moderate and influenced by rater's experience, lobar location and patient's age. Automated MR morphometry should be promoted to improve reproducibility of individual brain trophicity assessment in daily practice.

### SS154

# Automated MR-based volumetry of basal ganglia and thalamus at the chronic phase of cortical stroke

<u>C. Baudat</u>, B. Maréchal, R. Corredor-Jerez, P. Hagmann, P.-P. Maeder, V. Dunet; Lausanne/CH

**Purpose:** We aimed at assessing the potential of automated MR-based brain morphometry to assess individual basal ganglia and thalamus volumetric changes at the chronic phase after cortical stroke.

**Methods and Materials:** Nineteen patients (mean age: 68±21 years, male: 9) with cortical stroke at the chronic phase were retrospectively included. All patients were scanned at 3T using a T1-MPRAGE sequence. Resulting 3D images were processed with the MorphoBox prototype to automatically segment caudate nucleus, putamen, pallidum and thalamus structures. Deviations from reference range of resulting volumes estimates were assessed by z-scores taking into account the confounding effects of age and gender. Stroke volume in mL was estimated by manual delineation on T2 SE imaging. Z-scores scores were compared between ipsi- and contralateral stroke side and according to the vascular territory. Potential relationship between z-scores and stroke volume was assessed using the Spearman correlation coefficient.

**Results**: Putamen, pallidum and thalamus volume z-scores were lower ipsilaterally to MCA territory stroke (all p-value<0.05) while caudate nucleus volume z-scores were not different between ipsi- and contralateral stroke sides regardless of the stroke vascular territory (all p-values >0.31). In MCA territory stroke, ipsilateral putamen, pallidum and thalamus volume z-scores negatively correlated with the cortical stroke volume (rho<-0.66, p<0.02).

**Conclusion:** Except caudate nucleus, we observed ipsilateral basal ganglia and thalamus atrophy at the chronic phase after cortical stroke in the territory of the MCA. These results confirmed remote changes of basal ganglia after cortical stroke and the potential role for automated MRI volumetry to access brain plasticity after stroke.

#### SS155

### Automatic volumetry of glioblastoma sub-compartiments

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**Purpose:** Subcompartment analysis has shown prognostic value in imaging of gliomas. While manual volumetry is time consuming and not implemented in clinical routine newer advances in automatic software tools made fully automatic analysis of glioma subcompartments available.

**Methods and Materials**: We performed a qualitative and quantitative comparison of fully automatic and visual volumetry in patients with glioblastoma of the sub-compartments necrosis, non-contrast enhancing tumor (NCET), contrast enhancing tumor (CET), edema, total tumor volume (TOTAL) without edema and TOTAL.

Pre-operative MRI of 55 patients with glioblastoma were analyzed fully automatically and visually. Quality of automatic analysis was categorized by four raters in good, partially failed and failed. Statistical analysis was performed by Pearson correlation.

**Results:** Quality analysis showed in 32 patients good segmentations, partially failed segmentations were found in 19 patients and four failed segmentations (2x movement artifacts, 2x failed scull stripping).

The correlation analysis of fully automatic and visual volumetry resulted in: necrosis rho 0.37 (p=0.05); NCET rho 0.5 (p<0.01); CET rho 0.86 (<0.01); edema rho 0.83 (<0.01); TOTAL rho 0.83 (<0.01); TOTAL with edema rho 0.94 (<0,01). The time needed for automatic evaluation was 5 minutes. Dependent on the tumor complexity visual assessment took between10 to 30 minutes.

**Conclusion:** Although fully automatic segmentation performed well in unexcelled time, we strongly recommend checking results generated by automatic segmentation by an experienced neuroradiologist due to possible outliers.

SS202

### SS203

### Vertebral body insufficiency fractures: Detection of vertebrae at risk on clinical CT images using texture analysis and machine learning

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Purpose: Osteoporotic insufficiency fractures of the spine are frequent complications in elderly patients. We introduce an alternative for bone quality measurements based on texture analysis (TA) with machine learning (ML) of CT scans of the trunk to identify vertebrae at risk for fracture.

Methods and Materials: Consecutive standard CT scans of 57 patients with insufficiency fractures of the spine were analyzed. Intact vertebrae in the first scan that either fractured ('instable') or remained intact ('reference') in the consecutive scan were manually segmented on mid-sagittal reconstructions. If available, a third scan was assessed to validate the reference vertebra over a longer period. Texture features for all vertebrae were extracted using open source software (MaZda). Multiple ML approaches, e.g. random forest and support vector machines were used to classify instable and reference vertebrae as well as cases (instable and reference) and matched (gender, age and fracture level) controls from a prior study.

Results: 60 vertebrae were included. Mean time difference between the first and second scan was 237 days (SD ±117.5), between latter and third 548 days (SD ± 386). ML based classification of cases vs. controls showed sensitivity, specificity and AUC of 0.91, 0.86 and 0.93 and of 0.63, 0.43 and 0.45 for instable vs. reference vertebrae, respectively.

Conclusion: TA combined with ML allows to distinguish healthy and diseased bone with a high accuracy. However, within the diseased spine the prediction of single vertebrae that will fracture at a future point in time remains challenging.

### Lumbar spine MRI: Do we really need T1 sagittal images when using T2 Dixon sequences?

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Purpose: To determine whether lumbar spine MRI acquisitions in the sagittal plane can be reduced to a single fast spin-echo (FSE) Dixon T2 sequence, we aimed at showing that Fat Only images (FO) of FSE T2 Dixon sagittal sequences can replace the FSE T1 images.

Methods and Materials: Fifty consecutive lumbar spine MRI examinations performed for lumbar pain and/or lumbosciatalgia were reviewed. Two musculoskeletal radiologists independently and randomly performed readings of two protocols separately: standard protocol (T1 sagittal, in-phase (IP) and water only (WO) images of the T2 Dixon sagittal sequence) and short protocol (FO, IP and WO images of the T2 Dixon sagittal sequence). The following items were assessed: bone marrow abnormalities, juxta-discal and marginal abnormalities (including osteophytes, MODIC changes, fatty infiltration, Schmorl nodules, vertebral fractures), foraminal stenosis, facet joint arthritis, and spondylolysis. Interchangeability of these sequences was tested using a previously published method by comparing the interprotocol (short vs. standard) agreement with the intraprotocol agreement using the standard protocol, with a ±5% limit to define clinically important difference of excess of disagreement. Interprotocol agreement was also compared using kappa statistics

**Results:** Interprotocol agreement was similar to intraprotocol agreement on standard protocol (mean difference: -0.5%, 95%CI=[-1.07%;0.06%]; range: -3.05%;+1.15% across structures). Interprotocol kappa values were moderate to perfect (mean: 0.774, range: 0.478;0.922).

Conclusion: T2 Dixon FO images can replace T1 sagittal images in lumbar spine MRI, providing an opportunity to reduce acquisitions in the sagittal plane to a single FSE Dixon T2 sequence.

### Postpartum bone marrow edema in the sacroiliac joints may mimic sacroiliitis of axial spondyloarthritis on MR imaging

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Purpose: To compare MR imaging findings in the sacroiliac joints of postpartum women and female patients with known axial spondyloarthritis.

Methods and Materials: We obtained institutional review board approval for this prospective multicenter age-matched case-control study. After consenting, 30 healthy women (mean age 34.0 years) in the early postpartum period (vaginal or cesarean delivery) were examined with MRI. MRI of 30 age-matched female patients (mean age 33.8 years) with known axial spondyloarthritis served as control group (retrospective). Blinded to clinical information, images were assessed using different scoring systems (Spondyloarthritis Research Consortium of Canada (SPARCC) MRI index, Berlin method, Assessment of SpondyloArthritis international Society (ASAS) criteria, SPARCC structural score). Descriptive statistics (Bone marrow edema, erosion, fatty replacement, backfill, ankylosis), scores between groups and between delivery modes were compared.

Results: In the postpartum group, 63.3% (19/30) of women showed bone marrow edema around the sacroiliac joints, compared to 86.7% (26/30) in the spondyloarthritis group (based on ASAS criteria). Erosions were uncommon in the postpartum group (10% (3/30) postpartum vs. 56.7% (17/30) SpA). Fatty marrow replacement, backfill, and ankylosis were not seen postpartum. Mean scores in the spondyloarthritis group were higher than in the postpartum group (SPARCC MRI Index (11.3±10.9 vs. 8.7±13.2, P=.069), Berlin method (4.8±3.7 vs. 2.9±3.2, P=.028), SPARCC structural score (10.8 ±13.9 vs. 0.1±0.4, P<.001)). Scores were not different between birth modalities.

Conclusion: Postpartum women may demonstrate sacroiliac joint bone marrow edema on MR imaging that mimics sacroiliitis of spondyloarthritis.

#### SS204

#### Outcome of interlaminar vs. transforaminal epidural steroid injections in lumbar disc herniation with particulate steroids

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Purpose: The purpose of this study was to compare the outcome after computed tomography (CT)-guided interlaminar versus transforaminal epidural steroid injections in lumbar disc herniation patients with particulate steroids.

Methods and Materials: In this retrospective comparative effectiveness outcome study 202 patients were treated with CT-guided interlaminar (N=100) respectively transforaminal (N=102) epidural steroid injections. Baseline pain levels and after 1 day, 1 week, 1 month post injection were assessed using the 11-point numerical rating scale (NRS). Overall improvement was assessed after 1 day, 1 week and 1 month using the Patients Global Impression of Change (PGIC). To statistically compare NRS change scores the unpaired Student's t-test was used and the Chi-square test to compare the patients overall 'improvement.

Results: There were no significant differences in improvement between the interlaminar and transforaminal approach of epidural steroid injections after 1 day (30.5% vs. 23.5%, p=0.432), 1 week (41.7% vs. 41.6%, p=1.000) and 1 month (53.3% vs. 43.9%, p=0.322). The NRS change scores also showed no significant difference between the two cohorts after 1 day (p=0.272), 1 week (p=0.137) and 1 month (p=0.307). Differences in MR-findings were found in disc herniation morphology (p=0.006), nerve root contact or compression (p=0.0001), disc herniation location (p=0.0001) and facet degeneration (p=0.0001).

Conclusion: There was no significant difference in outcome between lumbar disc patients treated with interlaminar respectively transforaminal epidural steroid injections using particulate corticosteroids.

#### SS205

# Augmented reality-guided lumbar facet joint injections

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**Purpose:** To assess accuracy of augmented reality-guided lumbar facet joint injections.

**Methods and Materials:** A spine phantom completely embedded in hardened opaque agar with three ring markers was built. A 3-D model of the phantom was uploaded to an augmented reality headset (Microsoft Holo-Lens). Two radiologists, independently performed twenty augmented reality-guided and 20 CT-guided facet joint injections each: for each augmented reality-guided injection, the hologram was manually aligned with the phantom container using the ring markers. The radiologists targeted the virtual facet joint and tried to place the needle tip in the holographic joint space. CT was performed after each needle placement to document final needle tip position. Time needed from grabbing the needle to final needle placement was measured for each simulated injection. An independent radiologist rated images of all needle placements in a randomized order blinded to modality (augmented reality vs. CT) and performer as: perfect, acceptable, incorrect, unsafe. Accuracy and time to place needles were compared between augmented reality-guided and CT-guided facet joint injections.

**Results:** In total, 39/40 (97.5%) of augmented reality-guided needle placements were either perfect or acceptable compared to 40/40 (100%) CT-guided needle placements (P=.5). One augmented reality-guided injection missed the facet joint space by 2 mm. No unsafe needle placements occurred. Time to final needle placement was substantially faster with augmented reality guidance (mean 14 ± 6 s vs. 39 ± 15 s, P<.001 for both readers). **Conclusion:** Augmented reality-guided facet joint injections are safe and accurate in an experimental setting.

# SS206

Task-based assessment of objective image quality in musculoskeletal CT with iterative reconstructions: Impact of multiplanar reformations

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**Purpose:** The effects of iterative reconstruction (IR) techniques on CT image quality have extensively been evaluated in the axial plane, yet their impact on coronal and sagittal reformations have not been investigated so far. We aimed to assess the impact of image reconstruction planes on objective image quality in musculoskeletal CT with IR.

**Methods and Materials:** A custom 20-cm-diameter cylindrical phantom containing a central 10-cm-diameter cylindical insert made of Teflon<sup>®</sup> (relative contrast with air=2000HU) was scanned on a 64-detector row CT system, using a clinical protocol for knee CT/CT arthrography. Datasets were reconstructed at a nominal section thickness of 0.625mm, using four d ifferent algorithms: filtered back-projection, two statistical IR algorithms (ASIR and ASIR-V) at 50%, and a fully model-based IR (Veo). Multiplanar reformations were generated in coronal and sagittal planes. The area under the receiver operating characteristic curve (AUC) of a 0.2-mm-thick simulated fracture line was calculated from detectability indexes obtained using an updated nonprewhitening with eye filter model observer, which takes into account image noise and spatial resolution metrics.

**Results:** In the axial plane, the AUC was equal to 1.0 for each of the four image reconstruction algorithms. When switching from the axial plane to coronal or sagittal reformations, the AUC significantly decreased by approximately 20%, 12%, and 9% for FBP, ASiR, and ASiR-V, respectively, whereas the AUC remained constant at 1.0 for Veo.

**Conclusion:** Veo outperforms the three other image reconstruction algorithms tested, yielding the highest dectectability indexes for fracture lines through constant objective CT image quality in all three reconstruction planes.

# In-vitro parameter optimization of the triangle - bone, iodine contrast media and metal artifact volume - in DECT

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**Purpose:** Dual energy computed tomography (DECT) reduces metal artefact volume (MAV) by calculating virtual monenergetic CT scans (VMCT). Different energies influence densities of iodinated contrast media (iCM) and bone. This triangle - bone and iCM density and MAV - is mandatory for CT arthrography with joint related metallic implants (JRMI). We investigated the energy-related influence on different dilutions of iCM, MAV, and bone density in an experimental setting.

**Methods and Materials:** A phantom was built with a titanium metal plate, a piece of bovine long bone, and probes (1ml) of 0,9% saline solution and six different dilutions of iCM (400mg/ml, 300mg/ml, 200mg/ml, 100mg/ml, 50mg/ml, 25mg/ml iodine content). All contents were embedded in 0,5% gelatine.

DECT was performed on a 64-slice CT scanner (Siemens, Sensation 64) with two sequential scans (80keV and 140keV) and calculated to VMCT (40, 50, 70, 100, 120, 140, 190keV).

MAV, iCM to bone contrast to noise ratio (iCM-b-CNR) and density was digitally measured for all probes. Optimized iCM-b-CNR, density differences and reduction of MAV were correlated considering different VMCT energy levels.

**Results:** iCM with iodine content of 200, 300 and 400mg/ml and titanium plate were on the upper border of measurable density (3000HU) at any energy level. Bone density decrease with rising energy levels was parallel to 100mg/ml iodine content. iCM-b-CNR was optimal at VMCT of 120-190keV. MAV optimum was achieved with VCMT of 120-190keV.

**Conclusion:** Phantom study suggests iCM with 200mg/ml iodine content, VAM of 120keV considering iCM-b-CNR and MAV, with regard to CT arthrography with JRMI.

### SS208

#### Multi-energy spectral photon-counting CT in crystal-related arthropathies: Initial experience and diagnostic performance in vitro

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**Purpose:** To determine the in-vitro diagnostic performance of multi-energy spectral photon-counting CT (SPCCT) in crystal-related arthropathies. **Methods and Materials:** Four crystal types (monosodium urate, MSU; calcium pyrophosphate, CPP; octacalcium phosphate, OCP; calcium hydroxyapatite, CHA) were synthesized and blended with agar at the following concentrations: 240, 88, 46, and 72mg/mL, respectively. Crystals were scanned on a pre-clinical SPCCT system at 80kVp using four energy thresholds: 20, 30, 40, and 50keV. Linear attenuation coefficients of crystals were compared using the receiver operating characteristic (ROC) statistics. Area under the ROC curves (AUCs), sensitivities, specificities, and accuracies were calculated.

**Results:** For each pairwise crystal comparison, AUCs, sensitivities, specificities, and accuracies were all significantly higher in the two lower energy ranges (20-30 and 30-40keV). In the lowest energy range, MSU was confidently differentiated from CPP (sensitivity, 97.8%; specificity, 99.0%; accuracy, 98.4%) and CHA (sensitivity, 95.7%; specificity, 97.0%; accuracy, 96.4%), while MSU was more difficult to distinguish from OCP (sensitivity, 66.3%; specificity, 71.4%; accuracy, 68.8%). CPP was confidently differentiated from OCP (sensitivity, 95.0%; specificity, 95.4%; accuracy, 95.2%), while distinction between CPP and CHA was more difficult (sensitivity, 56.4%; specificity, 88.5%; accuracy, 72.7%). OCP was confidently differentiated from CHA (sensitivity, 89.8%; specificity, 91.7%; accuracy, 90.7%).

**Conclusion:** Multi-energy SPCCT can confidently differentiate MSU from CPP and CHA, CPP from OCP, and OCP from CHA in vitro. Distinguishing MSU from OCP, and CPP from CHA is more challenging. The accurate identification and characterization of MSU and various calcium crystals would help improve both diagnosis and management of crystal-related arthropathies.

# Withdrawn

### SS210

SS209

# Performance of an Automated vs. Manual MR Scanner Workflow of Whole-body MRI

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**Purpose:** To evaluate the performance of an automated magnetic resonance imaging (MRI) scanner workflow, reducing user interaction compared to the manual MRI workflow for whole-body (WB) MRI.

**Methods and Materials:** 20 patients underwent WB MRI for myopathy evaluation on a 3T MRI scanner. 10 patients (7 females;age, 52±13ys;body mass index [BMI],23.2±3.0) were examined with a prototypical automated scanner workflow, and 10 patients (6 females;age,35.9±12.4ys;BMI,24.9±5.6) with a manual scan. For each sequence (coronal T2-weighted turbo inversion recovery magnitude [TIRM] and axial T1-weighted contrast-enhanced sequence (ce-T1w)) overall image quality (IQ;5-point scale:5,excellent;1, poor) and completeness of examination volume was assessed by two readers. Interreader agreement was evaluated with intraclass correlation coefficients [ICC]. Examination time, number of user interactions and MR technicians' acceptance (1,highest;10,lowest) were also compared.

**Results:** Total examination time was significantly shorter for automated MRI (30.0±4.2 vs. 41.5±3.4 min,p<.0001) with significantly shorter planning time (2.5±.79 vs. 14.0±7.0 min,p<.0001). Number of user interactions with automated MRI was significantly lower (10.2±4.4 vs. 48.2±17.2, p<.0001) as were rated planning efforts for the automated workflow (2.20±.92 vs. 4.80±2.39;p=.005). Overall IQ was similar (TIRM:4.00±.94 vs. 3.45±1.19,p=.264; ce-T1w:4.20±.88 vs. 4.55±.55,p=.423). Interreader agreement for overall IQ was excellent (ICC .95 and .88). There were significant differences for the completeness of the study volume in the ce-T1w for reader 2 (p=.008).

**Conclusion:** The automated MRI workflow significantly reduced examination time and user interactions while producing comparable IQ in WB MRI for evaluation of myopathies.

# Automatic differentiation of lipoma and liposarcoma by radiomics using artificial intelligence

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**Purpose:** To assess the contribution of MRI-based radiomics in the automatic differentiation of lipoma and liposarcoma using artificial intelligence (AI).

**Methods and Materials:** This study was approved by the local Swiss Ethics Committee on research. We retrospectively identified 20 cases of lipoma and 17 cases of liposarcoma on histopathological analyses of surgical or percutaneous resection specimen from October 2014 till October 2017, and we retrieved their respective pre-operative MRI images from our institutional PACS. These lesions on *Spin Echo T1-weighted* images obtained with 1.5T and 3T MR scanner were manually segmented by two senior radiologists. We used an open-source python library to extract a large number of radiomics features (n=123063) from each lesion. We achieved benign (i.e. lipoma) and malignant (i.e. liposarcoma) discrimination based on radiomics data through features selection, dimension reduction (using principal component analysis) and classification (using a support vector machine classifier). We used a *Leave-One-Out Cross-Validation* approach to estimate the prediction error of our model due to the medium sample-size.

**Results:** Our method achieved an overall classification accuracy of 83.8% in identifying lipoma (versus liposarcoma), with a sensitivity of 100%, specificity of 64.7%, positive predicting value of 76.9% and negative predictive value of 100%.

**Conclusion:** Our radiomics-based approach for classification of lipomatous soft tissue tumor yielded promising results, in particular, with a very high accuracy in identifying benign lesions.

# Prostatic Artery Embolization in the treatment of localized prostate cancer: A proof-of-concept study

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**Purpose:** To assess histopathological features in radical prostatectomy specimens after PAE

**Methods and Materials:** Prospective bi-centric proof-of-concept trial at two tertiary referral centers in Switzerland (Luzern, St. Gallen). Patients were considered to participate in the trial if they suffered from clinically localized prostate cancer. Patients were scheduled to undergo robotic assisted radical prostatectomy (RARP) 6 weeks after PAE. PAE was performed as an outpatient procedure using microspheres 100um as embolising agent. Primary outcome measure was histological assessment of the excised prostate to determine whether pathological complete response, defined as complete absence of vital cancer cells, was achieved. Secondary outcome outcomes, intraoperative details and assessment of complications and adverse events

**Results:** Bilateral PAE was successfully completed in all patients. After prostatecomy vital prostate cancer cells were detected in all 12 specimens. Pathological specimens were characterized by demarcated zones of necrotic tissue in the central gland. Complete tumor regression of the index lesion was found in 2 patients. Preoperative MRI findings did not predict outcome of final histopathological workup. Two patients required additional surgery to remove necrotic tissue caused by PAE.

**Conclusion:** PAE did not lead to complete elimination of PCA and was associated with significant side effects. PAE currently cannot be recommended as a stand-alone treatment modality for PCA. However, extensive tumor regression was induced in some lesions and it might be worthwhile to further assess PAE in such cases.

#### SS213

# Repulsion of the central prostatic gland after PAE: Can we predict it?

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**Purpose:** Significant reduction of prostate volume caused by prostatic shrinkage has been described after Prostatic Artery Embolization (PAE). Within a clinical trial assessing efficacy and safety of PAE we observed complete repulsion of the central prostatic tissue in some of the patients. Our aim was to assess frequency and potential predictors of this promising enucleation-like reaction.

**Methods and Materials:** We analysed the cases with complete repulsion of the prostatic central gland following PAE. Clinical parameters, pre-interventional MRI, technical details of PAE and peri-interventional data were assessed to identify parameters, which might allow for a prediction of this reaction pattern.

**Results**: Repulsion of the prostatic central gland occurred in 3 out of 45 cases (6.7%) following PAE. While spontaneous prostatic tissue elimination occurred in one of the patients, necrotic tissue had to be removed by cystoscopy in the remaining cases. Patients had a clearly divergent prostate size (i.e. 120, 80 and 40 cc respectively). All of them suffered from postoperative pain assigned to the prostate (VAS 5-9). Prostate volume, size of the central gland, embolization particle size, vascular anatomy, pre-interventional MRI diffusion and postoperative PSA course of this tissue reaction pattern did not differ significantly from those of other patients.

**Conclusion:** Complete repulsion of the prostatic central gland after PAE is a reaction leading to minimally-invasive enucleation of the prostate. This reaction would facilitate bloodless removal of prostatic adenoma even in larger glands. Based on our data, targeted induction or prediction of this tissue reaction pattern does not seem to be possible.

#### SS214

#### Uterine artery embolization in postpartum hemorrhage: 10-year experience in a tertiary hospital

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**Purpose:** To demonstrate the clinical success rate of uterine artery embolization (UAE) in postpartum hemorrhage and to evaluate the potential effect of UAE on subsequent pregnancies.

**Methods and Materials:** All patients, who underwent UAE due to uncontrollable postpartum bleeding from October 2007 to October 2017, were included. Patients' age, associated medical disease, gravity, parity, delivery mode and the cause of postpartum hemorrhage were noted. Clinical success, based on clinically managed bleeding and complication rate of UAE were also assessed.

Long term follow-up (up to 10 years) was evaluated for the rate of placental disorder, fetus developmental growth retardation and postpartum hemorrhage in subsequent pregnancies.

**Results:** Nineteen patients (mean age 32 ±11) were included in this study. Vaginal birth was the delivery mode in 50%. In the majority of patients (84%), uterine atony was identified as the cause of postpartum bleeding. Clinical success rate estimated as 94.7% with UAE failure in one patient. No complications were observed during or post-UAE procedure. Long term follow-up revealed 7 (78%) subsequent pregnancies among 9 women willing to conceive, without associated placental disorder or fetus growth retardation. One patient experienced post-partum hemorrhage in a subsequent pregnancy, which was managed by medication.

**Conclusion**: The present study supports the efficacy and safety of UAE in postpartum hemorrhage without compromising the placenta disorder or fetus development in a subsequent pregnancy.

SS215

Endovascular repair of Isolated iliac artery aneurysms is durable – Results of a 20 year single-center experience

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**Purpose:** To evaluate the short- and long-term outcome after endovascular repair of isolated iliac artery aneurysms (IIAA).

Methods and Materials: 72 patients with a total of 85 IIAAs underwent endovascular repair between November 1996 and November 2015. Mean age was 73.9 ± 9.2 years. Aneurysms were classified according to the Zurich-Classification and treated with coiling of the internal iliac artery, stent-grafting of the common to external iliac artery or a bifurcated aortoiliac stent-graft. Results: Common iliac artery involvement was observed in 63 (74.1 %), internal iliaca artery in 21 (24.7 %) and external iliac artery in one patient (1.2 %) with 32 type Ia (38.1 %), 31 type Ib (36.9 %), 16 type IIa (19 %), three type IIb (3.6 %) and two type IIc (2.4%) aneurysms. Mean diameter was 5 ± 1.9 cm. 19 patients underwent emergency repair due to rupture (26.4 %). Overall primary technical success rate was 95.8 % with an in hospital mortality of 1.4%. During follow-up 17 endoleaks were observed (four type Ia, two type Ib, 10 type II; one type IIIa) with an overall re-intervention rate of 16.7 %. Primary patency rate was 98.6 %. During the mean follow-up period of 4.3 years (range, 0 - 14.2 years) 22 deaths occurred (30.6 %), with only two aneurysm related deaths (2.8 %).

**Conclusion:** Endovascular repair of elective and ruptured IIAA shows excellent short- and long-term results and should be considered as first line therapy. However secondary interventions are required in a considerable number of patients to ensure aneurysm exclusion.

# Outcomes of elective percutaneous peripheral revascularization in outpatients: 10-year single center experience

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**Purpose:** To evaluate the safety and feasibility of peripheral percutaneous endovascular procedures in a large group of outpatients suffering from peripheral arterial disease (PAD).

**Methods and Materials:** We evaluated all elective patients who underwent peripheral balloon angioplasty (PTA) or stenting for PAD of the lower extremities as "Out-Patient Admission Protocol" (OPAP) from January 2005 until December 2015. By protocol, patients were expected to be discharged 4 hours after the procedure. Clinical profile, procedure details and technical success were reviewed. Complications, conversion rate, readmission rate and long-term follow-up were evaluated.

**Results:** 449 consecutive patients with mean age of 66±10.1 years (280 men and 169 women) were evaluated. 417 patients (93%) suffered from claudication. Femoral access was obtained in 96% (6-French sheath in 87%) of patients. PTA alone was performed in 18% and PTA/stents in 82%. Technical success was 98.6%. Over the 8 observed failures, 4 patients had a second successful procedure. Closure devices were used in 52.4% procedures. All patients received heparin during the procedure and were discharged with dual anti-platelet therapy. Conversion and readmission rates were 2% and 0.6%, respectively. Complication rate was 3.6% (minor and major 2.8% and 0.8%, respectively). No correlation was found between complications and closure device usage. Restenosis rate was 24.5% during the long-term follow-up (mean 44 months).

**Conclusion:** As designed, The OPAP was feasible, safe and effective with very low conversion and complications rates. These results strongly support a larger use of such approaches as routine practice.

#### SS217

A single-center retrospective cohort study of stent retriever safety, firstpass efficacy and related functional outcome in acute ischemic stroke.

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**Purpose:** Differences in performance and long-term outcome among the Solitaire and Trevo stent retrievers during endovascular mechanical thrombectomy (EVT) are based on meta-analyses. Unfortunately, included studies differ in design, patient selection, technique and operator experience. Moreover, the rate of one-pass recanalization success is not reported. This single-center cohort study retrospectively studied performance and functional outcome of two stent systems.

**Methods and Materials:** All ischemic stroke cases managed by EVT between 2014-2017 were analyzed. Inclusion criteria were: terminal carotid or M1 occlusion managed by EVT with or without intravenous thrombolysis using either a Solitaire or Trevo. Exclusion criteria were: tandem carotid exclusion, stent use following direct thrombo-aspiration and calcified occlusion. Patient age, sex, baseline and 3-month mRS from the ASTRAL registry were recorded. The number of passes, complications, and mTICI score were compared.

**Results:** One-hundred-twenty-nine patients were included (avg. 71 years, 52% male), 62 managed with a Solitaire and 67 with a Trevo. No significant difference in age or sex was observed. Average baseline mRS was slightly higher in the Solitaire cohort (Solitaire 1.0, Trevo 0.6). First pass recanalization success obtaining either mTICI 2b or 3 was identical (Solitaire 71.5%, Trevo 71.1%). Average 3-month mRS was higher in the Solitaire group (Solitaire 3.5, Trevo 2.9), but absolute difference between 3-month and baseline mRS was not significantly different (Solitaire 2.2, Trevo 2.3)

**Conclusion:** Solitaire and Trevo achieve a high rate of one-pass recanalization success in acute ischaemic stroke. No significant differences in functional outcomes or complication rate could be demonstrated. **Purpose:** In vitro and in vivo evaluation of fast- and slow-release gemcitabine-eluting hydrogel (GEH) devices.

**Methods and Materials:** For in vitro elution, the GEH devices were placed in phosphate-buffered saline at 37 °C. Periodically, the solution was analyzed for gemcitabine. The devices consisting of fast release (n = 8), slow release (n = 6), or bland (n = 4) were delivered through a 5-Fr catheter into the gastroduodenal artery of a pig. Additionally, four pigs were treated with intravenous (IV) injection of gemcitabine. Pigs were killed at day 1 (n = 9), day 7 (n = 11), or day 21 (n = 2). Gemcitabine concentrations in the plasma and tissues were determined.

**Results**: In vitro, gemcitabine was completely eluted within 6 h or 30 days for the fast- and slow-release devices, respectively. All 22 pigs were treated without morbidity or mortality. Gemcitabine plasma concentrations peaked at about 105,000  $\pm$  30,000, 252  $\pm$  101, 22  $\pm$  29, and 0  $\pm$  0 ppb for the IV, fast-release, slow-release, and bland treatments, respectively. At days 1 and 7, gemcitabine concentrations were higher in the pancreas for the GEH devices than IV. Gemcitabine delivery to the pancreas was sustained over 21 days in the slow-release group.

**Conclusion:** Treatment with GEH devices resulted in at least equivalent gemcitabine concentration in the pancreas and reduced concentration in the plasma, heart, liver, and duodenum, at least equivalent to IV injection and reduced concentrations elsewhere. These results show the potential of sustained local delivery of gemcitabine to treat pancreatic neoplasms with reduced side effects

SS219

#### Selective Internal Radiation Therapy used as a First-Line Therapy in Patients with Uveal Melanoma Liver Metastases: Survival Analysis and Predictive Factors of Survival

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**Purpose:** To assess survival outcomes and prognostic factors of patients with uveal melanoma liver metastases treated with Selective Internal Radiation Therapy (SIRT) used as first-line therapy as opposed to salvage therapy.

**Methods and Materials:** A retrospective analysis of a prospectively collected database was performed on 22 patients who were treated with SIRT as first-line therapy between September 2010 and September 2017. Demographics, radiological, functional and clinical data, SIRT number and characteristics (partition model dosimetry), and subsequent treatments (chemo-/immunotherapy, thermal ablation, transarterial chemoembolization) were analyzed. The effect of those parameters was determined by univariate analysis and overall survival (OS) by Kaplan-Meier analysis.

**Results:** 22 patients (median age 59 years, range 30-82; 11 male) were treated in 29 sessions. At the time of analysis, 15 (68.2) patient had died and 7 (31.8) were alive. Median OS following the first SIRT was 13 months (95%CI, 8-28). Subsequent post-SIRT liver-specific therapies (thermal ablation and chemoembolization) were significantly predictive of survival (P<0.05). Metabolic tumor volume (hazard ratio (HR):1.01; 95%CI, 1.00-1.01) and tumor to healthy tissue ratio (HR:1.08; 95%CI, 1.02-1.15) were significantly correlated with survival (P<0.05). Other variables such as as treatment of the primary cancer, baseline extrahepatic disease at the time of SIRT or development of extrahepatic disease during follow-up were not correlated with survival. **Conclusion:** SIRT used as first-line therapy was effective. Subsequent post-SIRT liver-specific locoregional therapies correlated with survival. Clinical trials using SIRT as first-line therapy should be performed.

SS218

# Hepatocellular carcinoma: Radioembolization-induced liver disease occurrences using partition model for dose calculation

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**Purpose:** To assess Radioembolization-induced liver disease (REILD) occurrences after radioembolization (RE) for hepatocellular carcinoma (HCC) using partition model for dose calculation

**Methods and Materials:** Data of radioembolization treatment for HCC performed from the last 4 years in our university hospital were analysed. Serum Bilirubin level>50ug/l or significant ascites at 6-8weeks after RE defined REILD.

**Results:** 81 patients were included [mean age (60y ±11); MELD (8.2±2.31); Bilirubin (16±9.5) and albumin (37±5)]. 55% and 45% of RE was performed with resin or glass microsphere respectively. Mean injected activity was 2.2 GBq (±1). 8 (9.9%) REILD occurred at 2 months. Baseline MELD score (0.003) was significantly associated with REILD. 1-year overall survival was 52% without REILD versus 28% with REILD, p=0.1. MELD 2 months after RE was significantly higher than baseline, 9.49 (±3) versus 8.2(±2.31), p=0.0002. 25% of patients experienced MELD increase of 2 points or more at 2-months follow-up.

**Conclusion:** Partition model dose calculation allows injecting higher activity. Using higher activity did not increase REILD occurrence.

#### SS221

Hepatocellular carcinoma abutting large vessels: Comparison of four percutaneous ablations systems

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**Purpose:** To compare overall local tumor progression (OLTP), defined as the failure of primary ablation or local tumor progression, between single applicator monopolar RFA, microwave ablation (MWA), cluster-RFA and multibipolar radiofrequency (mbpRFA) treating HCC≤5cm abutting large vessels (≥3mm).

**Methods and Materials:** This study was approved by the ethics review board, and informed consent was waived. This multicenter, retrospective, per-nodule study was performed from 2007 to 2015. Among the 914 HCC nodules treated by thermal ablation, 160 HCC abutting large vessel (40 per treatment group) treated either by monopolar RFA, MWA, cluster-RFA or Mb-pRFA were matched for tumor size, alpha-feto-protein level and vessel size. OLTP rates were compared with the log-rank test and the multivariate Cox model after matching.

**Results:** No differences were observed in tumor size, vessel size or alpha-feto-protein levels among the three groups (P=1). The cumulative 4-year OLTP rates were 50.5%, 16.3%, 16.3% and 44.2% following monopolar RFA, cluster-RFA, multibipolar RFA and MWA, respectively, P = 0.036. On multivariate Cox regression, vessel size≥10 mm, monopolar RFA and MWA were independent risk factors of OLTP compared to cluster-RFA or mbpRFA.

**Conclusion:** Multi-applicator RFA provides better local tumor control in HCC abutting large vessels than single-applicator technique (monopolar RFA or MWA).

#### Preoperative portal vein embolization alone with biliary drainage compared to combination of simultaneous portal vein, right hepatic vein embolization and biliary drainage (liver deprivation) in cholangiocarcinoma

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**Purpose:** To compare estimated future remnant liver (FRL) growth after portal vein embolization alone (PVE) vs. Liver venous deprivation (LVD) (combining PVE and right hepatic vein embolization), before surgery for Klatskin tumor in patient who receive biliary drainage simultaneously or before venous interventional radiology.

**Methods and Materials**: 6 patients underwent LVD and 6 PVE alone before major hepatectomy for Klatskin tumor. Before embolization, FRL ratio, Prothrombin Time or bilirubin level were similar in both groups. The FRL was calculated before and 23.5 days (15-29) after embolization based on enhanced CT-Scan. PVE was performed with n-butyl-2-cyanoacrylate and right hepatic vein was embolized with vascular plugs during the same procedure. Biliary drainage was performed percutaneously or by endoscopy. Post-hepatectomy liver function and duration of hospital stay were assessed.

**Results:** In all patients, the procedure were performed during a 48 hours hospital stay without adverse events. Median FRL ratio was significantly higher after LVD, 58% (54-71) compared to PVE, 37% (30-44), p=0.017. FRL volume after embolization was 1.6 times higher after LVD than PVE (p=0.016). Four patients were operated in LVD group and 5 in PVE group. A trend for shorter median hospital stay after surgery and 90-days mortality was observed in LVD vs. PVE group: 14 vs. 44 days, (p=0.114) and 0 versus 2 death (p=0.429).

**Conclusion:** LVD allows to obtain better FRL ratio than PVE . This gain in functional liver volume may contribute to explain possible better post-operative outcome.

#### SS223

# What is the diagnostic performance of 18-FDG-PET/MR compared to PET/CT in the initial staging of breast cancer?

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**Purpose:** To compare the diagnostic performance of 18-FDG-PET/MR and PET/CT for the initial staging of breast cancer.

Methods and Materials: Two independent readers blinded to clinical/follow-up data retrospectively reviewed PET/MR and PET/CT examinations performed for initial breast cancer staging in 80 consecutive patients (mean age =55.3+/-7.7 years). The diagnostic confidence for lesions in the contralateral breast, axillary and internal mammary regions, bones and other distant sites were recorded. Sensitivity, specificity, positive predictive (PPV) and negative predictive values (NPV) were calculated and results were compared with the gold standard (pathology and/or follow up>24months). Results: 9/80 patients had bone metastases, 13/80 had other distant metastases, 44/80 had axillary, 9/80 had internal mammary metastases and 3/80 had contralateral breast tumors. Inter-reader agreement for lesions was excellent (weighted kappa=0.833 for PET/CT and 0.823 for PET/MR) with similar results regarding reader confidence between the two tests (ICC=0.875). In the patient-per-patient analysis, sensitivity and specificity of PET/MRI and PET/CT were similar (p>0.05). In the lesion-per-lesion analysis, the sensitivity of PET/MR and PET/CT for bone metastases, other metastases, axillary and internal mammary lymph nodes, and contralateral tumors was 0.924 and 0.6923 (p=0.034), 0.923 and 0.923 (p=1), 0.854 and 0.812 (p=0.157), 0.9 and 0.9 (p=1), 1 and 0.25 (p=0.083), respectively. The corresponding specificity was 0.953 and 1 (p=0.081), 1 and 1 (p=1), 0.893 and 0.92 (p=0.257), 1 and 1 (p=-1) and 0.987 and 097 (p=1) respectively.

**Conclusion:** Diagnostic confidence with both examinations was similar. Although PET/MR had a superior sensitivity for bone metastases than PET/ CT in the lesion-by-lesion assessment, the diagnostic performance in the patient-per-patient analysis was similar.

# SS224

# Analysis of pulmonary lymphangitic carcinomatosis in untreated lung cancer patients: What we can learn from HRCT and PET?

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**Purpose:** To investigate the respective sensitivity and specificity of HRCT and PET signs for the diagnosis of lymphangitic carcinomatosis (LC).

**Methods and Materials:** One hundred six patients addressed for initial staging of lung cancer were retrospectively included. Using double blind analysis, we assessed the presence of signs favoring LC on HRCT (smooth lines or nodular septal lines, subpleural nodularity, peribronchial thickening, satellite nodules, lymph node enlargement and pleural effusion). 18F-FDG PET/CT were reviewed to assess the presence of tracer uptake higher than background in peritumoral areas within a range of 3 cm.

**Results:** Among 106 included patients, 71% (76/106) had histologically confirmed LC. Peribronchial thickening (odds ratio: 9.4 [3.2–27.6], p<0.001) and lymph node enlargement (odds ratio: 3.9 [1.5–9.7], p=0.004) on HRCT and increased peritumoral FDG uptake (odds ratio: 91 [22.7-365.2], p<0.001) on PET/CT were significantly associated with LC on logistic regression analysis. Peribronchial thickening and lymph node involvement had a sensitivity, specificity, and ROC area of 66%, 83% and 0.75 (0.66–0.83) and 64%, 69% and 0.66 (0.56–0.76), respectively, while the presence of an increased peritumoral uptake of FDG had a sensitivity, specificity, and ROC area of 93%, 87% and 0.9 (0.83–0.97) for detecting LC.

**Conclusion:** Peribronchial Thickening and lymph node enlargement on HRCT and peritumoral FDG uptake higher than background on FDG PET/CT are significantly associated with LC in untreated lung cancer. Combining resultant morphologic and metabolic criteria may help to establish a powerful tool for the initial diagnosis of LC.

# FDG - PET/CT predicts PD-L1 expression in non-small cell lung cancer (NSCLC): The Hot to Global Volume Ratio (HGVR)

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**Purpose:** PD1/PD-L1 targeted therapy is changing the landscape of cancer treatment dramatically and its expression in the tumor microenvironment predicts survival. We investigated the correlation of FDG-PET functional and morphologic characteristics with tumoral expression in NSCLC.

**Methods and Materials:** We retrospectively analyzed FDG-PET/CT in 50 patients with histologically confirmed NSCLC who were investigated by immunohistochemistry for PD-L1 tumor expression on surgical sample or biopsy. Results were correlated to SUV<sub>max</sub>, SUV<sub>mean</sub>, metabolic tumor volume (MTV) and total lesion glycolysis (TLG). HGVR was calculated by dividing the difference between the morphologic and metabolic lesion volume by the morphologic volume and correlated to PD-L1 positivity.

**Results:** 26 adenocarcinomas and 24 squamous cell carcinomas were analyzed. All tumors showed metabolic FDG uptake with mean SUV<sub>max</sub> 13.4g/ ml (3.3–28.1), SUV<sub>mean</sub> 6.8g/ml (1.9–16.3), MTV 50.3cm<sup>3</sup> (1.2–456) and TLG 285.9g\*cm<sup>3</sup>/ml (5–2233). We found a statistically significant correlation between MTV and TLG (p=0.05, p=0.002), but not morphologic tumoral volume, SUV<sub>max</sub> and SUV<sub>mean</sub> – (p=0.2, p=0.15 and p=0.27) with PD-L1 expression. Wilcoxon rank-sum test confirmed the significant difference between MTV and TLG and PD-L1 tumor expression (p = 0.039; p = 0.027). We found a strong positive correlation between HGVR and PD-L1 expression (R = 0.834, p < 0.05).

**Conclusion:** HGVR, measuring intra-tumoral necrosis versus high peripheral glucose consumption, might serve as new factor to predict PD-L1 expression. This observation can be well explained by induction of PD-L1 expression by hypoxia/necrosis and might be highly relevant for immune oncology in the future.

SS226

# Pretreatment 18F-FDG PET whole-liver radiomics analysis predicts toxicity after 90Y-TARE for hepatocellular carcinoma.

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**Purpose:** To predict liver toxicity in patients undergoing transarterial radioembolization using Yttrium-90 (<sup>90</sup>Y-TARE) for unresectable hepatocellular carcinoma (uHCC) based on pretreatment 18F-FDG-PET whole-liver radiomics model.

**Methods and Materials:** Pretreatment <sup>18</sup>F-FDG-PET of 36 consecutive patients undergoing <sup>90</sup>Y-TARE for uHCC (25 resin, 11 glass microspheres) were analyzed. For each patient, extraction of radiomics features was performed using a whole-liver semi-automatic segmentation. Values of serum albumin, hepatic functions enzymes (ALT-SGPT, AST-ASAT), alkaline phosphatase (aP), gamma-GT (gGT) and total bilirubin performed 3 months after <sup>90</sup>Y-TARE were collected. Laboratory toxicity was graded according to the Common Terminology Criteria Adverse Events (CTCAE v4.03).

**Results:** A total of 108 radiomics features were extracted. Laboratory revealed albumin toxicity in 2 patients, ALT-SGPT toxicity in 7 patients, AST-ASAT toxicity in 17 patients, aP in 21 patients, gGT in 30 patients and total bilirubin toxicity in 7 patients (4 patients with grade 1 and 3 with grade 2). ROC analysis showed that three whole-liver textural features (homogeneity3, inverse\_difference\_moment2 and max\_spectrum) were able to predict total bilirubin toxicity at 3 months using a ROC analysis AUC 0.749 (CI 0.580-0.918, p=0.044); AUC 0.749 (CI 0.582-0.915, p=0.044); AUC 0.754 (CI 0.592-0.915, p=0.040), respectively. Whole-liver radiomics features did not predict albumin, ALT-SGPT, AST-ASAT, aP, nor gGT toxicity.

**Conclusion:** Pretreatment <sup>18</sup>F-FDG-PET whole-liver radiomics model can accurately predict liver toxicity in patients undergoing <sup>90</sup>Y-TARE for uHCC. This model analyzes patterns of tumoral and non-tumoral liver therefore describes the biological interplay of uHCC with the underlying cirrhosis and might serve as reader independent imaging tool to predict bilirubin toxicity in patients undergoing <sup>90</sup>Y-TARE.

#### SS228

Comparison of Glucagon-like-Peptide-1 (GLP-1) receptor PET/CT, SPECT/ CT and 3T MRI for the localisation of Insulinomas: Evaluation of accuracy in a prospective crossover imaging study.

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**Purpose:** Benign insulinomas are the most prevalent cause of endogenous hyperinsulinaemic hypoglycaemia (EHH) in adults and due to their small size difficult to localise. We aimed at prospectively comparing the accuracy and clinical impact of glucagon-like-peptide-1 receptor (GLP1-R) PET/CT, SPECT/CT, standardised 3-Tesla contrast-enhanced (ce)MRI and non-standardised baseline imaging (ceCT/ceMRI) in patients with EHH.

**Methods and Materials:** We prospectively enrolled patients with neuroglycopenic symptoms due to EHH and no evidence for metastatic disease on conventional imaging. Standardised ceMRI was performed using clinical routine sequences. SPECT/CT was performed 4h/72h after injection of 111In-DOTA-exendin-4 and PET/CT 2,5h after injection of 68Ga-DOTA-exendin-4 in a randomized, cross over design. The reference standard was surgery with histology and normalisation of blood glucose levels within 10 days.

**Results:** From January 2014 until March 2017, we recruited 52 patients. Baseline imaging identified suspicious lesions in 25/52 patients. 68Ga-DOTA-exendin-4 PET/CT, 111In-DOTA-exendin-4 SPECT/CT and standardised ceMRI detected suspicious lesions in 40/52, 33/52 and 32/52 patients In 38 patients conclusive histology was available for final analysis.

Accuracy for PET/CT, SPECT/CT, standardized ceMRI and baseline ceCT/ce-MRI was 93.9%, 67.5%, 67.6% and 40%, respectively. Impact on clinical management was 40.4%, 32.7% and 32.7% for PET/CT, SPECT/CT and standardised ceMRI. Percentage reading agreement was highest with PET/CT, followed by SPECT/CT and MRI.

**Conclusion:** GLP-1R PET/CT performed significantly better than SPECT/CT and ceMRI in the localisation of benign insulinomas and should be the diagnostic tool of choice in patients where localization fails with CT/MRI.

### 68Ga-PSMA-11 PET/MR detects mpMRI negative local recurrence in patients after HIFU

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**Purpose:** High-intensity focused ultrasound (HIFU) is a promising new modality for the treatment of localized prostate cancer (PCA). Control of PCA can be reached in about 60% after one treatment. Follow up of patients to rule out recurrence is recommended with biopsies and multiparametric MRI (mpMRI). However, mpMRI is often false negative. We investigated if the new tracer targeting the prostate specific membrane antigen (68Ga-PSMA-11) could be used to localize recurrent disease with PET/MR.

**Methods and Materials:** Interim analysis of the first eight patients scanned between 09/2016-09/2017 with negative mpMRI and positive template biopsy after HIFU from an ongoing trial (NCT02265159). All patients underwent a PET/MR scan 60 minutes after injection of 85 MBq 68Ga-PSMA-11. Focal 68Ga-PSMA-11 uptake was measured with the maximum standardized uptake value (SUVmax), areas with increased 68Ga-PSMA-11 uptake were compared with the template results and corresponding Gleason Scores (GS).

**Results:** All four patients with GS4+3 disease had increased focal 68Ga-PS-MA-11 uptake with a mean SUVmax of 9.1 (range 7.7-12.1), with a maximum tumor biopsy core length of 2-5 mm. Of the four patients with GS3+4 recurrences, two patients were negative on 68Ga-PSMA-11-PET. In both cases only one needle was positive with a tumor length of 0.5 and 1.5mm, respectively. The two patients with GS3+4 with positive PET results (SUVmax 4.7 and 5.5) had more extensive PCA with 2 and 4mm, respectively.

**Conclusion:** This are promising preliminary results, showing that 68Ga-PS-MA-11-PET/MR might detect significant cancer after HIFU in patients with negative mpMRI.

### Risks of Goalkeeper fractures in children

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**Purpose:** Goalkeeper fractures are frequent fractures of the distal radius in children, which repel a ball when playing football. The aim of this study was to evaluate risks which may predispose to this special type of fatigue fracture in children.

SS229

SS230

**Methods and Materials:** Monocentric study with a questionnaire to children with radiologically confirmed goalkeeper's fractures. Questionnaires were sent to 179 patients (mean 10.6 years ± SD 2.4 years) with proven goalkeeper's fractures. Forty-two (23%) children returned a complete questionnaire. We assessed the risks of goalkeeper's fractures and radiographic signs (AO fracture classification and growth plate shaft angle (GPSA)).

**Results:** The most common fractures in 42 patients were torus fractures (n=25, 60%). In 35 (83%) patients the radius metaphysis, in 4 (10%) patients the diaphysis, and in 3 (7%) patients the epiphysis was affected. The most severe fractures were observed in goalkeepers at the age 7 years and 13 to 14 years. All patients but one saved the ball with open and retroflexed hands. Risk factors for higher radiographic scores were older children or adults kicking the ball against younger children. Supervision of a coach and warming up may reduce the severity of forearm fractures. All positions (goalkeeper, striker, and defender) had similar frequencies for their fractures.

**Conclusion:** Goalkeeper's fractures are typical metaphyseal fatigue fractures of the distal radius and occur frequently in young soccer players. High shear forces on the radius metaphysis can lead to torus fractures in teenagers. Increased awareness and prevention can reduce these common stress fractures.

# Goalkeeper's fractures in children. Radiographic findings and diagnostic value of the growth plate shaft angle (GPSA) of the distal radius

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**Purpose:** The purpose of this study was to describe radiographic findings of goalkeeper's fractures in children. In addition, we evaluated the growth plate shaft angle (GPSA) of the distal radius on lateral radiographs in comparison with a normal cohort.

**Methods and Materials:** This retrospective study included 179 children under 16 years of age (mean 10.6y, 157 boys, 22 girls) with fractures of the distal radius and anamnesis for trauma after making a soccer ball save. A normal control group of 142 children was compared. Two radiology residents evaluated all radiographs in two readings. In the first reading, the residents used the AO-pediatric bone fracture-classification for fracture detection. In the second reading, they additionally measured the GPSA and compared it to the data of the control group. The residents determined the confidence of the fracture diagnosis.

**Results:** The most common goalkeeper's fractures (distal forearm fatigue fractures) were torus fractures (n= 92, 51%). In the control group, the average GPSA measured +1.6° (SD  $\pm$ 3.1°). The average GPSA in the group with goal-keeper's fractures measured -7.2° (SD  $\pm$ 7.9). The difference in the GPSA was significant (student t-test, p<0.001). GPSA measurement improved the accuracy of the diagnosis for the less experienced reader from 0.70 in the first reading to 0.87 in the second. The difference is significant (Fisher exact test, p<0.001). Reader B tended to have higher accuracy in the second reading. Both readers improved their confidence in the second reading (p<0.001). **Conclusion:** The measurement of the GPSA increases the accuracy and confidence of the radiographic diagnosis of goalkeeper's fractures.

# Postmortem imaging (CT-MRI) in a pediatric population: An imaging review

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**Purpose:** To illustrate the contribution of post-mortem whole body CT and MR (PMCT/MR) with various pediatric forensic examples.

To know the physiologic post-mortem tissue changes on whole body PMCT/ PMMR for an adequate imaging analysis.

**Methods and Materials:** We retrospectively reviewed the post-mortem imaging in 22 children (1 day -14 years) and 3 fetuses (24-36 GA) over a period of one year. The cases involved various medicolegal settings: 6 violent deaths, 3 iatrogenic deaths (medical or surgical), 13 unexpected deaths and 3 fetal deaths.

Imaging consisted of CT (64-slice,GE) (n=18), MRI (1.5T,Philips) (n=1), both CT and MRI (n=6). One case underwent contrast injection (Angiofil®) on CT/MR. The difference between the physiologic or pathologic findings are discussed.

**Results:** 1)PMCT/PMMR examples are used to illustrate the physiologic post-mortem changes (eg. effusions, cerebral venous dilatation, pulmonary condensations, hyperintensity of the pancreas and intestinal distension), resuscitation-related lesions (eg. anterior rib fractures), and underlying congenital malformations.

2)PMCT is particularly useful in demonstrating bone lesions (eg. damage to cervical spine in violent deaths). PMMR is better for the analysis of the brain and solid organs as well as thoraco-abdominal effusions. PM imaging allowed differentiation of five cases of abusive trauma among the 13 unexplained deaths by demonstrating characteristic bone and brain lesions.

**Conclusion:** Pediatric PM imaging is usefull for fœtopathological or forensic investigation; CT and MRI are complementary tools. In the event of an unexpected infant death, PMCT/PMMR allow for differentiation of sudden infant death syndrome and child abuse. Pediatric PMCT/MR with contrast media need further development.

SS232

#### Playful MRI simulator to reduce MRI anesthesia in children: experience in Geneva

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**Purpose:** To discuss the role of a playful MRI simulator to reduce anesthesia in young children for MRI studies.

**Methods and Materials:** In our unit, 1500 MRI are performed each year in children, of which 500 are performed under general anesthesia.

MRI simulator had used in 282 children (3 to 13 years old; mean : 6) who should have had anesthesia due to their age, psychic state or anxiety. Just before the real MRI, this simulation consists of placing the child in a miniature MRI designed to explain the constraints of MRI: positioning, noise and immobility. If an injection of gadolinium is necessary, an EMLA patch or a venous catheter is placed before the playful MRI.This preparation lasts about 20 minutes.

**Results:** The real MRI exam was of good quality in 92% of cases. Only 22 children needed anesthesia despite preparation by the simulator.

Our results show that this method was able to reduce by approximately 10% the number of MRIs done under anesthesia. The interest is to reduce the cost and the drug administration and to optimize the number of daily MRIs. The educational purpose of the simulator is particularly interesting for children who will have to undergo many MRIs during their childhood. Experience shows that parents are satisfied with this method and are better prepared to accompany their child to the exam.

**Conclusion:** The playful MRI simulator is a technique that avoids anesthesia in children during an MRI in the majority of selected cases above the age of 3 years.

SS231

### SS233

#### MRI Contribution in the Prenatal Diagnosis of Vascular Malformations

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**Purpose:** Vascular anomalies are classified into malformations - dysmorphgenesis with normal endothelial turnover - and tumors - cellular proliferation and hyperplasia. They are often detected by fetal screening US. Occasionally, a complementary MRI is performed.

The main objectives of this study were: 1.- To assess the accuracy of prenatal MRI examination in the diagnosis and characterization of vascular anomalies and 2.- To evaluate the relevance of additional information obtained by complementary MRI.

**Methods and Materials:** All congenital vascular anomalies detected in the last 10 years at 2 University Hospitals were retrospectively identified. Patients with prenatal US and MRI exams and a confirmed final diagnosis were included. The prenatal diagnosis suggested by imaging was compared with the final one, obtained from anatomo-pathological and/or postnatal exams. Relevance of additional MRI information was studied.

**Results:** Thirty-one patients filled the inclusion criteria: 5 tumors and 26 malformations -14 lymphatic, 1 arterial, 1 venous and 10 Galen vein. Prenatal imaging established the correct diagnosis in 25/31 cases (80.6%) - 2/5 tumors (40%) and 23/26 malformations (88.4%), including all Galen vein and 11/14 lymphatic malformations (78.6%). US and MRI diagnoses correlated in 27/31cases (87.1%) and differed in the remaining 4 cases (12.9%) - 3 tumors and 1 lymphatic malformation. MRI mainly informed about the extension and severity of anomalies.

**Conclusion:** Prenatal identification and appropriate characterization of vascular anomalies based on imaging remains difficult. Although MRI does not improve their characterization, it provides relevant information about the extension and the infiltration of adjacent structures, crucial to anticipate prognosis and postnatal care.

#### SS234

#### Gestational changes of the microvascular perfusion of the placenta, fetal liver and lungs assessed with in utero intravoxel incoherent motion imaging

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**Purpose:** Our aim was to characterize gestational changes in the microvascular perfusion fraction of the placenta, fetal liver and lungs using fetal intravoxel incoherent motion (IVIM) MRI.

**Methods and Materials:** Diffusion-weighted echo-planar imaging were performed at 1.5T and 3.0T with b-factors ranging from 0 to 900 s/mm<sup>2</sup> in 16 steps in 33 singleton pregnancies (17-36. gestational weeks). Using the IVIM principle, microvascular perfusion fraction (f), pseudo-diffusion (D\*) and diffusion coefficients (d) were estimated for the placenta, liver and lungs with a bi-exponential model. A nonlinear deformation algorithm was used to correct for the motion of the fetal organs and the placenta. IVIM parameters were compared to Doppler ultrasound based assessment of the umbilical artery resistance index (UA-RI).

**Results:** Placental f (0.29±0.08) indicated high blood volume in the microvascular compartment, and correlated negatively with the UA-RI (R=-0.457). The f of the liver decreased sharply during gestation (R=-0.436). Lung maturation was characterized by increasing perfusion fraction (R=0.547). We found no gestational changes in d and  $D^*$  values. The Doppler measurements of the umbilical artery and middle cerebral artery did not correlate significantly with the IVIM parameters of the lungs and liver.

**Conclusion:** In utero IVIM MRI provides a novel method for examining microvascular perfusion fraction and diffusion in the developing human fetus. We revealed gestational age associated changes of the placental, liver and lung IVIM parameters that likely reflect changes in placental and fetal circulation and the trajectory of microstructural and functional maturation of the fetal vasculature.

# Slice-by-slice intensity inhomogeneity correction from a globally-estimated bias field for fetal MRI reconstruction

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**Purpose:** We aim at improving bias field correction for fetal brain MRI reconstruction of a motion-free 3D high-resolution image given a set of motion-corrupted low-resolution multi-slice scans.

**Methods and Materials:** The approach uses a non-parametric bias field correction method to estimate a coherent and smooth bias field from the high-resolution reconstructed image. Then, the bias field is propagated to each slice and subtracted taking benefit of the reconstruction forward model.

We show the reconstruction results obtained for one patient diagnosed with unilateral ventriculomegaly. Acquisition was performed during the 26<sup>th</sup> week GA at Boston Children's Hospital using a 3T Siemens Skyra with a T2w HASTE sequence (TE/TR = 116-119/1600ms). It consists of 6 orthogonal scans of thick slices, 2 per anatomical direction, with a resolution of 1×1×2mm<sup>3</sup>.

Our method is publicly available and well documented at https://github. com/sebastientourbier/mialsuperresolutiontoolkit and ready to process large-scale datasets.

**Results:** We compare an image reconstructed using the previous *state-of-the-art* pipeline based on *independent* slice-by-slice bias field correction and the new pipeline integrating the proposed approach.

Visual inspection shows clearly that our method allows the estimation of a coherent bias field which provides a reconstructed image quasi free of smooth intensity inhomogeneities. We can also observe that the incoherency of the bias field introduces intensity artifacts (previous approach) that are removed thanks to the new approach.

**Conclusion:** Our method, based on slice-by-slice intensity correction from a globally-estimated bias field and integrated in the fetal MRI reconstruction framework, enables the retrospective reconstruction of an image quasi free of the smooth magnetic bias field.

#### SS236

#### Influence of phase-offset error correction method on haemodynamic parameters assessed by phase-contrast magnetic resonance in patients with congenital heart disease

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**Purpose:** To investigate the estimation of background velocity in large vessels by fitting a plane through stationary tissue (STATFIT) in a phase-contrast (PC) acquisition versus separate phantom measurements for phase-offset error correction in cardiovascular magnetic resonance (MR).

**Methods and Materials:** Retrospective analysis of effects of phase-offset error correction by STATFIT and phantom measurements on haemodynamic parameters in 36 patients (median age 18y, range 3–49y) with congenital heart disease who underwent PC flow quantification in 144 large vessels (ascending aorta and pulmonary arteries: MPA,RPA,LPA). Data without normal distribution are given as median (interquartile range) and compared between methods with Wilcoxon test.

**Results:** Phase-offset correction by STATFIT revealed higher velocity change than by phantom measurements [1.1(0.5 to 1.6)cm/s versus 0.6(0.3 to 0.9) cm/s, p<0.0001] and more variable change of flow volume [-2.3(-9.8 to 4.6)% versus -1.6(-5.1 to 2.1)%], resulting in different flow volumes than without correction for both methods [p=0.007 and p=0.001]. Although the corrected flow volumes of all vessels were not different between methods [42.4(29.1 to 61.2)ml versus 41.8(29.5-62.2)ml, p=0.35], STATFIT showed higher Q<sub>p</sub>/Q<sub>s</sub> [median difference 0.11, p<0.0001], lower pulmonary regurgitation fraction [median difference -0.5%, p=0.019] and smaller percentage of blood flow to the right lung [median difference -3.0%, p=0.0001] than phantom correction. (RPA+LPA)/MPA did not change significantly from 0.975±0.148 to 0.980±0.157

**Conclusion:** Both phase-offset error correction methods significantly change flow velocity and volumes assessed by phase-contrast MR. Which method more accurately corrects background velocity remains open and warrants further study.

### SS237

#### Software automated versus manual pediatric protocol optimization in chest computed tomography: Phantom study evaluating effects on radiation dose and image quality

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**Purpose:** The aim of this study was to compare software automated versus radiologist manual Computed Tomography (CT) protocols optimization strategies by using a CT phantom with different acquisition parameters and iterative reconstruction (IR) levels in order to maintain high image quality while decreasing dose and image noise.

**Methods and Materials:** A CT phantom underwent simulated pediatric chest CT scans using both automated and manual parameters optimization approaches performed by a radiologist.

Phantom was scanned within different protocols varying kV, mAs, pitch, IR. The subjective and objective image qualities were assessed by both radiologists and software.

Computed tomography dose index (CTDI) and dose-length product (DLP) values were collected and analyzed. Equivalent dose to organ at risk (OAR) was assessed with a Monte Carlo system using a digital phantom simulating a six-year-old pediatric patient.

**Results:** Dose to OAR, CTDIvol and DLP were substantially lower (90%,58% and 32% respectively) adopting a manual approach, maintaining a good subjective image quality as demonstrated by a human visual scoring (VGA) test evaluation on images.

Through CT acquisitions, linearity and resolution were constant while image noise (mean -6.4, standard deviation 10.1) and uniformity (mean -6.4, standard deviation 10.1,) varied between scans, as observed by 3 experienced radiologists by VGA.

Iterative reconstruction was associated with a further dose reduction using level 3 (max 6) in order to avoid texture effect.

**Conclusion:** In a simulated pediatric chest CT study, radiologist guided acquisition resulted the best choice in terms of optimal dose-image quality ratio while maintaining good image quality.

# Repeatability of ventilation and perfusion impairment assessed with matrix pencil decomposition MRI and lung function in children with cystic fibrosis

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**Purpose:** To test short term variablity of ventilation and perfusion impairment detected in cystic fibrosis (CF) children and healthy controls using matrix pencil decomposition MP-MRI and nitrogen multiple breath washout (N<sub>2</sub>-MBW) technique.

**Methods and Materials:** Twenty-three children with CF (mean age: 13.5 years, range: 6-18 years) and twelve healthy controls (range: 6-17 years, mean age: 11.9 years) were examined on a 1.5T MR-scanner. Lung function was assessed with MP-MRI, yieling fractional ventilation (FV) and relative perfusion (Q) images. Signal distributions on the segmented FV and Q images were analyzed to estimate threshold values indicating functional impairment. Values of impaired ventilation ( $R_{\rm FV}$ ) and relative perfusion ( $R_{\rm q}$ ) were calculated for every subject. N<sub>2</sub>-MBW washout was performed in every subject according to consensus and the primary outcome was the lung clearance index (LCI).

**Results:**  $R_{FV}$  and  $R_{Q}$  was significantly higher in CF patients compared to healthy controls on both visits. In both groups, no significant difference in  $R_{FV}$ ,  $R_{Q}$  or LCI between both visits was found (Wilcoxon signed-rank test). The short-term repeatability of MRI and MBW outcomes (agreement between visits) calculated using inter-class correlation (ICC) was higher for CF participants (ICC:  $R_{FV}$ =0.87,  $R_{Q}$ =0.87, LCI=0.9) than for healthy children (ICC:  $R_{FV}$ =0.75,  $R_{Q}$ =0.6, LCI=0.68). A strong correlation between functional MRI outcomes ( $R_{FV}$ ,  $R_{Q}$ ) and LCI was found.

**Conclusion:** MP-MRI is feasible and repeatable in children with CF and healthy controls. We assume, that the outcomes of MP-MRI could be used as a biomarker for the detection of changes in lung function impairment in lung disease.

Please note that abstracts appear as submitted to the online submission system.

#### Predictive and prognostic value of left ventricular mechanical dyssynchrony assessed by myocardial perfusion SPECT in asymptomatic patients under hemodialysis

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**Purpose:** Patients under hemodialysis (HD) have increased risk of major adverse cardiac events (MACEs). In these patients, myocardial perfusion scintigraphy (MPS) provides useful prognostic information. Left ventricular mechanical dyssynchrony (LVD) has been proven to predict allcause death in patients under HD. It remains unclear, whether the same prognostic value pertains also to the prediction of MACEs.

**Methods and Materials:** Ninety asymptomatic patients under HD (duration range 2-216 months) without history of coronary artery disease (CAD) were evaluated. All underwent clinical evaluation and MPS. MPS was reprocessed to derive LV ejection fraction (EF), perfusion scores (SSS and SDS) and LVD [phase histogram bandwidth (PHB) and phase standard deviation (PSD)].

**Results:** MACEs were reported in 10 patients (11.1%) at  $\geq 2$ -year follow-up (median 29 months). At univariate analysis, a correlation was demonstrated between MACEs and LVD (p<0.001), BMI (p=0.04), ECG changes during stress (p=0.03),dyspnea (p=0.02), SSS (p=0.04) and SDS (p=0.02). At multivariate analysis, only LVD (p<0.001), SSS (p=0.01) and SDS (p=0.001) were independent predictors of MACEs. No thresholds of SSS or SDS showed predictive value (p=0.79 for SSS  $\geq 4$ , p=0.10 for SSS >8 and p=0.66 for SDS  $\geq 2$ ). At survival analysis, patients with LVD had a significantly shorter MACE-free survival (p<0.001). This predictive value held true even in patients with an unremarkable pattern of perfusion.

**Conclusion**: In asymptomatic patients without known CAD under hemodialysis, LVD is highly predictive of the onset of MACEs at ≥2-year follow-up and provides incremental value over perfusion scores alone.

#### NSS102

Age- and Sex-dependent Changes in Sympathetic Activity of the Left Ventricular Apex Assessed by 18F-DOPA PET Imaging

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**Purpose:** Sexual dimorphism in autonomic nervous control of the cardiovascular system is currently gaining increasing attention in the context of Takotsubo cardiomyopathy. Previous studies suggest that there are sexand age-dependent differences in peripheral autonomic control, however, sex sepcific data on cardiac sympathetic activation are lacking.

**Methods and Materials:** Regional quantitative analysis of cardiac (<sup>18</sup>F)-Dihydroxyphenylalanine (DOPA) uptake was retrospectively performed with SUVmax normalized to blood pool in 133 patients (69 females, age 52.4±17.7 years), referred for assessment of neuroendocrine tumours between 02/2007-03/2016. Correlation calculated with Pearson and Spearman's correlation coefficient.

**Results:** Overall cardiac <sup>18</sup>F-DOPA uptake was significantly higher in women as compared to men (1.32±0.21 vs. 1.21±0.38, p=0.002). This sex-difference was most pronounced in the left apical region (LV, 1.28±0.27 in women vs. 1.13±0.27 in men, p=0.001) and in elderly individuals >55 years of age (1.39±0.25 in women vs. 1.12±0.29 in men, p=0.001). Women showed a prominent increase in myocardial <sup>18</sup>F-DOPA uptake with age (Pearson r=0.37, p=0.002) with the strongest increase seen in the LV apical region (r=0.41, p<0.001). No age-dependent changes of cardiac <sup>18</sup>F-DOPA uptake were observed in men (r=-0.01, p=0.9) or in the right ventricular (p=NS) region.

**Conclusion:** Our study suggests that there are sex- and age-dependent changes in regional cardiac sympathetic activity. The strong increase in LV apical <sup>18</sup>F-DOPA uptake with age in women might reflect a potential mechanism explaining the higher susceptibility of postmenopausal women to Takotsubo-cardiomyopathy.

# NSS103

Diagnostic accuracy of bone scintigraphy in the assessment of cardiac transthyretin-related amyloidosis: A bivariate meta-analysis

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**Purpose:** Cardiac transthyretin (ATTR) amyloidosis is a progressive and fatal cardiomyopathy. The diagnosis of this disease is frequently delayed or missed due to the limited specificity of echocardiography. Increasing literature data are demonstrating the ability of bone scintigraphy with technetium-labelled radiotracers in detecting myocardial amyloid deposits in particular in patients with ATTR amyloidosis. Therefore we aimed to perform a bivariate meta-analysis on the diagnostic accuracy of bone scintigraphy in patients with cardiac ATTR amyloidosis.

**Methods and Materials:** A comprehensive computer literature search of studies published through October 2017 about the role of bone scintigraphy in patients with ATTR amyloidosis was performed using the following search algorithm: A) amyloid or amyloidosis and B) TTR or ATTR or transthyretin and C) scintigraphy or scan or SPECT or SPET or bone or skeletal or skeleton or PYP or DPD or HMDP or MDP or HDP. Pooled sensitivity, specificity, positive and negative likelihood ratios (LR+ and LR-) and diagnostic odds ratio (DOR) of bone scintigraphy in patients with cardiac ATTR amyloidosis were calculated.

**Results:** The meta-analysis of six selected studies including 529 patients provided the following results about bone scintigraphy in cardiac ATTR amyloidosis: sensitivity was 92.2% [95% confidence interval (95%Cl) 89-95%], specificity 95.4% (95%Cl 77-99%), LR+ 7.02 (95%Cl: 3.42-14.4), LR- 0.09 (95%Cl: 0.06-0.14), DOR 81.6 (95%Cl: 44-153). Mild heterogeneity among the included studies was found.

**Conclusion:** Our evidence-based data demonstrate that bone scintigraphy with technetium-labelled radiotracers provides a very high diagnostic accuracy in the non-invasive assessment of cardiac ATTR amyloidosis.

NSS104

#### Quantitative and anatomical assessment of lung perfusion with 99mTc-MAA SPECT/CT in emphysema and lung cancer patients

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**Purpose:** Prior to lung resection, it is of paramount importance to predict the postoperative lung function. The current clinical practice is to use planar (2D) scintigraphy with its obvious limitations. Our aim is to assess the feasibility and potential value of quantitative SPECT/CT for 3D lung perfusion imaging with anatomical lungs /lobes delineation.

**Methods and Materials:** Planar and SPECT/CT lung perfusion scans were acquired (Intevo, Siemens) after each <sup>99m</sup>Tc-labelled macroaggregated albumin (<sup>99m</sup>Tc-MAA) administration. The percentage of total lung perfusion was assessed for each lung region using the established 2D-projection method and compared to the 3D-anatomical and quantitative method (CT Pulmo 3D and xSPECT-Quant - Siemens). Matched-pair data were compared using Student's paired t-test.

**Results:** We enrolled 105 patients in our single centre, prospective, cohort study from 10/2016 to 10/2017. As expected, the left:right split function was similar between the 2D and 3D method. However, at the lobar level, there was a very significant difference between the two; while 2D systematically underestimated the contribution of the upper lobes, lower lobes were consistently overestimated compared to 3D, mean [±uncertainty at 95% confidence]: -32% ±8 and -34% ±7 for the left and right upper lobes and +25% ±4 and +18% ±4 for the left and right lower lobes, respectively (p<<0.001).

**Conclusion:** 3D Quantification of lung perfusion is feasible in clinical practice and shows substantial incongruity to the routinely used 2D-method at the lobar level. Further studies are warranted to assess reproducibility and its clinical value, especially in predicting postoperative outcome.

# NSS105

# Diagnostic and prognostic value of early FDG-PET in patients with disorders of consciousness

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**Purpose:** Early behavioural assessment using a new observational Motor Behaviour Tool (MBT) (Pignat et al. 2016) allow us to better identify clinical signs of covert consciousness and differentiate in the acute phase patients presenting cognitive motor dissociation (CMD) from other patients with Disorders of Consciousness (DOC). Aim: to correlate the FDG-PET uptake pattern in the CMD presentation known to have a better outcome (higher outcome scores at discharge).

**Methods and Materials:** We prospectively enrolled 45 DOC patients admitted to the Acute Neurorehabilitation Unit. Forty-four subjects had interpretable FDG-PET (20' awake rest, 150MBq 18F-FDG injection, 20' uptake, 20' acquisition) less than 6 weeks post-insult. Early behavioral examination in the intensive care unit (24h post-sedation withdrawal, Coma Recovery Scale-Revised complemented with MBT) assessed level of consciousness. According to MBT evaluation 2 groups were constituted: presenting CMD (36/45, 80%); not presenting CMD ("classical" DOC) (9/45, 20%).

**Results:** For all 9 patients of the classical DOC we observed an important and diffuse reduction of brain uptake including a reduction in motor cortex. In 6/9 (67%) patients a subcortical hypometabolism was present. In all 35 patients of the CMD group, premotor cortex was preserved in at least one hemisphere. The most frequently observed pattern was a moderate but diffuse decrease of uptake with a preserved motor and pre-motor cortices. **Conclusion:** The preservation of motor cortex metabolism in at least one hemisphere in the CMD group, evaluated with a simple observation of the FDG distribution pattern, has an important diagnostic and prognostic value in DOC.

### 18F-FDG-PET/CT imaging in an oxidative stress susceptible mouse model with relevance to schizophrenia

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**Purpose:** Oxidative stress is a major risk factor involved in the development of psychiatric diseases such as schizophrenia. Transgenic mice lacking the glutamate cysteine ligase modifier subunit (GCLM-KO), resulting in 70% decreased levels of the major non-protein cellular anti-oxidant glutathione showed morphological and behavioral phenotypes relevant for schizophrenia. Because glucose metabolism and glutathione function are interconnected, we aimed to study whether GCLM-KO mice might have a different basal glucose metabolism than wild type mice (WT).

**Methods and Materials:** <sup>18</sup>F-FDG PET imaging was performed on three WT and four GCLM-KO mice aged from 40 to 60 days. Ten MBq were injected intravenously and 45-minute microPET were acquired. The following organs, heart, brain, lungs, liver, pancreas, bladder, spleen and bone were delignated. The brain was further sub-segmented using the MIRO atlas.

**Results:** The <sup>18</sup>F-FDG uptake (% of total body uptake) in the liver of GCLM-KO mice was decreased as compared to WT mice ( $6.1\pm0.03\%$  vs.  $8\pm0.05\%$ , p= 0.047). Respectively, no significant difference was seen in other organs: heart:  $3.4\pm1.5\%$  vs. $2.7\pm1.7\%$  (p=0.57), kidney:  $1.6\pm1.0\%$  vs. $2.5\pm1.0\%$  (p=0.27), lungs:  $2.8\pm0.7\%$  vs. $2.2\pm0.1\%$  (p=0.46), and brain:  $3.5\pm1.3\%$  vs. $3.2\pm0.7\%$  (p=0.82). No brain areas showed difference in uptake between WT and KO mice.

**Conclusion:** The absence of <sup>18</sup>F-FDG uptake difference in various organs between GCLM-KO and WT suggested that they have similar glucose consumption. Immunohistochemical studies showed increased of activated microglia in GCLM-KO mice, but no such effect was observed in their overall brain glucose consumption as compared to WT. MicroPET imaging using radiotracers targeting neuroinflammation is currently under investigation.

# Labeling of 3BNC117 a broadly neutralizing human anti-HIV antibody for clinical imaging

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**Purpose:** Molecular imaging has the potential to reveal hidden reservoirs of HIV virus. Our aim was to test in-vitro and in-vivo a <sup>123</sup>I-labeled full h IgG antibody against HIV-1 (3BNC117) before a phase I clinical study.

**Methods and Materials:** <sup>125</sup>I-radioiodination was optimized using different antibody amounts, oxidants, and purification methods. The maximum binding sites ( $B_{max}$ ) and equilibrium dissociation constant ( $K_d$ ) were determined with Scatchard plot using gp120 heptamer. Immunoreactivity was extrapolated with non linear regression to infinite antigen excess of Bound <sup>125</sup>I-IgG/ Total <sup>125</sup>I using hyperbolic function. A radiolabeling protocol was then established to be transposed to <sup>123</sup>I labeled 3BNC117. Three test syntheses were done for validation of IMPD. Immunoreactivity tests were succesfully repeated. Human dosimetry was extrapolated from mice biodistribution data using OLINDA.

**Results:** Labeling was optimized with 50µg <sup>125</sup>I-3BNC117 and 500µg <sup>123</sup>I-3BNC117. Reproducible results were obtained using custom made iodogen vials as oxydant. The most efficient method for purification was ultracentrifugation (50K dalton cut off). Radiolabeling yield was ≥50% (HPLC) with ≥96% pure product obtained. B<sub>max</sub> and K<sub>d</sub> were between 0.4–1.0 nmol/ mg antigen and 0.1-0.3 nM, respectively. Immunoreactivity was retained after radiolabeling (>80%). Dosimetry study extrapolated to humans resulted in an effective dose of 13.2 µSv/MBq for <sup>123</sup>I-3BNC117.

**Conclusion:** The broadly neutralizing anti-HIV1 human antibody 3BNC117 was successfully labeled with <sup>125</sup>I and <sup>123</sup>I. Final products showed specific binding to gp120 heptamer and preserved immunoreactivity. An IMPD was successfully submitted to Swissmedic/FOPH and an ethics committee-approved clinical trial is underway.

### NSS108

# Albumin-Binding PSMA Ligands: Optimization of the Tissue Distribution Profile

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**Purpose:** Radioligands targeting the prostate-specific membrane antigen (PSMA) have shown high potential in the radiotheragnostic management of prostate cancer. The aim of this study was to investigate PSMA ligands modified with an albumin-binding entity and directly compare them to the clinically-employed PSMA-617.

**Methods and Materials:** Several albumin-binding PSMA ligands were synthesized and radiolabeled with <sup>177</sup>Lu. The compounds were tested for stability and potency of binding to mouse and human plasma proteins using ultrafiltration assays. Cell uptake experiments were performed using PS-MA-positive PC-3PIP and PSMA-negative PC-3flu cells. Furthermore, biodistribution and SPECT/CT studies were performed with BALB/c nude mice bearing PC-3PIP/flu tumor xenografts.

Results: <sup>177</sup>Lu-labeled albumin-binding PSMA ligands (50 MBq/nmol, radiochemical purity >98%) showed high stability up to 24 h in saline (>95%) and binding to human (>95%) and mouse plasma proteins (>64%). PSMA-specific uptake in PC-3PIP cells was comparable to <sup>177</sup>Lu-PSMA-617 (60-63%, 4 h incubation). Biodistribution studies clearly showed enhanced blood circulation and, as a consequence, an increased tumor uptake over time. The most promising radioligand showed a more than 2-fold increased area under the curve (AUC) for the tumor uptake as compared to <sup>177</sup>Lu-PSMA-617. The tumor-to-kidney (~5.9) and tumor-to-blood ratios of AUCs (~46) were generally high, although somewhat lower than the ratios obtained <sup>177</sup>Lu-PSMA-617 (37 and 71, respectively). The excellent characteristics of this class of compounds were confirmed by distinct visualization of tumors using SPECT/CT. **Conclusion:** The herein applied concept of albumin-binding PSMA ligands may be attractive for future clinical translation, potentially enabling more potent radionuclide therapy using lower quantities of activity and/or less frequent applications.

# Could short thyroid hormone withdrawal be an effective strategy for Radioiodine Remnant Ablation in differentiated thyroid cancer patients?

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**Purpose:** Guidelines recommend thyroid-hormone-withdrawal (THW) of 3-4 weeks before radioiodine-remnant-ablation (RRA) of differentiated-thyroid-carcinoma (DTC).We aimed to evaluate the reliability of a shorter THW to achieve adequate TSH-levels (i.e.30 mU/L); the association between length of THW and thyroid-remnant-ablation-rate and response to therapy; the potential association between pre-ablation TSH-levels and patients' outcome.

**Methods and Materials:** Patients were broken down into two groups according to the length of THW: group A) 2-weeks of THW, B) ¾-weeks of THW. By means of multivariate-analysis, including main DTC prognostic factors, we assessed the impact of THW-length and TSH-levels on ablation-rate and outcome.

**Results:** we evaluated 222 patients, 85 of whom were treated with RRA after 2-weeks THW (group A). All other 137 patients underwent RRA after 3-4-weeks THW (group B). At the time of RRA all patients presented TSH levels ≥30 mU/L. Successful thyroid-remnant ablations were observed in 185 DTC patients (83%) and incomplete-ablation in the remaining 37 patients (27%). After a median follow-up time of 3.4 years, we found 183 patients (82%) with excellent response to treatment and 39 patients (18%) showing incomplete response. Multivariate-analysis showed that the only parameters associated to successful remnant-ablation were tumour-size and serum-thyroglobulin at the time of RRA (ablation-Tg). Kaplan-Meier response to therapy curves showed that ablation-Tg, tumor-size and lymphnode status were significantly associated with prognosis. Multivariate-Cox-model showed that only ablation-Tg was significantly associated to treatment response.

**Conclusion:** Prior to RRA, a short 2-week THW is an effective method to stimulate TSH levels.

NSS110

#### Imaging of medullary thyroid carcinoma with the CCK-2 receptor agonist 177Lu-PP-F11N – Preliminary results of the "Lumed" study

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**Purpose:** Despite the introduction of new molecular targeted therapies, there is still an unmet need for an effective systemic therapy for advanced medullary thyroid carcinoma (MTC). Targeting the cholecystokinine-2 (CCK-2) receptor with radiolabeled gastrin analogues is a potential approach for radionuclide therapy of MTC. The aim of this study is the feasibility testing of targeting CCK-2 receptors with the novel <sup>177</sup>Lu-labelled gastrin analogue PP-F11N in six patients with advanced MTC. (ClinicalTrials.gov: NCT02088645).

**Methods and Materials:** Six patients fulfilling the inclusion criteria (advanced MTC, Calcitonin > 100 pg/ml and/or doubling time < 24 months) were included in the study. All of them received two injections of 1 GBq <sup>177</sup>Lu-PP-F11N with 4 weeks interval with and without infusion of succinylated gelatine in a cross-over design. Planar scintigraphy and SPECT/CT scans were performed at several time points post-injection. Several vital parameters were measured.

**Results:** Tumor specific radiotracer uptake was visible in all patients. Due of the high density of CCK-2 receptors in the gastric mucosa, a high intensity of tracer uptake was visible in the stomach. Furthermore, uptake in the kidneys was visible. Apart from self-limiting flushing, nausea and vomiting (grade 1 according to CTCAE version 4.0), there were no adverse reactions observed.

**Conclusion:** Visualization of tumor in all patients proves that the principle of CCK-2 receptor targeting of MTC with this new radiopharmaceutical is feasible. Organs of relevant physiologic uptake are stomach and kidneys. The administration of the new CCK-2 receptor ligand <sup>177</sup>Lu-PP-F11N was safe. The potential of radionuclide therapy with <sup>177</sup>Lu-PP-F11N can be further evaluated.

### NSS109

influence of baseline hemoglobine level and skeletal metastasis burden on achievable number of radium 223 therapy cycles in patients with castration resistent prostate cancer

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**Purpose:** To evaluate the influence of baseline hemoglobine level and skeletal metastasis tumor burdon in bone scintigraphy on number of radium 223 cycles in patients with castration resistent prostate cancer with symptomatic bone metastases (mCRPC).

**Methods and Materials:** 51 patients with mCRPC where treated with radium 223 between 5/2014 and 11/2017. Retrospectively tumor burdon in baseline bone scintigraphy (BS) was assessed with a 5 point visual grading scale: 1= <6 bone mets, 2= 6-10 bone mets, 3=11-20 bone mets, 4= dissiminated bone mets and 5= superscan. Metastasis burden and baseline hemoglobine (HB) values were correlated with the number of achieved radium 223 therapy cycles.

**Results:** 30/51 (59%) patients completed 6 cycles of Ra 223 and 21 (41%) dropped out before completing therapy for different reasons. In average 4,6 cycles were given per patient. Drop out rate and average of given cycles was markedly lower (28%; 5.2) in patients with lower metastatic burden (grade 1-3) than with high tumor burden (grade 4,5): 48%; 4,2. In 11 patients with low metastatic burden and HB > 12 g/dl drop out rate was only 9% (5.8 cycles) compared to 62% (3,7 cycles) in 13 patients with high tumor burden and HB < 11 g/dl.

**Conclusion:** Baseline skeletal metastasis tumor burdon and hemoglobin levels have influence on drop out rate and number of achievable radium 223 therapy cycles in patients with castration resistent prostate cancer. This knowledge might help in patient selection.

### NSS112

Prognostic value of skeletal tumor burden calculated on baseline bone-SPECT-CT in castration resistant prostate cancer treated with 223-Ra

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**Purpose:** To assess the prognostic value of skeletal tumor burden, calculated on baseline bone-SPECT-CT (BS), in patients with mCRPC treated with 223-Ra dichloride (223-Ra)

**Methods and Materials:** 18 patients with a mCRPC (mean 74 ± 6 years) underwent bone SPECT/CT before 223-Ra therapy. In order to determine skeletal tumor burden semi-automated isocontour VOIs, normalized to highest normal bone uptake, were performed on pre-treatment BS. End points were overall survival (OS), event free survival (EFS), bone marrow failure (BMF) and treatment discontinuation (Tdis). The following parameters were recorded: active tumor volume (ATV), number of bone metastases (Nmets), PSA, ALP, ECOG status, pre-CHT and radiotherapy pre-RT.

**Results:** 6 of 18 patients (33.3%) developed BMF; a significantly increased risk of BMF was observed in patients with Nmets > 20 mets (p 0.005), ATV > 290 cm<sup>3</sup> (p 0.0001) and ALP >178 (p 0.007). EFS and OS were significantly associated, in univariate analysis, with ATV (p 0.03), Nmets > 20 (p 0.003) and ALP (p 0.012). Tdis was correlated with ECOG status (p 0.011). In a multivariate analysis only ATV and Nmets>20 resulted as independent predictors of BMF (p 0.018) and OS (p 0.001). A cutoff value of ATV>100 cm<sup>3</sup> and Nmets > 20 had the best prognostic value (p=0.024; median OS 10 mo with ATV>100 cm<sup>3</sup> and p 0.0009, median OS 8 mo with Nmets > 20, respectively).

**Conclusion:** Baseline high skeletal tumor burden increase the risk of BMF and could be an accurate marker of EFS and OS in patients treated with 223-Ra

#### Adjunctive diagnostic value of integrated 18F-Choline-PET/contrast-enhanced-CT in primary hyperparathyroidism.

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**Purpose:** we aimed to evaluate the role of integrated-<sup>18</sup>F-Choline-PET/contrast-enhanced(Ce)-CT in detecting parathyroid adenomas/hyperplasias in patients with primary hyperparathyroidism (PHPT) and negative conventional-imaging (CI) wok-up (i.e. neck-ultrasonography plus <sup>99</sup>mTC-sestamibi-scan). We compared the detection-rate (DR) of <sup>18</sup>F-Choline-PET/CeCT with that of <sup>18</sup>F-Choline-PET/CT and Dynamic-Computed-Tomography (4DCT). We analyse the correlation between the standard-uptake-value (i.e. SUV-ratio) and Ce-degree of each parathyroid adenoma and the association between SUV-ratio and parathyroid-hormone (PTH) and calcium (Ca) levels. Finally, a multivariate-analysis evaluated the association between clinical parameters (i.e. Ca, PTH, age and gender) and <sup>18</sup>F-Choline PET/CeCT results.

**Methods and Materials:** we prospectively evaluated 44 patients with biochemically proven PHPT and negative CI. All patients underwent <sup>18</sup>F-Choline-PET/CeCT, <sup>18</sup>F-Choline-PET/CT and 4DCT, which were acquired at the same time by using the same dedicated PET/CT-scanner. Experienced readers interpreted the images separately, and the DRs of the three imaging modalities were calculated. SUV-ratio and Ce-degree were registered for each positive finding. Histopathology, laboratory-report and multidisciplinary follow-up were used as standard of reference.

**Results:** <sup>18</sup>F-Choline-PET/CeCT proved positive in 32 of 44 patients, with an overall DR of 72.7%. This was significantly higher (p<0.05) than that of <sup>18</sup>F-Choline-PET/CT (56.8%) and 4DCT (54.6%). No positive correlation was found between SUVs and the Ce-degree and between SUV-ratio and PTH or Ca levels. In multivariate-analysis, only Ca levels were significantly associated to <sup>18</sup>F-Choline-PET/CeCT positive findings.

**Conclusion:** in the case of PHPT and negative CI studies, <sup>18</sup>F-Choline-PET/ ceCT may provide adjunctive diagnostic information in about 70% of patients. Its diagnostic impact is significantly higher than that of <sup>18</sup>F-Choline-PET/CT and 4DCT.

NSS114

# Diagnostic performance of 18F-FDG PET/CT in evaluating patients with suspicious spinal infections: A bivariate meta-analysis

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**Purpose:** Spondylodiscitis and other spine infectons (SIs) usually require a diagnostic approach based on multimodal imaging. There are increasing literature data about the role of hybrid 18F-FDG PET/CT in patients with SIs. Therefore we aimed to perform an updated bivariate meta-analysis about the diagnostic performance of 18F-FDG PET/CT in patients with suspicious SIs.

**Methods and Materials:** A comprehensive computer literature search of studies published through November 2017 about the diagnostic performance of <sup>18</sup>F-FDG PET/CT in patients with suspicious SIs was performed using the following search algorithm: A) "PET" OR "positron emission tomography" OR "FDG" OR "fluorodeoxyglucose" AND B) ((spondylodiscitis) OR (spondylodiskitis) OR (discitis) OR (diskitis) OR (spondylodiscitis) OR (vertebral osteomyelitis) OR (spinal infection) OR (spinal infections)). Studies performing <sup>18</sup>F-FDG PET only were excluded. Pooled sensitivity, specificity, positive and negative likelihood ratios (LR+ and LR-) and diagnostic odds ratio (DOR) of <sup>18</sup>F-FDG PET/CT in patients with suspicious SIs on a per examination-based analysis were calculated.

**Results:** Ten studies on the use of <sup>18</sup>F-FDG PET/CT in patients with suspicious SIs (281 cases) were included. The bivariate meta-analysis provided the following results on a per examination-based analysis: sensitivity was 94.4% [95% confidence interval (95%CI) 87.3-97.7%], specificity 90.7% (95%CI 71.8-97.4%), LR+ 3.9 (95%CI: 2.6-6), LR- 0.12 (95%CI: 0.08-0.18), DOR 54.8 (95%CI: 22-135). Mild heterogeneity among the selected studies was found.

**Conclusion:** <sup>18</sup>F-FDG PET/CT demonstrated an excellent diagnostic performance in patients with suspicious SIs. Large multicenter studies and cost-effectiveness analyses are needed to strengthen the role of this imaging method in this setting.

#### NSS115

Diagnostic value of quantitative 99mTc-DPD-SPECT/CT for the detection of prosthetic loosening in patients with hip and knee joint replacement

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**Purpose:** Evaluation of diagnostic accuracy of maximum standardized uptake values (SUVmax) of 99mTc-DPD in periprosthetic bone of patients with painful hip- and knee prosthesis regarding the detection of prosthetic loosening. SUVs were derived by a SPECT/CT that enables standardized quantitative SPECT.

**Methods and Materials:** 30 patients with suspicion of prosthetic loosening were assessed, fourteen patients had knee joint replacements, 16 patients hip joint replacements. 12 Patients had bilateral replacements.

Patients underwent standardized <sup>99</sup>mTc-Dicarboxypropandiphosphate(DP-D)-SPECT/CT examination:

Scans 3h after injection of 740MBq of <sup>99</sup>mTc-DPD on a quantitative SPECT/CT. Quantitative reconstruction with Siemens' xSPECT Quant and xSPECT Bone, using CT for attenuation correction but also to incorporate tissue-boundaries from CT. SUVmax of xSPECT Quant and xSPECT data were compared with diagnosis of prosthetic loosening according to intraoperative findings or clinical outcome after 1 year. Sensitivity and specificity calculated using receiver operator characteristics.

**Results:** xSPECT Quant reconstruction SUVmax of loose replacements was significantly higher compared to stable replacements (18,3±4,8 vs. 12±4,4, p=0.0002). ROC-analysis revealed an AUC of 0.87(p=0,0002). With cut off value of 12 the estimated sensitivity and specificity were 94% and 76% with an accuracy of 84%. Compared to xSPECT Quant reconstruction, xSPECT Bone data showed a higher mean SUVmax of both, loosened and stable replacements, however not significant (16,7±7,9 vs. 13,4±8,9, p=0,132).

**Conclusion:** Uptake quantification of periprosthetic bone metabolism in patients with painful joint replacements using quantitative <sup>99</sup>mTc-DPD-SPECT/CT offers a promising quantitative marker that is likely to improve the accuracy for the diagnosis of prosthetic loosening.

#### NSS116

### SPECT/CT in foot arthrodesis

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Purpose: To evaluate the value of SPECT/CT in foot arthrodesis

**Methods and Materials:** SPECT/CT of 140 joints (34 uppper ankle joint (UA), 28 lower ankle joint (LA), 27 talonavicular joint (TN), 12 calcaneo-cuboideal (CC) and others) with arthrodesis in 74 patients where evaluated retrospectively regarding fusiuon grade in CT (0=no fusion, 1= < 50% fusion, 2= > 50% fusion, 3= complete fusion) and uptake (0= no uptake, 1= minor uptake, 2= intermediate uptake, 3= high uptake) on SPECT/CT. Additionally, presence of osteoarthritis in adjacent joints was assessed. In 57 patients follow-up was available.

**Results:** According to SPECT/CT results arthrodesis was successfull (Grade 2 or 3 CT fusion and 0 or 1 uptake) in 71% (24/34) of UA joints, 72% of LA joints, 67% (18/27) TN and 100% (12/12) CC joints. In 8 joints there were discrepant findings in SPECT/CT (fusion grade 2 and grade 2 or 3 uptake). Fusion rate in 6-12 months old arthrodesis was 53% (16/30), 74% (25/34) in 12-24 months old arthrodesis and 90% în arthrodesis > 24 months old. Average SPECT/CT uptake in arthrodesis decreased with age: 6-12 m: 1.53, 12-24 m: 1.32, > 24m: 0.37. Osteoarthritis was observed in 85 joints adjacent to the arthrodesis. During follow-up rearthrodesis was performed in 18 joints.

**Conclusion:** SPECT/CT is valuable tool evaluate the success of arthrodesis of different foot joints and osteoarthritis of adjacent joints.
## NSS117

### Temporal evolution of SUV in Tc-99m-DPD quantitative bone scintigraphy: Role of the time delay between imaging and injection

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**Purpose:** To evaluate the effect of post-injection delay on SUV quantification using <sup>99</sup>mTc-DPD at different non-pathologic bone sites and report normal values of bone uptake in patients undergoing quantitative SPECT/CT (xSPECT/CT).

**Methods and Materials:** We retrospectively assessed xSPECT/CT (Siemens SYMBIA INTEVO) uptake values in 31 patients aged 70±10.5y with degenerative (n=17) or neoplastic (n=14) diseases. SUV<sub>max</sub> (g/mL) were measured in non-pathologic – as controlled by CT scan imaging – vertebral body, iliac crest and proximal femoral diaphysis with VOI of 3 cm<sup>3</sup>. We tested for correlation between time delay between imaging and tracer injection with SUV quantification in the different subgroups.

**Results:** Time delay between injection and imaging was 207±29min [range 166–282]. Mean SUV<sub>max</sub> [95% CI] in vertebral body, iliac crest and proximal femoral diaphysis were 14.7±1.3[14.2–15.5], 11.6±1.4[11.1–12.1] and 9.1±0.8[8.8–9.4] and g/mL, respectively with significant difference between sites (p<0.005). A positive correlation existed between injection time delay and non-pathologic vertebral body SUV<sub>max</sub> (R=0.476, p=0.006) varying by 6.5% per hour, but not in normal iliac crest or femoral diaphysis.

**Conclusion:** This study reports for the first time the SUV values evolution over time in different non-tumoral bone structures across patients and might serve as reference for normal cutoffs. A positive correlation with a small variation of SUV<sub>max</sub> values was shown between injection time delay and non-pathologic vertebral body SUV<sub>max</sub><sup>+</sup> but not in normal iliac crest or femoral diaphysis, thus favoring the relative stability of xSPECT SUVmax measurement in the 2 to 4 hours' EANM recommended post-injection time frame.

#### NSS118

#### Gastric half-emptying time: A novel simplified tool for gastroparesis evaluation

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**Purpose:** With new GMP laboratory standards, radionuclide preparation for Gastric emptying (GE) scintigraphy might be challenging. Our aim is to present a simplified protocol, compatible with GMP standards, and to assess the time of half-emptying as a single quantitative value in the evaluation of gastroparesis.

**Methods and Materials:** We retrospectively analyzed the data of 50 patients who underwent GE scintigraphy with a shortened clinical procedure adapted from Tougas et al. protocol (Am J Gastroenterol. 2000) with the Bonta criteria by ingesting a standardized radiolabeled meal. Patients were classified into three groups: accelerated (8/50=16%), normal (31/50=62%) and slowed (gastroparesis) GE (11/50=22%), based on gastric residue present at the end of examination. Nonlinear gastric emptying curves were fitted using nonlinear least squares described by Elashoff et al. (Gastroenterology 1982) and the time values of half-emptying were derived. Wilcoxon rank sum tests were used to assess distribution differences amongst groups.

**Results:** The labelling procedure was easy to perform and the clinical procedure well tolerated by patients. In 30/50 (60%) patients, images until 2 hours after ingestion were sufficient to obtain diagnosis. We found significant differences for half-emptying times between groups of normal GE vs gastroparesis, normal vs accelerated GE and gastroparesis vs accelerated GE (p < 0.005). The median half-emptying times were 43, 78 and 414 minutes for the accelerated, normal and gastroparesis group, respectively.

**Conclusion:** GE scintigraphy with a GMP-compatible labelling, and shortened clinical procedure, is simple and well tolerated. Half-emptying time assessment was enough to differentiate normal from pathologic GE.

### NSS119

### Is it reasonable to donate a kidney after 60 years of age?

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**Purpose:** We aimed to evaluate the outcome of kidney function following kidney donation in donors aged over 60 years.

**Methods and Materials:** We enrolled 24 living donors (14F, 10M) with a mean age of 66y (range 60-78y). All donors had had an estimation of renal function by I-123-Hippuran renal scintigraphy (RS) and of glomerular filtration rate (GFR) by measuring plasma clearance of Cr51-EDTA prior to kidney donation. A second assessment was made >6 months after kidney donation (mean 3±1.7y; range: 0.6-5.7y). The accumulation index (AI) acquired during RS (defined as the percentage of the injected activity extracted by the kidney during 1 minute) was assessed.

**Results:** The mean GFR after donation was 51.2±8.7ml/min/1.72m<sup>2</sup> (range: 36-70ml/min/1.72m<sup>2</sup>). In 22 patients, we compared AI of the remnant kidney before and after contralateral kidney donation: 8.7±1.9 versus 10.4±1.8 (P=0.007). Therefore, there was a significant increase in the AI of the remnant kidney of around 20% (AI ratio 120%±25%, P=0.001). In 20 patients, we compared GFR before and after kidney donation (73.5±16 versus 50.9±9.3ml/min/1.72m<sup>2</sup>, P<0.0001). The GFR significantly decreased by about 29±15% after donation (P<0.0001).

**Conclusion:** As in younger donors, the remnant kidney in living donors aged >60 years partially compensates for the loss of the contralateral kidney. The GFR decreased about 29±15%, which is comparable to the decrease in GFR of 25–30% described in the literature for younger adult donors.

#### NSS120

#### Swiss Survey on Hybrid Imaging CTs Doses in Nuclear Medicine and Proposed National Dose Reference Levels

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**Purpose:** A multidisciplinary working group led by the Swiss Federal Office of Public Health was formed to plan and perform a nationwide survey of patient radiation exposure from computed tomography (CT) in hybrid devices across Nuclear Medicine departments.

**Methods and Materials:** The survey included 16 departments (of which 5 were university hospitals) and the submitted responses included 10,673 entries for the 33 different protocols proposed (11 in PET and 22 in SPECT). The working group determined the selection and exclusion criteria applied to the analysis. This work presents the survey preparation and data analysis including the exclusion criteria used.

**Results:** The results are used to inform recommendations for National Diagnostic Reference Levels (DRL) for CT procedures in Nuclear Medicine in Switzerland. Of the 33 protocols initially proposed, 10 protocols for both PET and SPECT modalities were retained after exclusion criteria and thresholds were applied.

**Conclusion:** The results obtained in terms of volume-weighted computed tomography dose index (CTDIvol) and dose length product (DLP) have been put forward as recommendations for national Diagnostic Reference Levels for protocols in hybrid imaging devices in Nuclear Medicine in Switzerland and will be published by the Federal Office of Public Health.

**NSS123** 

## NSS121

Virtual-PET: Pixel-Wise Prediction of the Metabolic FDG-PET Activity of Brown Fat from the Anatomical CT Images using Radiomics and Deep Learning

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**Purpose:** To predict FDG-PET activity from the pixel-data of anatomical CT images

**Methods and Materials:** (1) In a pilot study, 74 propensity-score matched patients (37) with active brown adipose tissue (BAT) undergoing a routine FDG-PET/CT were selected retrospectively and analyzed with a standard radiomics approach (19 texture features [TF]). (2) Next, we scanned 16 mice with active and ablated brown fat on a dedicated small animal CT, for radiomics analysis also. The TFs were assessed with a nonparametric Wilcoxon test (p<0.05 indicative for significant differences). (3) Third, we manually segmented the supraclavicular brown fat depot of 134 FDG-PET/CT's (67 with active BAT). The CT data was used to train a deep neural U-network (8 hidden layers) implemented in Keras/Tensorflow to pixel-wise predict the SUV of the PET scan (107 patients for training, 27 for validation). The residual SUV-error was computed and resulting virtual PETs were assessed qualitatively.

**Results:** (1) We found 10 TFs confounded by CT scan parameters (kVp, mAs, FOV), which were excluded from further analysis; 4 TFs differed significantly between active and inactive BAT in humans, (2) 6 TFs differed significantly in mice. (3) The network converged after 130 epochs at a residual cumulative error of approx. 0.27 g/ml. The network consistently predicted higher FDG activity in active BAT-depots.

**Conclusion:** Deep Learning can predict metabolic activity from anatomical data, even in visually indistinct tissues (e.g. active vs. inactive brown fat) and across different species. Further research is necessary to assess other tissues and tumors.

NSS122

#### Fluvastatin Inhibits Brown Fat: A PET/MRI Study

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**Purpose:** To prospectively investigate the effect of Fluvastatin on brown fat activity in healthy male volunteers with FDG PET.

**Methods and Materials:** In this interim analysis of a prospective clinical trial (clinicaltrials.gov-identifier NCT03189511) 7 healthy male volunteers were analyzed. The study consists of two visits, spaced 14 days apart, with daily statin intake in the period between the visits. On each visit, after stimulation of brown fat by 3h application of cold pads and oral administration of 200 mg Mirabegron (beta-3-agonist), volunteers underwent partial body PET/MRI after injection of 85 MBq <sup>18</sup>F-FDG, and afterwards ultrasound guided core-needle biopsy of the supraclavicular brown fat. SUV<sub>max</sub>, SUV<sub>mean</sub>, and volume of the supraclavicular brown fat was measured for both visits and compared with a Wilcoxon test for paired data. Gene expression in the biopsy samples was compared using a t-test. A p-value  $\leq 0.05$  was considered significant.

**Results:** Fluvastatin intake for two weeks lowered the median SUVmax from 13.65 to 7.74 (p=0.05), the SUVmean from 4.6 to 3.7 (p=0.05) and the volume from 31.95 to 15.9 (p=0.03). Furthermore, the expression of the brown fat marker uncoupling protein 1 (UCP1) was significantly reduced in the biopsy specimens after Fluvastatin.

**Conclusion:** Fluvastatin inhibits brown fat activity in humans. These results confirm earlier animal trials, and may explain the development of type II diabetes in certain patients under statin therapy.

# Detection rate of unknown primary neuroendocrine tumours by using somatostatin receptor PET/CT in patients with metastatic disease: A meta-analysis

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Purpose: The high diagnostic performance of somatostatin receptor PET/ CT in patients with neuroendocrine tumours (NETs) was demonstrated by several articles. However only some studies evaluated the detection rate (DR) of unknown primary tumours (UPTs) by using this imaging method in patients with metastatic NETs. Therefore we aimed to perform a meta-analysis to add evidence-based data in this setting.

**Methods and Materials:** A comprehensive computer literature search of studies published in PubMed/MEDLINE, Web of Science and Cochrane library databases through August 2017 and regarding the use of somatostatin receptor PET/CT in patients with metastatic NETs and UPTs was carried out. Pooled DR on a per patient-based analysis was calculated to measure the diagnostic performance of somatostatin receptor PET/CT in this setting. A sub-analysis considering the change of management by using somatostatin receptor PET/CT was also performed.

**Results:** Twelve studies on the diagnostic performance of somatostatin receptor PET/CT in detecting UPTs in metastatic NETs were included. The meta-analysis of these selected studies provided the following DR on a per patient-based analysis: 56% [95% confidence interval: 48-63%]. Mild heterogeneity among the selected studies was found (I-square= 53%). The most common primary tumour sites were the bowel and the pancreas. A change of management by using somatostatin receptor PET/CT was demonstrated in 20% of patients.

**Conclusion**: Somatostatin receptor PET/CT is a very useful imaging method in detecting UPTs in patients with metastatic NETs. More studies on the change of management by using this imaging method in patients with metastatic NETs and UPTs are needed.

#### **NSS124**

### 68Ga-DOTA-TOC PET/CT predicts exact tumor staging in head and neck paragangliomas, compared to 18F-DOPA PET/CT and 123I-MIBG SPECT/CT

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**Purpose:** We compared functional imaging modalities in the diagnosis and staging of head and neck PGL, using <sup>68</sup>Ga-DOTA-TOC PET/CT (diagnostic CT), <sup>18</sup>F-DOPA PET("low-dose" CT) and <sup>123</sup>I-MIBG scintigraphy, including SPECT/CT ("low-dose" CT). Functional and anatomical imaging (combined cross-sectional imaging) referred as reference standard.

**Methods and Materials:** Three male and eight female patients (age range 26 to 73 years) with anatomical and/or histologically proven disease were included in this study. Comparative evaluation included morphological imaging with CT, functional imaging with <sup>68</sup>Ga-DOTA-TOC PET, <sup>18</sup>F-DOPA PET and <sup>123</sup>-IMIBG imaging. Imaging results were analyzed on a per-lesion basis.

**Results:** The overall detection rate of <sup>68</sup>Ga-DOTA-TOC PET on a per-lesion basis was 100% (McNemar p<0.5), of <sup>18</sup>F-DOPA PET 67.9% (McNemar p<0.01) and that of <sup>123</sup>I-MIBG imaging was only 8.0% (McNemar p<0.0001) and of SPECT/CT was 12.0% (McNemar p<0.0001), respectively. <sup>68</sup>Ga-DOTA-TOC PET and anatomical imaging identified 28 lesions. <sup>18</sup>F-DOPA PET detected 19 manifestations. <sup>123</sup>I-MIBG imaging identified only 2 lesions and SPECT/CT 3 lesions. Two additional lesions were detected by <sup>68</sup>Ga-DOTA-TOC PET, but negative in both, <sup>123</sup>I-MIBG and CT imaging.

**Conclusion:** <sup>68</sup>Ga-DOTA-TOC PET/ CT predicts exact tumor staging in head and neck paragangliomas, compared to <sup>18</sup>F-DOPA PET and to <sup>123</sup>I-MIBG imaging, including SPECT/CT, respectively.

NSS127

## NSS125

# Differences in Ga-68-NODAGA-RGD versus F-18-FDG PET/CT for the assessment of nodal and extranodal involvement of Non Hodgkin Lymphoma (NHL)

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**Purpose:** To compare uptake level and pattern on Ga-68-NODAGA-RGD versus F-18-FDG-PET/CT in nodal and extranodal NHL during initial staging. **Methods and Materials:** We prospectively assessed tracer uptake for 68Ga-

NODAGA-RGD versus 18F-FDG-PET/CT in two female patients (mean age: 71y) with NHL undergoing both modalities within <2 weeks. We performed a lesion-based analysis to determine visual uptake pattern of both tracers in nodal and extranodal disease. Quantitative measurements included SUV<sub>max</sub>, SUV<sub>mean</sub> (g/mL), metabolic tumoral volume (MTV) (cm<sup>3</sup>) for each tracer.

**Results:** In total, 25 NHL lesions were analysed in the following localizations: lymph nodes (n=10), bone (n=12), spleen (n=1), muscle (n=1), pleura (n=1). Mean SUV<sub>max</sub>, SUV<sub>mean</sub> and MTV [95% CI] were, 2.2[1.9–2.5], 1.3[1.1–1.5], 8.6[6.3–10.9] for RGD PET/CT and 16.6[13.8–19.4], 10.4[8.3–12.5], 14.2[2.9–25.6] for FDG-PET/CT, respectively. Bone lesions showed higher RGD but lower FDG uptake as compared to lymph nodes (2.5±0.2 versus 1.8±0.2, p=0.022 and 12.8±1.8 versus 20±1.9, p=0.011). A positive correlation between FDG-MTV and RGD-MTV was shown (Pearson's r=0.65, p=0.003) with 20% higher volume in the latter. No correlation was shown between SUVmax in FDG and RGD (Pearson's r=0.123, p=0.56). Lesions showing peripheral RGD uptake pattern had higher FDG-SUV<sub>max</sub> compared to lesions with diffuse RGD uptake [21.2 (n=9) versus 14 (n=16), p=0.007].

**Conclusion:** RGD-PET/CT demonstrated the presence of peritumoral activity corresponding to angiogenesis changes in nodal and extra-nodal NHL, which was outside lesions with increased FDG glycolysis activity. Thus, angiogenesis visualization with RGD-PET/CT probes the tumoral microenvironment, which could have additional prognostic information.

#### NSS126

## 68Ga-DOTATATE PET/CT vs. 111In-pentetreotide scintigraphy (SPECT/CT) in GEP-NET: A prospective assessor-blinded case-control study

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**Purpose:** To compare the diagnostic accuracy of 68Ga-DOTATATE PET/CT and 111In-pentetreotide SPECT/CT for the diagnosis of gastroenteropancreatic neuroendocrine tumors (GEP-NET).

**Methods and Materials:** In a prospective assessor-blinded case-control study, we recruited consecutive patients with established or suspected GEP-NET and indication for 111In-pentetreotide scintigraphy to receive 68Ga-DOTATATE PET/CT.

Results: In the patient-based analysis, 111In-pentetreotide resulted in 22 true positives, 22 true negatives, 1 false positive, and 7 false negative scans. Contingency table analyses revealed a sensitivity of 75.9% (95%CI: 56.5% 89.7%), a specificity of 95.7% (95%CI: 78.1% - 99.9%), a positive predictive value of 95.7% (95%CI: 78.1% - 99.9%), and a negative predictive value of 75.9% (95%CI: 56.5% - 89.7%). In the patient-based analysis, 68Ga-DOTATATE resulted in 25 true positives, 20 true negatives, 5 false positive, and 2 false negative scans. Contingency table analyses revealed a sensitivity of 92.6% (95%CI: 75.7% - 99.1%), a specificity of 80.0% (95%CI: 59.3% - 93.2%), a positive predictive value of 83.3% (95%CI: 70.8% - 94.4%), and a negative predictive value of 90.9% (95%CI: 56.5% - 98.9%). In the lesion-based analysis, 111In-pentetreotide correctly detected 107 lesions, while 68Ga-DOTATATE detected 427 lesions. Adverse events (AEs) were recorded in 12/52 patients (23.1%), including 2 grade I AEs, 5 grade II AEs, 5 grade II AEs, and no grade IV AE. No AE was fatal. Only 1 AE was probably in relationship to the study intervention.

**Conclusion:** 68Ga-DOTATATE PET is relatively safe, and has a higher sensitivity than 111In-pentetreotide, with a considerably higher lesion detection rate. However, specificity was higher for 111In-pentetreotide imaging.

## 68Ga-PSMA-11 PET/MRI for detection of recurrent prostate cancer following radical prostatectomy at low PSA values up to 0.5 ng/ml

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**Purpose:**68Ga-PSMA-11-PET/CT has significantly improved the detection rate for recurrent prostate cancer (PCA) with published values of up to 55% for patients with a serum PSA between 0.2-0.5ng/ml. A first analysis in a relatively small cohort of simultaneous 68Ga-PSMA-11-PET/MRI, showed some improvement of the detection over PET/CT at low PSA values. We therefore focused now on patients with PSA values up to 0.5 ng/ml.

**Methods and Materials:** We retrospectively analyzed a cohort of 66 consecutive patients who underwent a 68Ga-PSMA-11-PET/MRI for biochemical recurrence with a PSA value up to 0.5 ng/ml in our institution between April 2016 and November 2017. Median PSA level was 0.23 ng/ml (interquartile range: 0.22 ng/ml). Detection of PSMA-positive lesions within the prostate fossa, local and distant lymph nodes, bones or visceral organs was recorded.

**Results**: In 26 of 40 (65%) patients with a PSA between 0.2-0.5 ng/ml and in 9 of 26 (34.6%) patients with a PSA <0.2 ng/ml, suspicious lesions were present. 4 of the 66 patients were scanned with rising PSA levels under continuous or previous antihormonal therapy, this 4 patients had all PS-MA-positive lesions despite the low PSA values. Overall 18 lymph nodes and 4 bone metastasis were detected on 68Ga-PSMA-11-PET/MRI changing the management in 22 of 62 (35%) patients.

**Conclusion:** Our data confirm that 68Ga-PSMA-11-PET/MRI has a high detection rate for recurrent prostate cancer even at very low PSA levels ≤0.5 ng/ml. Furthermore, it showed that the detection of lesions outside the prostate bed could alter management in 35% of the patients.

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#### The central zone has increased 68Ga-PSMA-11 uptake: Mickey mouse' ears can be hot on 68Ga-PSMA-11 PET

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**Purpose:** Given the increasing role of the new tracer targeting the prostate specific membrane antigen (PSMA, <sup>68</sup>Ga-PSMA-11) in patients for staging of prostate cancer (PCA), an accurate knowledge of physiologic <sup>68</sup>Ga-PSMA-11 distribution is essential. Aim of the study was to investigate the normal accumulation of <sup>68</sup>Ga-PSMA-11 within the different prostatic zones in patients referred for staging PCA.

**Methods and Materials:** All patients undergoing <sup>68</sup>Ga-PSMA-11 PET/MR for staging of PCA between June 2016 and May 2017 were retrospectively analyzed. All patients underwent radical prostatectomy (RPE) and gave written informed consent for further data analysis. Standardized ROIs were positioned in central (CZ) transition (TZ) and peripheral zones (PZ), according to T2-FRFSE sequences either in axial or coronal planes. SUV<sub>max</sub> and SU-V<sub>mean</sub> were assessed for each ROI. ROIs were placed within benign tissue, without spill-over from PCA and according to post-RPE histological report. Semiquantative parameters differences for each zone were compared by Wilcoxon test signed-ranks.

**Results:** Eighteen patients were analyzed. 65 ROI were positioned, 22 in CZ, 22 in PZ and 21 in TZ. Differences for SUV<sub>max</sub> between CZ and PZ and between CZ and TZ were found to be statistically significant (p=0.001, p=0.005 respectively). Differences for SUV<sub>mean</sub> between CZ and PZ were found to be statistically significant (p=0.001). No significant differences for SUV<sub>mean</sub> were found between CZ and TZ (p=0.2).

**Conclusion:** Our data suggest that a higher <sup>68</sup>Ga-PSMA-11 accumulation in CZ is normal, leading to a "Mickey Mouse ears" shape on <sup>68</sup>Ga-PSMA-11-PET. This pattern could help to avoid false positive interpretation of PET scans.

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### Rôle de la répondante sécurité patients en Imagerie Médicale à l'Hôpital Riviera Chablais / Rolle des Patientensicherheitsverantwortlichen in der Radiologie des Spitals Riviera-Chablais

### <u>J. Flury</u>; Cully/CH

**Purpose:** Nouveau rôle dans la radiologie, le but est de partager mon activité, de sensibiliser les professionnels présent à l'importance de la sécurité des patients et sa culture.

Suite à une formation sur la sécurité des patients en 2016, je suis répondante sécurité des patients / qualité pour le service d'Imagerie Médicale de l'Hôpital Riviera-Chablais (5 sites).

#### Durant ce 20%, en autre :

- j'analyse les déclarations d'incidents, propose des améliorations, et en gère le suivi.
- Je travaille en binôme avec un radiologue, nous nous réunissons une fois par mois. Durant l'année 2016 nous avons notamment revu toutes les guidelines de nos 5 services afin de les harmoniser.
- Notre hôpital est en pleine mise en place de TeamSTEPPS, qui sont des outils et stratégies de communication qui visent l'amélioration de la sécurité des patients. Je suis donc responsable de sa mise en place dans notre service.
- Je fais partie des TRM qui vont visiter les sites de scanner pour les audits qui viennent d'être lancés en Romandie.

### Methods and Materials:

#### **Results:**

**Conclusion:** Il me semble que ce rôle est relativement nouveau dans un service de radiologie et je pense que partager cette activité et ses implications devraient intéresser mes collègues TRM.

### Objectivation de la réduction de dose en radiologie interventionnelle suite à la mise à jour des salles Allura / Objektivierung der Dosisreduktion in interventionneller Radiologie nach Aktualisierung der Alluraräume

<u>C. Chevallier</u>, N. Ryckx, F. R. Verdun, R. A. Meuli; Lausanne/CH

**Purpose:** La dose délivrée lors d'examens en radiologie interventionnelle est non négligeable et les mesures de diminution de dose au patient et au personnel sont une des priorités des services de radiologie actuels.

**Methods and Materials:** Les 4 salles de radiologie interventionnelle et cathétérisme cardiaque (Allura, Philips, The Netherlands) du CHUV (Lausanne, Vaud) ont été mises à jour entre avril et août 2015 par l'installation de Clarity. La collecte des données a été faite à l'aide du logiciel Dosewatch (GE Healthcare, MW, USA) entre août 2013 et juin 2017. Les examens les plus représentatifs des hautes doses de neuroradiologie (angiographies cérébrales) et de cardiologie (coronarographies) ont été analysés. Les valeurs PKSair (risque d'induction de cancer), Kair (risque d'érythèmes ou brûlures) et Temps de Fluoroscopie (complexité de la procédure) ont été analysées en moyennes mensuelles pour ces deux types d'examens.

**Results:** En Neuroradiologie, une réduction de 70% du PKSair et de 78% du Kair a été mise en évidence pour un temps de scopie similaire. En cardiologie, une réduction de 45% resp. 43% du PKSair et 44% resp. 40% du Kair a été calculée pour les salle bi-plan resp. monplan, mais avec une augmentation significative du temps de scopie de 20 %.

**Conclusion:** Une diminution significative des risques chez les patients ainsi que de l'exposition du personnel, liée à l'exposition des patients, a été mise en évidence. Pour une imagerie dynamique (p.ex. cardiaque), la mise à jour Clarity semble moins adaptée à conserver une qualité d'image acceptable.

### CT ORL : ce que le TRM devrait connaître pour choisir le protocole adapté / HNO-CT: was Radiologiefachleute kennen müssen um das angepasste Protokoll zu wählen

<u>C. Chevallier</u>, V. Dunet, M. Bernasconi, C. Dromain, R. A. Meuli; Lausanne/CH

**Purpose:** Les pathologies ORL sont imagées par des CT standards ou double énergie (DECT). Le développement du DECT et des protocoles de post-processing permettent des utilisations diverses du DECT par les TRM, mais requièrent une compréhension et une aptitude à modifier les paramètres afin d'obtenir des images de qualité facilitant ainsi l'interprétation des radiologues. Cette présentation a pour but de mettre en évidence le rôle du TRM dans la réalisation du CT ORL et de donner des points de repère pour choisir la meilleure approche afin d'optimiser la qualité de l'examen tout en minimisant la dose.

**Methods and Materials:** Les bases du DECT seront expliqués pour les différentes machines. Selon le patient et la pathologie investiguée, seul un choix technique précis fournira le meilleur résultat au point de vue du contraste des tissus, du temps d'injection, de la réduction d'artéfacts et de l'optimisation de la dose. La méthodologie pour le choix du protocole, de la méthode de réduction d'artéfact, de la décomposition de matériel et du contrôle de dose sera développée et illustrée pour une pratique clinique quotidienne.

**Results:** Les protocoles doivent être adaptés en fonction des différentes pathologies étudiées et techniques utilisées, tout en gardant une certaine flexibilité dans l'adaptation des paramètres par le TRM.

**Conclusion:** Les connaissances théoriques, pratiques et de post-processing des acquisitions DECT doivent être fournis aux TRM pour leur permettre de choisir le protocole le mieux adapté pour une interprétation optimale du radiologue.

#### Contrôle radiologique au service de l'assurance-qualité des tabliers de radioprotection / Radiologische Kontrolle zu Diensten der Qualitätssicherung der Bleischürzen

<u>N. Cherbuin, A. Dominguez</u>, C. Lemesre, <u>C. Bruguier</u>, L. Thomas, F. Dedouit, J. Damet; Lausanne/CH

**Purpose:** L'utilisation intensive de tabliers de protection peut entraîner une usure prématurée caractérisée par une dégradation de la protection contre les radiations. En conséquence, l'obligation de contrôle du bon fonctionnement des équipements de radioprotection est renforcée dès 2018 dans la législation suisse (OrX, art 24).

**Methods and Materials:** Les tabliers de radioprotection, identifiés dans un programme de gestion et de maintenance, sont contrôlés visuellement chaque année selon un protocole standardisé. Lorsque ce contrôle laisse un doute sur l'intégrité du tablier, un contrôle radiologique est réalisé au scanner grâce à deux topogrammes à 0° et 180°. A cet effet, le tablier est maintenu en position anatomique à l'aide de blocs de mousse sur la table du CT. Après analyse, l'opérateur rend compte à l'expert de l'état de ses équipements.

**Results:** L'analyse visuelle du parc de tabliers d'un bloc opératoire de notre hôpital montre qu'environ 10% des tabliers sont éligibles pour le contrôle radiologique. La moitié des tabliers contrôlés au scanner montrent des dégâts internes significatifs et la protection de l'utilisateur n'est plus garantie. Dans la majorité des cas, des fissures attribuées aux efforts exercés sur les coutures des sangles de maintien sont l'origine des ruptures du matériau de protection.

**Conclusion:** Dans le cadre de l'assurance qualité développée dans notre hôpital, nous proposons une méthode simple de contrôle des tabliers de radioprotection par imagerie permettant de dresser un bilan de l'état des équipements de protection des services utilisateurs.

## TRMs and Phantoms in PET-CT : Increasing Knowledge

### M. Pappon; Lausanne/CH

**Purpose:** As the technology in PET-CT is growing so quickly, comprehension of TRMs have to seek the same way. With new technologies (TOF, PSF, Digital PET, gating modes, ...), image quality and clinical procedures are changing really fast.

To control these machines, imaging phantoms is necessary. It is part of Radiophysicist job, but implication of TRM on their preparation, acquisition and treatment can offer new perspective of comprehension of PET-CT.

**Methods and Materials:** We are going to show the differents kind of phantoms used to control PET systems, and which kind of control or calibration it can implicate, and how it can be possible to increase the comprehension of « how the image is build ».

Also, we are going to explain how we can use the same phantoms for other possibilities such as European Accreditation, or research application.

**Results:** We will be able to explain that producing quality images in PET-CT may be better when Technologist are part of the control process. It is a way to approach new technologies and to control older one.

**Conclusion:** Finally, we will try to show that using and understanding common phantoms can be a way to be part of the conception of new kinds for specific activities, such as the other kind of existing phantoms (heart beating, Hoffman, ..).

## Anévrismes stables ou instables ? / Aneurysma stabil oder instabil?

#### <u>C. Fasoli</u>; Zurich/CH

**Purpose:** Forschungen zeigen, dass durchschnittlich 3% der Bevölkerung ein Aneurysma im Schädel erleiden. Diese Aneurysmen werden entweder auf Grund der Ruptur der Aneurysmawand und den damit verbunden Beschwerden oder als Zufallsbefund entdeckt.

**Methods and Materials:** Die Stabilität des Aneurysmas ist deshalb von Wichtigkeit. Um zu bestimmen, ob eine Aneurysma nun stabil oder instabil ist, werden in der Klinik Hirslanden Zürich verschiedene Sequenzen des Schädel MRTs durchgeführt.

**Results:** Dabei stehen im Moment die Sequenzen T1\_3D\_Backblood sowie TOF (Time of flight) und in Zukunft die 4D Flow Messung im Vordergrund.

**Conclusion:** Beispiele für die Planung und den Nutzen dieser Sequenzen, vor allem aus der Sicht der diplomierte Radiologiefachfrau /-mann HF, werden dargelegt und erläutert.

### Optimisation des injections de contraste IV en CT tenant compte de l'indication clinique et des données du patient / Optimierung der Injektion von IV Kontrastmittel im CT, je nach Indikation und Patient

<u>S. Behzad Imsand</u><sup>1</sup>, H. Brat<sup>2</sup>, D. Fournier<sup>2</sup>; <sup>1</sup>Epalinges/CH, <sup>2</sup>Sion/CH

**Purpose:** Après avoir mis en œuvre la gestion et l'optimisation des doses d'irradiation sur les CT de ses huit sites en utilisant notamment le logiciel Dosewatch™, le Réseau Radiologique Romand (3R) poursuit cette démarche en se concentrant sur l'optimisation de l'utilisation des produits de contraste iodés.

L'objectif est d'adapter les protocoles d'injection aux indications cliniques et aux caractéristiques de chaque patient.

Methods and Materials: Le projet se déroulera en 2 phases.

La première consiste en l'analyse de nos pratiques actuelles d'injection sur les différents sites avec l'étude des paramètres d'injection couplée à une analyse qualitative et quantitative du rehaussement des lésions. La deuxième vise une harmonisation et optimisation des protocoles sur tous les sites basée sur les différences relevées dans la phase 1, les indications cliniques et les données liées aux patients, notamment la composition corporelle. Cette deuxième phase s'appuiera sur les acquis de Dosewatch™ (protocoles déjà définis, utilisation du BMI), sur les données fournies par des impédancemètres pour déterminer la composition corporelle, ainsi que sur des analyse sur fantôme. La récolte des données d'injection est effectuée par un module spécifique du logiciel Dosewatch™ en lien avec un modèle d'injecteur unifié sur tous les sites (Stellant™).

**Results:** Il s'agit d'un projet pluridisciplinaire et multicentrique regroupant des collaborateurs de 3R (médecins et TRM), des firmes Ge Healthcare (logiciel et CT) et Philips Healthcare (CT), ainsi que de l'Institut de radiophysique du CHUV. Le projet est en cours. Ses résultats seront présentés lors du congrès.

#### Intérêt du CT à double énergie dans le cadre du contrôle post thrombolyse par voie endovasculaire après un AVC / Interesse des Dual-Energy CT als Kontrolle nach endovaskulären Thrombolyse nach Hirnschlag

#### M. Bonvin; Lausanne/CH

**Purpose:** Après une thrombectomie cérébrale par voie endovasculaire (TEV) il est difficile de différencier une hémorragie d'un résidu de produit de contraste sur un scanner natif du cerveau. L'utilisation du scanner à double énergie (DECT) doit permettre une meilleure identification diagnostique.

**Methods and Materials:** D'après l'étude de Joanna G. (J NeuroIntervent Surg 2016), les performances du DECT sont supérieures à celles d'un scanner cérébral standard pour l'identification d'une ischémie en phase aigüe lors du contrôle à 24h post TEV.

Sur notre site, un protocole DECT dédié au contrôle à 24 heures post TEV a récemment été mis en place. Cependant, le DECT n'est à ce jour disponible que sur une seule machine, en horaire de jour. La mise à jour du DECT sur d'autres scanners, notamment aux urgences, est en cours de réalisation, permettant ainsi l'utilisation de cette technique à tout moment.

**Results:** Les contrôles à 24 heures post TEV vont être réalisés de façon systématique avec le DECT et permettront ainsi un diagnostique plus fiable des ischémies cérébrales en phase aigüe.

**Conclusion:** Dans la pratique clinique, les TEV interviennent le plus tôt possible dans la prise en charge du patient souffrant d'un AVC. Le contrôle réalisé 24 heures après la TEV doit pouvoir être effectué quelle que soit l'heure. Il est nécessaire d'avoir à disposition un scanner DECT ouvert en continu, dans le service des urgences, afin de réaliser tous les contrôles post TEV avec le DECT.

### Installation d'une IRM aux urgences (24h/24h) Quelles implications pour les TRM / Einrichtung einer Magnetresonanz auf der Notfallabteilung (24/24) Implikationen für Radiologiefachleute

#### <u>C. Rohner</u>; Lausanne/CH

**Purpose:** Un état des lieux de la situation de l'unité IRM d''un hopital universitaire (CHUV), a été effectué. Les demandes d'examens IRM en urgence ont fortement augmentées au cours de ces dernières années. Les urgences sont actuellement rajoutés au programme planifié de la journée. Un système de piquet est actuellement mis en place. Des demandes avec une prise en charge plus urgente sont également apparues (AVC). L'installation d'une IRM aux urgences est devenue indispensable. L'IRM sera fonctionnelle à la fin de l'année 2017.

**Methods and Materials:** Le CHUV a décidé d'installer une IRM 3T, nécessaire en vue des diagnostics demandés. Les ressources du personnel ont étés calculées, avec une prise en compte des horaires de contraintes (machine ouverte 24h/24h). La machine choisie est du même constructeur que les 4 autres machines présentes sur site, mais avec un nouveau soft. Ceci implique une formation pour tout le groupe des TRM IRM. Une sensibilisation aux problèmes de sécurité a été donnée à l'ensemble des intervenants externes amenés à collaborer avec les TRM de l'IRM.

**Results:** Les résultats constatés: Planification des patients Formation des TRM Collaboraation avec les intervenants externes

**Conclusion:** La modification des pratiques est-elle pertinente? Avons -nous réussi à endiguer les urgences de manière optimale? Quelles conséquences sur la pratique des TRM?

## Comparaison de deux logiciels de post-traitement de perfusion T2\* de patients atteints de glioblastome / Vergleich von 2 Softwares für post-processing von T2\* Perfusion bei Patienten mit Glioblastom

<u>E. L. Delacoste, E. Nendaz Sacasa</u>, B. Delattre, M. I. Vargas Gomez; Geneva/CH

**Purpose:** Comparer deux logiciels de post-traitement de perfusion cérébrale T2\* de patients atteints de glioblastome, afin d'évaluer la reproductibilité et la robustesse des résultats semi-quantitatifs.

**Methods and Materials:** Des protocoles sur Intellispace et Syngo.via ont été mis en place afin de générer des cartes de perfusion. Onze acquisitions de perfusion T2\*, provenant de dix patients (ratio de genre M/F : 4 ; âge moyen : 63 ans [min : 40, max : 80]), atteints d'un glioblastome ont été analysées.

**Results:** Concernant la comparaison inter-opérateur, pour Syngo.via, le protocole AIF automatique avec correction T1 possède la meilleure moyenne (0,08). Pour Intellispace, le meilleur protocole est celui utilisant le gamma variate (0,25).

Afin de comparer les différences inter-logiciels, la moyenne des différences des résultats avec le gamma variate d'Intellispace et l'AIF automatique avec correction T1 de Syngo.via est la plus faible (-0,003). Avec la comparaison intra-logiciel nous pouvons remarquer que les options d'Intellispace sont cohérentes entre elles, sauf le gamma variate qui a des résultats plus élevés. Cependant, celles de Syngo.via ne sont pas cohérentes entre elles et possèdent des résultats deux fois plus élevés qu'Intellispace.

Pour finir, les résultats entre un petit et un grand ROI de référence dévient que de quelques centièmes (0,07).

**Conclusion:** Nous pouvons conclure que la méthode du gamma variate d'Intellispace et celle de l'AIF automatique avec correction T1 de Syngo.via sont les plus concordantes inter-logiciel et inter-opérateur. Leurs résultats sont les plus reproductibles et les plus robustes.

## Infiltration lombaire sous guidage IRM 3T / Lumbale infiltration unter 3T MRI

## <u>A. Stockli</u>, E. Maturana; Thônex/CH

**Purpose:** L'infiltration lombaire sous guidage IRM est réalisée principalement sur des IRM ouvertes. Ce geste reste cependant tout à fait praticable sur une IRM 3T fermée. C'est ce que nous réalisons au service de radiologie des Trois-Chêne. L'objectif de cette présentation est de montrer la faisabilité, les avantages et les contraintes liées à la réalisation d'une infiltration lombaire sous guidage IRM 3T.

**Methods and Materials:** Mise en place d'un protocole d'installation et de positionnement du patient ainsi que d'une technique d'asepsie et de marquage du point d'entrée appropriées à l'environement d'un champ magnétique permanant 3T.

L'adaptation et l'implémentation d'un protocole IRM avec des séquences spécifiques pour le contrôle et le guidage de l'aiguille.

Matériel spécifique: antenne ouverte imperméable, aiguilles conditionnelles 3T.

**Results:** Les cas réalisés montrent l'intérêt de cette technique notamment pour le controle du positionnement de l'aiguille par rapport aux structures tissulaires rencontrées autres qu'osseuses, difficilement visualisables au CT-scan et tout particulièrement les nerfs spinaux.

**Conclusion:** Bien que non spécifique à l'interventionnelle, une IRM 3T peut tout à fait convenir à la réalisation d'une infiltration lombaire.

Avantage de cette technique : non irradiant, précision du geste, augmentation de la polyvalence de la machine.

## IRM avec pace-maker / Magnetresonanztomografie (MRT) mit Herzschrittmacher

#### C. Fasoli; Zurich/CH

**Purpose:** Immer mehr Patienten besitzen einen Herzschrittmacher, der möglicherweise bereits MRT-tauglich ist.

**Methods and Materials:** Damit auch diese Patienten sorglos ein MRT erhalten können durchlaufen sie in der Klinik Hirslanden Zürich ein eigenes Prozedere, dass sich in Bezug auf den üblichen Verlauf vor allem vor und nach der Untersuchung unterscheidet. Auf diese Vorsichtsmassnahmen wird nebst den Sicherheitsmassnahmen, die während der eigentlichen Untersuchung relevant sind, eingegangen.

**Results:** Anhand von diesem Beispiel werden die dafür nötigen Begriffe MRT-tauglich / nicht tauglich / bedingt tauglich und MRT-Modus erklärt und die in der Klinik Hirslanden Zürich vorhandene Checkliste erläutert.

**Conclusion:** Auf mögliche Schwierigkeiten die dabei auftreten können, wird hingewiesen und entscheidende Hürden, wie beispielsweise nicht funktionstüchtige Elektroden, hervorgehoben.

#### Spectroscopie cérébrale en IRM, analyse de données et applications de reconstructions par le Technicien en Radiologie médicale / MR-Spektroskopie im Gehirn, Datenanalyse und Rekonstruktionsapplikationen durch Radiologiefachleute

<u>S. Adamastor, M. Gulizia</u>, M. Clément, A. Klauser, J.-N. Hyacinthe, F. Lazeyras; Geneva/CH

**Purpose:** L'étude réalisée porte sur la spectroscopie cérébrale en IRM et son application dans la routine clinique de patients souffrant de pathologies cérébrales. Nous avons traité trois problématiques.

**Methods and Materials:** La première consiste à analyser les données de trente-huit patients atteints de pathologies cérébrales tumorales et non-tumorales pour évaluer la sensibilité et spécificité de la technique pour détecter les lésions progressives.

Le second sujet traite les différences observées entre les valeurs obtenues avec le logiciel de reconstruction Siemens et LCmodel qui est le gold standard utilisé mais plus complexe à manipuler. Finalement, nous déterminons la possibilité que les techniciens en radiologie médicale (TRM) puissent réaliser en autonomie les reconstructions spectroscopiques sur le logiciel Siemens. Pour cela, nous avons créé une marche à suivre.

**Results:** Nous relevons un important diagnostic différentiel entre les lésions de type inflammatoire et tumoral. La différenciation entre un gliome de bas grade et une lésion non-tumorale est complexe. Les deux rapports de métabolite ayant la spécificité la plus haute sont la Cho/NAA et les lipides à 1.3 ppm. Les égressions linéaires et les graphiques Bland-Altman montrent que globalement la sensibilité de Siemens est supérieure à celle de LCmodel mais la specificité de LCmodel est supérieure à Siemens. La marche à suivre permettrait aux les techniciens du service de réaliser les reconstructions de manière autonome.

**Conclusion:** La spectroscopie peut être une aide en cas de diagnostics difficiles. Le TRM est capable de réaliser les reconstructions grâce au programme Siemens. Les différences de sensibilité et spécificité entre LCmodel et Siemens sont notables.

### IRM post mortem : Elaboration de procédures et de protocoles spécifiques / Post mortem MRI: spezifische Prozeduren und Protokolle

C. Bruguier, M. P. Genet, S. Grabherr, F. Dedouit; Lausanne/CH

**Purpose:** L'implantation d'une IRM 1.5 tesla dans notre institut a demandé une réflexion globale sur des protocoles d'aquisition spécifiques, la prise en charge des cas évalués en médecine légale, et les procédures de sécurité pour le personnel. Dans ces différents processus le TRM a eu un rôle important et central.

**Methods and Materials:** Pour mettre en place les différents processus, des séances interdisciplinaires ont été planifiées où les consignes de sécurité pour l'IRM et la préparation des cas à l'examen IRM ont été discutés. Pour l'évaluation des séquences, des examens ont été effectués sur des cas forensiques, suivis de réunions avec des médecins légistes et des radiologues pour évaluer la qualité des images obtenues.

**Results:** L'ensemble du personnel a suivi des séances d'information et de formation sur l'environnement sécuritaire de l'IRM. Un protocole de préparation pour les cas évalués par IRM a été mis en place. Des protocoles et des études, comme l'évaluation des lésions traumatiques cérébrales ou de strangulation par exemple, ont été implantés en adaptant des séquences cliniques et en tenant compte des particularités des cas forensiques.

**Conclusion:** Les TRM ont pu démontrer leurs compétences en prenant en charge l'ensemble des processus. Après plus de deux ans de tests par les TRM, l'adaptation de différents protocoles cliniques aux cas évalués dans notre institut permet l'obtention d'images de qualité.

La détermination des différentes indications et l'intégration de cette étape supplémentaire dans la prise en charge des corps médico-légaux ouvrent la possibilité de pouvoir utiliser dans le futur l'IRM post-mortem à des fins diagnostiques.

## Défis et opportunités pour les techniciens en radiologie / Herausforderungen und Opportunitäten für Radiologiefachleute

Y. Jaermann; Vevey/CH

**Purpose:** La profession de technicien en radiologie en tant que telle est très jeune en Suisse. Elle reste encore à ce jour méconnue tant du public que des professionnels

Le contexte politico-économique nous pousse à des réflexions de fond pour ancrer les techniciens en radiologie médicale dans le monde des professions de la Santé.

Dans un cadre où de nombreuses professions cherchent à s'accaparer des pans entiers de l'activité des techniciens en radiologie, des actions lourdes dans le domaine de la formation sont à entreprendre. De même, une ouverture sur de nouvelles compétences et des champs d'activité diversifiés permettront d'entrevoir l'avenir que la profession mérite

Methods and Materials: Bref historique de la profession

## Aperçu de la formation

Situation de la profession dans le monde de la santé

**Results:** Propositions de pistes et d'actions au niveau de la formation et de la politique professionnelle

Conclusion: Le TRM a besoin dêtre pro-actif plutôt que réactif

### Intelligence artificielle en imagerie médicale : que deviendront les TRM et médecins radiologues ? / Künstliche Intelligenz in der médizinischen Bildgebung: was wird aus MTRAs und Radiologen?

### P. Vorlet; Savigny/CH

**Purpose:** L'intelligence artificielle (IA) va déferler en imagerie médicale, c'est inévitable. C'est le sujet phare des médecins radiologues (MR) de tous les derniers congrès. Mais nous, TRM, qu'allons-nous devenir ? Les objectifs de cette présentation sont de tenter :

- D'expliquer pourquoi notre monde professionnel se transformera,
- D'explorer quels chemins les industriels emprunteront,
- D'apporter des scenarii réalistes de l'avenir des professions TRM et MR,

- De proposer des solutions concrètes pour profiter de l'IA et non la subir.

**Methods and Materials:** C'est une synthèse de lectures systématiques issues de revues spécialisées, et lectures critiques d'articles scientifiques. Par conséquent, une sélection basée sur une grille de lecture a été réalisée. Puis les articles restants ont été regroupés selon les objectifs précités pour obtenir un discours concret, représentatif et impartial. Les solutions concrètes présentées découlent de projets en cours ou naissants au sein de la section romande de l'ASTRM.

**Results:** Ces lectures critiques ont permis d'identifier les différents futurs des professions de TRM et de médecins radiologues, de les pondérer pour enfin prioriser le scénario le plus probable et réaliste compte tenu des informations à disposition. Ce résultat a permis d'une part, de mesurer de manière concrète la stratégie professionnelle actuelle de la section romande. Et d'autre part, la nécessité d'anticiper les évolutions du métier pour la mise sur pied d'autres projets.

**Conclusion:** Les TRM ne pourront pas éviter l'arrivée en force de l'IA dans l'imagerie médicale. Ce travail permet d'en comprendre les tenants et les aboutissants, et apporte des pistes d'actions et de solutions.

#### Développement de l'expertise professionnelle chez les étudiants TRM de dernière année bachelor à travers l'analyse des pratiques professionnelles via séquence vidéo / Entwicklung der Berufsexpertise von studierenden Raidiologiefachleuten dank Analyse von Videosequenzen

### L. Flaction; Lausanne/CH

**Purpose:** Proposer aux futurs diplômés de percevoir leur propre marge de progression à travers l'analyse d'une vidéo, selon une grille d'observation, portant sur le déroulement de la prise en charge d'un patient en radiologie conventionnelle et la réalisation d'une incidence fondamentale, afin qu'ils prennent conscience de leur niveau taxonomique.

**Methods and Materials:** La séquence à analyser porte sur un échange de 10minutes entre le TRM étudiant de 1ère année et le patient simulé, lors d'une validation pratique de type ECOS de positionnement radiologique. A travers la recherche d'indicateurs pertinents proposés dans une grille d'observation, les étudiants sont encouragés à émettre des jugements professionnels.

**Results:** Ce dispositif pédagogique a mis en évidence le soutien aux étudiants dans leur apprentissage en permettant 1)d'identifier la complexité de leur rôle de futur diplômé; 2)de formuler des problèmes professionnels; 3) de réfléchir à un discours professionnel. Les enseignants ont observé chez les étudiants une posture réflexive mettant en évidence une progression vers l'expertise souhaitée. Au final, ce dispositif permet de construire des compétences collectives en accroissant le rôle d'expert, en privilégiant l'autonomie et la création d'une identité professionnelle.

**Conclusion:** La formation par l'analyse des pratiques n'interroge pas uniquement l'objet de formation et la compétence didactique, mais conduit le sujet à analyser ses pairs au travers de son vécu. Le sujet s'implique dans le cadre de l'analyse via vidéo et il ne faut pas le déstabiliser/déconstruire. Au contraire, l'objectif est de permettre au sujet participant de développer son expertise en mobilisant ses compétences acquises au long de son cursus.

# L'événement indésirable comme source d'apprentissage dans la pratique des TRM / Unerwünschte Ereignisse als Lernquelle in der Berufspraxis derRadiologiefachleute

<u>F. Guignard</u>, C. Chautems, <u>I. Künzli</u>, J.-F. Cremona, F. Poncet, N. Busigny; Lausanne/CH

**Purpose:** *Cette présenta*tion témoigne de l'importance du comment et pourquoi exploiter les erreurs issues de la pratique afin d'enrichir la formation continue des TRM et ainsi modifier la perception et l'attitude des professionnels face à l'erreur.

**Methods and Materials:** Un événement indésirable grave survenu à un patient a induit la mise en place d'un dispositif permettant l'observation de la prise en charge relationnelle des patients par les TRM dans leurs activités cliniques. Cet accompagnement a été effectué par des formateurs d'adultes que sont les TRM praticiens formateurs (PF) et suivi systématiquement d'un entretien avec un retour formalisé.

Une grille d'observation contenant le lieu de l'observation, le type de modalité, de patient et des indicateurs a permis une récolte de données quantitatives et qualitatives.

**Results:** Des résultats graphiques issus des données mesurables quantitativement ainsi que la récurrence des certains commentaires permettent de donner une vision en temps réelle d'une forme de qualité de la prise en charge relationnelle tout en identifiant les lacunes individuelles et collectives.

**Conclusion:** L'identifications des besoins individuels ou collectifs des TRM permet de cibler des actions ponctuelles de formation continue tout en visant à changer de paradigme dans la formation continue pour passer de l'erreur sanctionnée de celui de l'erreur « source d'apprentissage ».

## PICC Team : création d'une équipe pluridisciplinaire / Picc Team: Schaffung eines interdisziplinären Teams

<u>P. Frossard</u><sup>1</sup>, S. Ilic<sup>1</sup>, G. Gullo<sup>1</sup>, A. Colin<sup>1</sup>, C. Balhau Rolo<sup>1</sup>, D. Bodenmann<sup>2</sup>, F. Doenz<sup>1</sup>, S. D. Qanadli<sup>1</sup>; <sup>1</sup>Lausanne/CH, <sup>2</sup>Frauenfeld/CH

**Purpose:** La demande de mise en place de PICC (Peripheral Inserted Central Catheter) est en constante augmentation. Ce geste était, jusqu'à récemment, réalisé par les radiologues interventionnels. La conjonction de ces deux faits amène quelques questions quant à l'organisation et à la prise en charge de cet acte : Comment raccourcir le délai de la prise en charges des patients nécessitant une mise en place de PICC. Comment éviter de surcharger les salles dédiées à des actes plus complexes. Comment garder la disponibilité des radiologues interventionnels pour des actes médicaux plus complexes.

**Methods and Materials:** Une réponse a été trouvée sous la forme de la création d'une équipe pluridisciplinaire dédiée à cet acte et de la délégation de ce geste à du personnel paramédical et médicotechnique.

**Results:** La PICC Team était née, composée de radiologues interventionnels, de deux infirmier-ère-s et de trois TRM comprenant deux filières de prise en charge de patients.

Ce PICC Team a effectué, depuis avril 2017, 668 procédures dont 362 (54%) par la filière TRM / infirmier-ère-s.

**Conclusion:** Nous proposons de décrire les étapes nécessaires à la formation et la mise en place de cette équipe au sein de notre service.

## Examens de la colonne lombaire avec produit de contraste en IRM / Kontrastmitteluntersuchungen der LWS im MR

#### C. Marquart; Zurich/CH

**Purpose:** Zur Vereinfachung des Arbeitsablaufs der MTRA, werden die Indikatoren für den Entscheid zur intravenösen Kontrastmittel (KM) Injektion bei der LWS in der MRT dargelegt.

**Methods and Materials:** Untersucht wurden 50 Patienten im Alter zwischen 30 und 80, 25 männlich 25 weiblich, 50% mit Kontrastmittel 50% ohne Kontrastmittel. Untersucht wurden Auslösende Faktoren für die KM Injektion in den drei Sequenzen, STIR, T2 oder T1 in Weichteilen und/oder Knochenstrukturen.

Oft wird in der Wirbelsäule eine STIR ergänzend gefahren, um frische Frakturen oder entzündliche Veränderungen zu detektieren. Ein "aufleuchten" im Fettgewebe bei operierten oder adipösen Patienten ist normal. Doch ab wann ist es indiziert Kontrastmittel zu spritzen? Eine Entscheidung die die Ärzte treffen. Wo ist die Grenze? Wenn das die MTRA's sehen können, verbessert das den Arbeitsablauf und führt zu weniger Rückfragen und Störungen an die Radiologen.

**Results:** Auslösende Faktoren waren Weichteilauffälligkeiten, selten waren positive Zeichen in Knochenstrukturen Auslöser für eine Injektion.

In T2 und STIR sind Zystische Strukturen oder Muskelveränderungen Kontrastmittelindiziert. In T1, narbige Strukturen (Hypointens) oder Intraspinale Auffälligkeiten.

**Conclusion:** Zur Differenzierung extraspinaler Entzündungen, Abszessen oder Tumoren wird Kontrastmittel eingesetzt.

Take Home Message für die MTRA: Weichteilauffälligkeiten sind eher KM indiziert.

Die KM-Gabe bewährt sich zur Differenzierung einer Entzündung, eines Abszesses oder Tumors bei T2 und STIR positiven Zeichen in Muskelgewebe, Zystische Läsionen Intraspinal oder T1/T2 Veränderungen Intraspinal.

Die Ergebnisse sind nicht immer einfach zu interpretieren, doch mit einem geschulten Auge der MTRA, werden die Arbeitsabläufe vereinfacht.

### Mammographie, technique de positionnement / Mammografie -Positionierungstechnik

M. P. Miller: Zurich/CH

## Purpose:

Psycho-Soziale Kompetenz

Positionierung und Einstelltechnik: Standard und Zusatzaufnahmen Kriterien für perfekte MGR

Qualitätssicherung

## Methods and Materials:

### 1. Psycho-Soziale Kompetenz

- sicheres, freundliches Auftreten der Patientin Verständnis entgegenbringen für die Situation
- das Vertrauen der Patientin gewinnen
- gute Aufklärung über den Untersuchungsablauf erhöhen Motivation und Kooperationsbereitschaft der Patientin

### Vorbereitung

- Anamnesebogen studieren
- Mammografie-Voraufnahmen ansehen
- Patienten-ID überprüfen
- Gerät positionieren, Belichtung einstellen
- sich der Patientin mit Namen vorstellen
- Aktuelle Beschwerden erfragen
- Gespräch steuern
- Gewinnendes Auftreten bringt Vertrauen und baut Ängste ab!

## Vorteile der Kompression

- Vermindert die Strahlendosis
- Reduziert Streustrahlen
- Verbessert den Bildkontrast
- Geringere Unschärfe
- Weniger Parenchymüberlagerungen (Summationseffekte)
- Bessere Beurteilung von Architekturstörungen 2. Positionierung und Einstelltechnik: Standard und Zusatzaufnahmen
- cranio caudal cc
- medio-lateral-oblique 45° mlo
- Medio-Lateral 90° ml
- Cleavage (Busenaufnahme)
- cc nach innen gedreht
- cc nach aussen gedreht (Cleopatra-Aufnahme)
- Gerollte Aufnahme für Parenchymüberlagerungen (Summationseffekte)
- Vergrösserung Zieltubus
- Implantate Eklund
- Präparatradiografie
- 3. Kriterien für perfekte MGR
- PGMI System bewertet die Aufnahmequalität und Positionierung von Mammogrammen
- P = Perfekte Aufnahme
- G = Gute Aufnahme
- M = Mässige Aufnahme
- I = Inadäquate Aufnahme
- Mind. 75% perfekt od. gut
- Weniger als 3% inadäquat

Besonderheiten (Thoraxdeformation, Kyphose, dezentrierte Mamillen) stets vermerken

4. Qualitätssicherungsmassnahmen

Bildanalyse: Audits mit Radiologen

## Results: Qualitätssicherung

BAG: R-08-02 Qualitätsprüfungen an Mammographie-Röntgenanlagen

- AP: Abnahmeprüfung
- ZP: Zustandsprüfung
- KP: Konstanzprüfung
- IW: Instandhaltung / Wartung

#### Bildanalyse PGMI: Regelmässige Audits mit Radiologen Conclusion: Perfekte Einstelltechnik nur möglich

- gute Vorbereitung
- hohe psycho-soziale Kompetenz
- Vertrauen gewinnen
- Patientin für Positionierung führen können
- adäguate Kompression
- Strahlendosis beachten, ggf. auf manuelle Belichtung schalten, v.a. bei Implantaten
- Besonderheiten, Abweichungen notierung
- regelmässige Trainings / Kurse besuchen
- Broschüre: «KBV Mammografien regelrecht erstellen»

Faire parler les morts : réflexions socio-anthropologiques sur le développement de l'imagerie post-mortem / Tote zum Sprechen bringen: sozio-anthropologische Ueberlegungen über die Entwicklung von postmortaler Bildgebung

<u>C. Schnegg</u>, S. Rey; Lausanne/CH

**Purpose:** Depuis une quinzaine d'années, plusieurs technologies d'imagerie médicale – scanner, IRM, angiographie – sont intégrées dans le dispositif d'enquête médico-légal et s'ajoutent aux outils conventionnels de détermination des causes de la mort. Ces techniques suscitent un fort engouement scientifique et médiatique, de même que l'entrée de nouveaux professionnels, TRM et médecins-radiologues, dans le domaine de la médecine légale. L'imagerie forensique est en particulier développée en Suisse par des équipes qui la décrivent comme une technique révolutionnaire car elle limite les interventions humaines sur le corps et accroît la neutralité de la démarche scientifique. Se situant dans le champ des sciences sociales, notre présentation se centre sur ses enjeux socio-anthropologiques.

**Methods and Materials:** Notre enquête est fondée sur l'ethnographie des pratiques d'enquête dans un centre à la pointe de l'imagerie forensique.

**Results:** Les techniques d'autopsie virtuelle introduisent une rupture dans le rapport au corps mort: alors que l'autopsie engage une proximité des experts avec les corps et une série d'examen qui engagent tous leurs sens, ces nouvelles techniques de visualisation mettent le corps à distance, excepté pour les TRM qui manipulent les cadavres, et en produisent des représentations esthétisées. Mais elles ont aussi le pouvoir spécifique de « réanimer » le corps par l'intermédiaire de l'angiographie qui rétablit la circulation sanguine.

**Conclusion:** Alors que plusieurs innovations dans le domaine de l'imagerie post-mortem vont dans le sens de simuler la vie biologique, ces techniques redéfinissent le rapport au corps mort de manière inédite.

Please note that abstracts appear as submitted to the online submission system.

## P001

### Intravoxel Incoherent Motion: Model-free Determination of Tissue Type in Abdominal Organs using Machine-Learning

A. Ciritsis, C. Rossi, M. Wurnig, V. D. Phi van, A. Boss; Zurich/CH

**Purpose:** For diffusion datasets including low and high b-values, the Intravoxel Incoherent Motion model is commonly applied to characterize tissue. The aim of the present study was to show that machine learning allows a model-free approach to determine tissue type without a-priori assumptions on the underlying physiology.

**Methods and Materials**: In eight healthy volunteers, diffusion datasets were acquired using an echo-planar imaging sequence with 16 b-values in the range between 0-1000 s/mm2. Using the k-nearest-neighbors (K-NN) technique, the machine learning algorithm was trained distinguishing abdominal organs (liver, kidney, spleen, muscle) using signal intensities at different b-values as training features. For systematic variation of model complexity, performance was assessed by calculation of accuracies and the kappa coefficient ( $\kappa$ ). Most important b-values for tissue discrimination were determined by principal component analysis (PCA).

**Results:** The optimal trade-off between model complexity and overfitting was found in the range between K=11 to 13. On "real world" data, the K-NN algorithm was capable to distinguish tissue types with best accuracy of 94.5 % and  $\kappa$ = 0.92 reached for intermediate model complexity (K=11). The PCA showed that most important b-values are: b=1000s/mm<sup>2</sup>, b=970s/mm<sup>2</sup>, b=750s/mm<sup>2</sup>, b=20 s/mm<sup>2</sup>, b=620s/mm<sup>2</sup> and b=40 s/mm<sup>2</sup>. Applying a reduced set of six most important b-values, a similar accuracy was achieved on with average accuracy 93.7 % and a kappa coefficient of 0.91.

**Conclusion:** Machine learning allows for a model-free determination of tissue type using IVIM signal decay curves as features. The technique may be useful for segmentation of abdominal organs or distinction between healthy and pathological tissues.

#### PO02

Can emergency CT reliably detect significant blunt bowel and mesenteric injury?

<u>N. C. Keller</u>, T. Zingg, F. Agri, R. A. Meuli, J.-F. Knebel, S. Schmidt; Lausanne/CH

**Purpose:** To evaluate and compare two previously validated imaging-based scoring systems for the detection of significant blunt bowel and mesenteric injury (sBBMI) by emergency computed tomography (CT).

**Methods and Materials:** We consecutively included all our polytrauma patients addressed from 2008 to 2015 to our emergency department (trauma registry cohort) following a road traffic accident provided that they had undergone whole-body CT before surgery. In consensus, two radiologists, blinded to patients' outcome, reviewed all the CT examinations in view of 6 mesenteric, 4 intestinal and 9 other abdominal trauma CT findings. The latter were then correlated with patients' surgical outcome or clinical follow-up (>24h). Furthermore, two previously validated imaging-based bowel-injury scoring systems were compared with each other by applying them on our cohort (t-test, chi-square test).

**Results:** Among 681 analyzed patients 21 (3.1%) had sBBMI, confirmed by emergency laparotomy. Pneumoperitoneum, small hemoperitoneum, diffuse bowel wall thickening, mesenteric or pericolic stranding, vascular extravasation, and anterior abdominal wall injury were significantly correlated with sBBMI, as were each of the two scoring systems, the Faget and Mc Nutt score (p<0.001).

**Conclusion:** The prevalence of sBBMI among polytrauma patients is low; however early diagnosis is necessary. Certain CT-features are pathognomic; thus, they must not be overlooked. Scoring systems may be helpful, but do not seem not mandatory for the detection of significant blunt bowel and mesenteric injury.

### Renal Cell Carcinoma: Associations Between Tumor Imaging Features and Patient Age, Gender and Body Mass Index

<u>A. Hötker</u><sup>1</sup>, C. A. Karlo<sup>1</sup>, P. L. Di Paolo<sup>2</sup>, J. Zheng<sup>2</sup>, C. Moskowitz<sup>2</sup>, P. Russo<sup>2</sup>, H. Hricak<sup>2</sup>, O. Akin<sup>2</sup>; <sup>1</sup>Zurich/CH, <sup>2</sup>New York/US

**Purpose:** To investigate associations between imaging features of tumors and age, gender and body mass index (BMI) in patients with renal cell carcinoma.

**Methods and Materials:** This IRB-approved study included 1348 patients with histopathologically confirmed renal cell carcinoma of the clear cell subtype (ccRCC, n=904) or non-clear cell subtype (n=444), who underwent pre-treatment CT less than 180d before nephrectomy between 1999 and 2011. Two radiologists independently analyzed all imaging studies and identified features (necrosis, renal vein invasion, contact with renal sinus fat, multicystic appearance and nodular enhancement), which were then correlated with patient age, gender and BMI at time of surgery.

**Results:** Inter-reader agreement on imaging features ranged from substantial to excellent (kappa: 0.688-0.982). In the ccRCC group, multicystic tumor appearance was significantly associated with lower patient age (57.2/57.4 vs. 60.2/60.1y;  $p \le 0.0149$ ) and lower BMI (28.7/28.9 vs. 30.8/30.7kg/m<sup>2</sup>; $p \le 0.018$ ); the presence of renal vein invasion was significantly associated with lower BMI in males (28.7/28.0 vs. 30.2kg/m<sup>2</sup>; $p \le 0.0441$ ); and both tumor contact with the renal sinus and nodular enhancement were significantly associated with greater patient age ( $p \le 0.0069$ ). In the non-ccRCC group, necrosis was associated with lower BMI for females ( $p \le 0.0328$ ).

**Conclusion:** This study expands on prior epidemiological studies by demonstrating significant associations between imaging features of RCC and patient age and BMI. Future studies that incorporate these findings while investigating genomic, molecular and metabolic variables in patients with RCC could provide new insights into the heterogeneous clinical behavior of renal cancer.

P004

## Management of active lower gastrointestinal bleeding detected by angio-CT: Which criteria decide about angioembolisation or surgery?

<u>M. Pannatier</u><sup>1</sup>, R. Duran<sup>2</sup>, R. A. Meuli<sup>2</sup>, S. Schmidt<sup>2</sup>; <sup>1</sup>Sion/CH, <sup>2</sup>Lausanne/CH

**Purpose:** To determine radiological or clinical criteria serving as guide for the emergency treatment in patients with active lower gastrointestinal bleeding detected by angio-CT.

**Methods and Materials:** We retrospectively included all the patients admitted in emergency between August of 2003 and June 2017 for acute lower GI bleeding proven by angio-CT. They were divided into two groups based upon the chosen initial emergency treatment: interventional radiology (n=61) versus surgery (n=27). In consensus, two observers reviewed CT-images (location, density of bleeding), delay between imaging and treatment, patients' hemodynamic parameters (shock index, lactate, and haemoglobin level), clinical data and final outcome aiming at detecting any differences between these two groups (Fisher, chi-square test).

**Results:** No hemodynamically significant differences were observed between the two groups. In cases with acute colonic bleeding the delay between CT and angiography (median 141.5min) was shorter than the delay between CT and surgery (median 693.5min) (p=0.027). In patients with clinically reported haematochezia or melena interventional radiology was the preferred treatment option regardless of the bleeding source, being either the colon (p=.001) or the small bowel (p=0.03). Whenever the bleeding originated from the proximal small bowel we observed a trend in favour of treatment by interventional radiology (p=0.0528) unlike for colonic haemorrhage or bleeding from the distal small bowel.

**Conclusion:** In emergency patients with active lower GI bleeding revealed by angio-CT, interventional radiology should be the first treatment choice, being faster accessible, less invasive, and associated with fewer complications. Surgery should be considered in case of unsuccessful embolization and recurrent bleeding.

## PO05

P006

## Ultrasound-based elastography of the liver: Clinical indications, technical aspects and accuracy of measurements

<u>T. Borges Baptista</u><sup>1</sup>, M. Picarra<sup>1</sup>, G. Gullo<sup>1</sup>, P. Frossard<sup>2</sup>,

M. Fraga Christinet<sup>1</sup>, J.-Y. Meuwly<sup>1</sup>; <sup>1</sup>Lausanne/CH, <sup>2</sup>Morges/CH

**Learning objectives:** Understand the clinical applications in chronic liver diseases and cirrhosis

Review the different ultrasound-based (US-based) elastography techniques Review the accuracy of measurements performed with the different USbased elastography methods

**Background:** Chronic liver disease is an increasing problem in our population. As the disease progress, an increasing deposition of fibrous tissue occurs within the liver, with the development of cirrhosis as ultimate result. The degree of fibrosis is an important prognostic factor. During years, liver biopsy was the only way of staging this degree of fibrosis.

Since recently, non-invasive methods for liver fibrosis assessment, as USbased or MR-based elastography are available.

The different US-based elastography methods are based on the identification of tinny movements within the tissues, related to the propagation of a shear wave. These methods use different physical concepts and produce similar but not superimposable results. The physical basis of elastography need to be understand, in order to adequately use each method and interpret their results.

Now at least three different US-based elastography measurement techniques are validated for non-invasive assessment of liver fibrosis. They can be used to differentiate patients without or with only minimal fibrosis, from patients with severe fibrosis or cirrhosis. The accuracy of each technique varies with the degree of fibrosis.

Imaging findings or procedure details: Fasting patient

Supine

Shallow breath hold

Measurement in the right liver

Acquisition of multiple measurements

**Conclusion:** Profound knowledge of the physical basis and technical aspects of the US-based elastography is mandatory to understand variability and errors in the measurements.

## Imaging spectrum of neuroendocrine tumors of the gastro intestinal tract

<u>A. Akammar</u>, N. El Bouardi, Y. Alaoui Lamrani, M. Boubbou, B. Alami, M. Maaroufi; Fez/MA

**Learning objectives:** To become familiar with imaging features of neuroendocrine tumors of the gastro intestinal tract. To determine the role of interventional radiology in the management of neuroendocrine tumors of the gastro intestinal tract.

**Background:** We report a retrospective study that evaluates 30 cases of neuroendocrine tumors of the gastro intestinal tract, seen during the fouryears period from January 2013 to December 2016.

All patients underwent CT scans; MRI was performed in five cases. Histopathological confirmation was achieved in all of the cases.

**Imaging findings or procedure details:** The average age of our patients was 55 years with a female predominance. Clinical presentations were not specific, with diarrhea, abdominal pain, weight loss, bowel obstruction, and gastro intestinal bleeding. The affected digestive segments were: stomach (n=), pancreas (23%), liver (40%), appendix (11%), sigmoid (2%). Most of patients were treated with surgery and chemotherapy.

**Conclusion:** Neuroendocrine tumors of the gastrointestinal tract are not common but should be considered in developing the differential diagnosis for gastrointestinal tract tumors especially when the tumors have characteristic imaging features. Interventional radiology contributes in the therapeutic management of these tumors

## Rendez-vous at the biliary intersection: Usefulness of combined biliary procedures

<u>S. Cappio</u>, A. Leoncini, M. Maffei, R. C. Balzarotti Canger, F. Del Grande; Lugano/CH

**Learning objectives:** The aim of this educational exhibit is to emphasize the importance of combined biliary procedures between the interventional radiologist (IR) and the gastroenterologist to increase the treatment success and to reduce complications in selected patients. The advantages of two combined biliary procedures will be described

**Background:** Klatskin's tumor induced hyperbilirubinemia treatment is an indication for interventional radiology procedures, whilst hyperbilirubinemia induced by pancreatic cancer or papilloma is an indication for endoscopic procedures. Usually a single procedure or two repeated procedures are enough for satisfactory jaundice palliation but sometimes the passage from the right or left biliary tract to the common bile duct (CBD) is not possible for the IR or the gastroenterologist cannot perform ERCP due to a difficult papilla.

**Imaging findings or procedure details:** We describe in detail two cases of combined biliary procedures, where the absence of the collaboration between the two specialists would have led to an unsatisfactory outcome.

In the first procedure the IR was not able to catheterize the descending CBD trough a two-sided biliary approach and a percutaneous CBD puncture. That was finally performed with ERCP and a kissing stent placement. In the second procedure the gastroenterologist could not catheterize the papilla with ERCP due to an ampullary lesion and the IR. The combined transluminal biopsies were consistent with an Apudoma and "conservative" plastic stent placement was inserted.

**Conclusion:** Combined interventional biliary procedures between an IR and a gastroenterologist are an important strategy for selected patients.

#### P008

## Measuring tumor response in oncology: RECIST1.1 and beyond

O. Löpfe, N. Vietti Violi, C. Beigelman, A. Denys, C. Dromain; Lausanne/CH

**Learning objectives:** Limitations of RECIST criteria will be discussed and the emerging solutions available with new criteria developed for targeted therapy and immunotherapy will be presented.

**Background:** Response Evaluation Criteria in Solid Tumors (RECIST) is a common standardized method of response assessment in oncology. RE-CIST criteria are based on tumor size measurement and allow the use of simple international criteria usable by all practicioners. Although basic RE-CIST methodology is well described, inexperienced readers may encounter difficulties with certain subtleties of RECIST 1.1, in particular to select target lesions, as well as lymph nodes and bone assessment. Moreover, RECIST criteria have some limitations in particular with patients receiving a targeted therapy or immunotherapy. The largest experience has been accumulated with patients suffering from GIST and treated with imatinib. It became apparent that tumour size was not an early predictor of tumor response, while structural and perfusion modifications were readily observed.

**Imaging findings or procedure details:** Presentation of Choi criteria to evaluate the response of GIST under Imatinib and kidney cancer under Sunitinib, Chun criteria to evaluate the response of colorectal liver metastatasis under Bevacizumab, EASL (European Association of Study of Liver) as well as mRECIST criteria taking into account the viable portion (enhanced after injection during the arterial phase) to evaluate the response of hepatocellular carcinoma treated with new therapies or chemoembolization and irRECIST as well as iRECIST to evaluate the response under immunotherapy. **Conclusion:** The goal of this poster is to review the current criteria of RECIST 1.1 measurements and illustrate a set of pitfalls in RECIST assessment.

PO12

## Grey matter volume estimation in thalamic nuclei based on partial-volume analysis of T1-weighted MRI: Application to schizophrenia patients

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**Purpose:** We aim at analyzing grey matter (GM) volume within seven thalamic nuclei per hemisphere in Schizophrenia patients, by taking into account partial volume (PV) characteristics in T1-weighted MR imaging.

**Methods and Materials:** Twenty-three schizophrenia patients (SCHZ) (age=40.4±9.0; 18/6 males/females) and 27 healthy controls (HC) (age=37.7±7.9; 18/9 males/females) were recruited from the Lausanne University Hospital-CHUV (from 10/2010 till 03/2016, local Ethics approved the study). The MPRAGE T1-weighted images were acquired on a 3-Tesla scanner (MAG-NETOM Trio-a-Tim system, Siemens Healthcare, Erlangen, Germany) using the following parameters: 32-channel head coil, voxelsize=1x1x1.2mm³, FO-V=240×257×192mm<sup>3</sup>, TR= 2300ms and TE=2.98ms. We retrospectively apply a PV segmentation method1 to estimate GM tissue concentrations CGM and perform an atlas-based segmentation to divide each thalamus in seven clusters. The atlas was constructed using 67 subjects from HCP dataset<sup>2</sup>. Their thalamus was parcellated<sup>3</sup> and mapped to MNI<sup>4</sup> to build spatial probabilistic maps per cluster. GM average concentrations were computed in all thalamic clusters (<C<sub>GM</sub>><sup>cluster</sup>). General Linear Models (SPSS) were estimated for each hemisphere with the seven measures as dependent variables, group membership (HC vs SCHZ) as fixed factor, and age and gender as covariates

**Results:** All thalamic clusters showed a decreased <C<sub>GM</sub> > in patients on both right and left thalamic nuclei. Group differences were statistically significant only for <C<sub>GM</sub> > in left and right posterior-Medio-Dorsal-medial-Pulvinar nuclei (p=.046, p=.001), the right Pulvinar (p=.004), and right Ventral-Latero-Dorsal (p=.011).

**Conclusion:** Our PV study within different thalamic nuclei allowed identifying statistically significant focal GM loss within the thalamus in schizophrenia patients.

PO10

#### Automated Pixel-Wise Brain Tissue Segmentation of Diffusion-Weighted Images via Machine Learning

### A. Ciritsis, A. Boss, C. Rossi; Zurich/CH

**Purpose:** The diffusion-weighted (DW) MR signal sampled over a wide range of b-values potentially allows for tissue differentiation in terms of tissue cellularity, microstructure, perfusion, and T2 relaxivity. This study aimed at implementing a machine learning algorithm for automatic brain tissue segmentation from DW-MRI datasets, and determining the optimal set of features for accurate segmentation.

**Methods and Materials:** DWI was performed at 3 Tesla in eight healthy volunteers using fifteen b-values and 20 diffusion-encoding directions. The pixel-wise signal attenuation, as well as mean diffusivity and fractional anisotropy (FA) of the diffusion tensor were used as features to train a support vector machine classifier for gray matter, white matter, and cerebrospinal fluid classes. The datasets of two volunteers were used for validation. For each subject, tissue classification was also performed on 3D T1-weighted data sets with a probabilistic framework. Confusion matrices were generated for quantitative assessment of image classification accuracy in comparison to the reference method.

**Results:** DWI-based tissue segmentation resulted in an accuracy of 82.1% on the validation dataset and of 82.2% on the training dataset excluding relevant model over-fitting. 50% of the classification-performance was attributable to five features (i.e. signal measured at b-values of 5-10-500-1200 s/mm2 and FA). This reduced set of features led to almost identical performances for both, the validation (82.2%) and the training (81.4%) datasets.

**Conclusion:** Machine learning techniques applied to DWI data allow for accurate brain tissue segmentation based on morphological and functional tissue information; thereby potentially improving tissue segmentation in cases of compromised brain anatomy.

## The value of diffusion weighted MRI in the differentiation of benign and malignant lesions in the head and neck region

## <u>A. A. Peters</u>, S. Y. Kim, D. W. Tshering Vogel, H. C. Thöny; Bern/CH

**Purpose:** To retrospectively determine whether diffusion weighted magnetic resonance imaging can help to differentiate between various inflammatory and tumoral diseases of the head and neck.

**Methods and Materials:** After obtaining consent from the institutional review board, a search was made in the radiology records for patients with diffusion weighted MR imaging for benign and malignant lesions, which were confirmed either on histopathology or after adequate follow up. A total of 70 patients were included in this study, they were grouped into primary carcinomas (n=15), metastasis (n=12), lymphoma (n=12), benign tumors (n=27) and inflammation (n=4). Malignant tumors are usually hypercellular and show diffusion restriction. This can be assessed semiquantitavely by measuring the apparent diffusion coefficient (ADC) values.

**Results:** The ADC values in benign lesions were higher than in malignant lesions, the mean ADC value of benign tumors being  $1.46 \times 10^{-3} \text{ mm}^2/\text{sec}$  and of inflammation  $1.51 \times 10^{-3} \text{ mm}^2/\text{sec}$ . Among the malignant lesions, the ADC values were lower in lymphoma with a mean value of  $0.56 \times 10^{-3} \text{ mm}^2/\text{sec}$ . The mean ADC values of carcinoma and metastasis were similar with values of  $0.85 \times 10^{-3} \text{ mm}^2/\text{sec}$  and  $0.81 \times 10^{-3} \text{ mm}^2/\text{sec}$  respectively.

**Conclusion:** Diffusion-weighted MR imaging can help in differentiation of benign and malignant lesions of the head and neck region. Lesions with low ADC values are usually malignant and lesions with high ADC values are likely to be benign.

Withdrawn

## P013

PO14

## NeuroSHAPE: A novel software interface implementing state-of-the art targeting for MRI-guided transcranial focused ultrasound neurosurgery

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**Purpose:** The current standard for targeting subcortical structures during functional neurosurgical interventions relies on transferring stereotactic 3D coordinates from an anatomical atlas onto the patient's brain MR or CT images. Our purpose is to utilize statistical shape models (SSM) to overcome the limitations of the atlas based targeting approaches, such as the lack of information on inter-patient variability, and to develop a user-friendly interface for radiologists involved in the planning of image-guided neurosurgical interventions.

**Methods and Materials:** We demonstrate the use of a prototype targeting pipeline through five exemplary MRgFUS interventions that have been performed between January 2016 and December 2017 at the University Children's Hospital in Zurich. The method uses the pre- or intraoperatively acquired 3DT1 and T2 MR images of the patients, on which the visible outlines of the thalamus are delineated manually. Based on the anatomical correspondence between the visible thalamus outlines and the individual thalamic nuclei stored within the SSM, individualized targets maps and confidence interval maps are generated.

**Results:** The outlines of the thalamus could be delineated on the patient's intraoperative MRI, and the predicted volumes of the ventrolateralis-posteroventralis (VLpv or Vim) nucleus and the cerebello-thalamic tracts were in close proximity to the actual imaging targets (targeting distance <5mm). **Conclusion:** The efficiency and safety of functional neurosurgical interventions, such as high intensity focused ultrasound ablation, depend on the accuracy by which the target structures are reached. Using patient-specific, imaging based markers of the individual thalamic anatomy has the potential to improve accuracy.

## The influence of CT perfusion on the selection of stroke patients for endovascular therapy

J. M. Ospel, G. M. Karwacki, K. Blackham; Basel/CH

**Purpose:** Determine whether CT perfusion (CTP) changes patient selection for interventional therapy in acute stroke patients compared to combined native CT and CT angiography (CTA) data.

**Methods and Materials:** 286 consecutive acute stroke CT examinations (non-contrast CT, CTA, CTP) from patients who were examined within a 4,5 hours time window and received intravenous lysis were retrospectively evaluated in a blinded fashion. An experienced neurointerventionalist reviewed the cases first without and, after a month delay, with the CTP data (Syngo.via, Siemens Healthineers). Clinical information provided: NIHSS, age and side of neurologic deficit. Differences in detection rate of vessel occlusion and interventional decision were compared. Criteria for intervention on CTP included <100 ml core infarct volume and > 1.2 mismatch ratio. Mann-Whitney-U test was used to detect differences in the detection rate of vessel occlusions.

**Results:** ASPECTS score was >= 7 in all cases. Detection rates of vessel occlusions and/or decision to intervene did not differ significantly between the two interpretive sessions (n = 165 in the reading without CTP vs. n = 171 when the additional CTP data was added, p = 0,315).

**Conclusion:** In the common scenario of an acute ischaemic stroke patient presenting within the 4.5 hour intravenous lysis window to a tertiary referral center, CTP is not adding significant value to triage. The decision to proceed with endovascular intervention should not be delayed by obtaining and processing CTP.

#### Diffusion MRI and Magnetic Resonance Spectroscopy in Detecting Malignancy in Maxillofacial Lesions

M. K. Zayet, S. Eiid, M. Dahaba; Cairo/EG

**Purpose:** The purpose of this study was to define the malignant metabolic profile of maxillofacial lesions using diffusion MRI and magnetic resonance spectroscopy, as adjunctive aids for diagnosing of such lesions.

**Methods and Materials:** Twenty-one patients with twenty-two lesions were enrolled in this study. Both morphological and functional MRI scans were performed, where T1, T2 weighted images, diffusion weighted MRI with four apparent diffusion coefficient (ADC) maps were constructed for analysis, and magnetic resonance spectroscopy with qualitative and semi-quantitative analyses of choline and lactate peaks were applied. All patients underwent incisional or excisional biopsies for definitive diagnosis.

**Results:** Statistical analysis revealed that lactate had the highest areas under the curve (AUC) of 0.9 and choline was the lowest with insignificant diagnostic value. The best cut-off value suggested for lactate was 0.125, where any lesion above this value is supposed to be malignant with 90 % sensitivity and 83.3 % specificity. Lactate again showed the best combination of positive and negative likelihood ratios, whereas for the maps, ADC map with 500 and 1000 b-values showed the best realistic combination of likelihood ratios, however, with lower sensitivity and specificity than lactate.

**Conclusion:** Diffusion weighted imaging and magnetic resonance spectroscopy are state-of-art in the diagnostic arena and they manifested themselves as key players in the differentiation process of orofacial tumors. The complete biological profile of malignancy can be decoded as low ADC values, high choline and/or high lactate, whereas that of benign entities can be translated as high ADC values, low choline and no lactate.

PO16

#### Effect of Changing Voxel Size of Cone Beam Computed Tomography Scans on Detection of Vertical Root Fracture in Teeth Restored with Glass Fiber Post

N. N. A. Marzaban, <u>M. K. Zayet</u>, A. A. Nawwar; Cairo/EG

**Purpose:** To assess the sensitivity, specificity and diagnostic accuracy of cone beam computed tomography (CBCT) scans with different voxel sizes in the detection of vertical root fracture in endodontically treated teeth restored with fiber post.

**Methods and Materials:** Seventy-six extracted single rooted teeth were used after root canal treatment and fiber post cementation for all of them. Vertical root fracture was induced in thirty-eight teeth of the sample. All the sampled teeth were imaged by CBCT with voxel sizes: 0.1, 0.15, 0.2 and 0.4 mm. Three radiology specialists examined the scans.

**Results:** The voxel sizes 0.15 and 0.2 mm had the highest sensitivity (100%), while 0.4mm had the lowest sensitivity (92.1%). Voxel size 0.4 mm had statistically significantly higher specificity than the voxel sizes: 0.1, 0.15 and 0.2 mm. No statistical significant difference in specificity or diagnostic accuracy between the voxel sizes: 0.1, 0.15 and 0.2 mm. While, 0.4 mm had statistically significantly lower diagnostic accuracy (96.1%) than the other voxel sizes. Very good interobservers' agreement for voxel sizes 0.1, 0.15 and 0.2 mm were obtained. The lowest interobservers' agreement was that for voxel size 0.4 mm.

**Conclusion:** In detection of vertical root fractures in endodontically treated teeth restored with fiber posts, the voxel sizes 0.15 and 0.2 mm provide the highest diagnostic accuracy with optimum spatial resolution and reasonable radiation doses.

### MRI findings of non-traumatic acute/subacute bilateral limbs deficit: Could it be myelitis or radiculitis? What can be the role of advanced MRI sequences in their diagnosis?

<u>A. Fitsiori</u>, P. Lalive D'epinay, M. Schibler, K.-O. Lövblad, M. I. Vargas Gomez; Geneva/CH

**Learning objectives:** The aim of this presentation is to familiarize radiologists with MRI findings of myelitis and radiculitis of spinal nerves and highlight the utility of MRI advanced sequences in their differential diagnosis.

**Background:** In patients with non-traumatic bilateral limbs motor and/or sensory deficit, the main conditions to exclude are ischemia and myelitis/ radiculitis of spinal nerves. MRI has proven its value for the diagnosis of acute transverse myelitis, as well as in some cases of radiculitis. We would like to illustrate the MRI findings of patients presented with acute or sub-acute motor and/or sensory deficit of the limbs, based on the studies realized in our department in this setting, between the 1<sup>st</sup> January 2017 and the 30<sup>th</sup> April 2017.

**Imaging findings or procedure details:** The most common finding is contrast enhancement of the quada equina and spinal roots, in some cases demonstrating both an intra-dural and extra-dural involvement of the nerves, best evaluated in coronal T1 post-contrast fat saturation images. Another common finding is an intra-medullar high T2 signal, associated or not with contrast enhancement. Pial enhancement can also be found, sometimes also involving the brain, best demonstrated in enhanced FLAIR images. Differential diagnosis with ischemia remains challenging, although diffusion sequence can be helpful.

**Conclusion:** MRI is a useful tool in the setting of acute/subacute bilateral limb deficit for its differential diagnosis, as well as in follow up of myelitis and/or radiculitis and radiologists should be aware of radiological manifestations of these conditions. Application of advanced or multiple plane MRI sequences may be mandatory for the diagnostic work up.

## P018

## 3D multimodal image fusion - Pushing the envelope in cardiac imaging

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**Purpose:** To allow for comprehensive diagnostics of coronary artery disease (CAD) by 3D image fusion of CT coronary angiography (CT-CA, for morphological information), CT-CA derived fractional flow reserve (CT-FFR, for stenoses assessment), dynamic whole-heart 3D CMR stress perfusion (CMR-Perf, for ischemia diagnostics), and late gadolinium enhancement (CMR-LGE, depicting myocardial scar).

**Methods and Materials:** 10 patients who underwent cardiac CT and MR due to suspected CAD were included retrospectively. A software facilitating 3D image fusion of multimodal cardiac image data was developed. Postprocessing of CT data included: a) automatic segmentation of the coronary tree and heart contours; b) automatic calculation of CT-FFR values; c) color-coding of the coronary tree according to CT-FFR. Postprocessing of CMR data included: a) manual segmentation of the left ventricle (LV) in CMR-Perf and CMR-LGE datasets, b) automatic co-registration of CMR datasets (acquired in short-axis geometry) to CT data (axial acquisition), c) mathematical projection of CMR-Perf and CMR-LGE values onto the high-resolution LV derived from CT datasets. Color tables were chosen carefully to avoid confusion. Results of hybrid 3D analysis were compared to separate readouts from CT-CA and CMR.

**Results:** Multimodal 3D imaging fusion and interactive rendering was feasible in all patients. Perfusion deficits and myocardial scar could be correlated to culprit coronary lesions where applicable. In one case with myocardial hypoperfusion but no coronary stenosis (being assumed false positive in conventional readout), ischemia could be explained by a narrow coronary artery with pathologic FFR.

**Conclusion:** Hybrid 3D cardiac imaging is feasible and offers comprehensive, non-invasive CAD diagnostics.

#### P019

## 3D image fusion of whole-heart dynamic cardiac MR perfusion and late gadolinium enhancement: Identifying areas for revascularization

J. von Spiczak, M. Mannil, H. Alkadhi, R. Manka; Zurich/CH

**Purpose:** To develop a framework for three-dimensional image fusion of whole-heart dynamic 3D cardiac MR perfusion (3D-PERF) and 3D late gadolinium enhancement (3D-SCAR) to delineate stress-induced myocardial perfusion deficits and areas of scars.

**Methods and Materials:** Five patients with coronary artery disease (54±20 years) undergoing cardiac MR were included. A software framework was developed to allow for 3D fusion of 3D-PERF and 3D-SCAR data revealing perfusion deficits along with myocardial scar. Computation steps included: 1) manual segmentation of the left ventricle in 3D-PERF and 3D-SCAR images; 2) semi-automatic thresholding of perfusion and scar data; 3) automatic calculation of ischemic and scar burden; 4) projection of perfusion and scar values on an artificial template of the left ventricle; 5) semi-automatic co-registration to an exemplary heart contour easing 3D orientation; 6) 3D rendering of the combined datasets using automatically defined color tables. All tasks were performed by two independent, blinded readers. Interreader agreement was determined by calculating intraclass correlation coefficients.

**Results:** Image acquisition, post processing, and 3D fusion was feasible in all cases. All patients showed stress-induced perfusion deficits in 3D-PERF; three patients showed late gadolinium enhancement in 3D-SCAR. Average ischemic burden was 16% and average scar burden was 8% for both readers. Interreader agreement was excellent for both 3D-PERF (ICC=0.95) and 3D-SCAR (ICC=0.99). 3D fusion allowed intuitive visual assessment of perfusion deficits, scar, their overlap, and areas possibly accessible to revascularization.

**Conclusion:** 3D fusion of 3D-PERF and 3D-SCAR facilitates anatomic correlation of stress-induced myocardial perfusion deficits and scar tissue for identifying areas for potential revascularization.

## Does length matter? A comparative cohort study of two lengths of tunneled central venous catheters for hemodialysis

<u>K. Damodharan</u>, N. Venkatanarasimha, A. Gogna, S. Chan, C. W. Too, C. Sivanathan; Singapore/SG

**Purpose:** To compare the performance of tunneled hemodialysis central venous catheters (CVC) of two lengths when inserted via the right internal jugular vein (RIJV) and determine if either should be favored for the Asian population.

**Methods and Materials:** This was a retrospective comparative cohort study of all patients who underwent new tunneled CVC (Hemostar®, Bard) insertion via the RIJV for hemodialysis between July 2014 and June 2016 in a single institution. Two lengths of CVCs were used, 19cm cuff-to-tip and 23cm. All CVCs were inserted under imaging guidance. Complications requiring catheter removal or change within 120 days were compared between cohorts. Analysis was performed using chi-square and Student's t-test.

**Results:** 993 patients (384 19cm CVCs and 609 23cm CVCs) were included in our study. 23cm CVCs had higher incidence of poor-flow or blockage (10.82%) compared to 19cm CVCs (6.25%). This was statistically significant with relative risk of 1.74 (95% confidence interval: 1.11 – 2.72). 23cm CVCs had catheter tips deeper in patients (3.9 vertebral body heights below carina as compared to 3.5, p<0.001), despite these patients being taller (1.61m as compared to 1.56m, p<0.001). Other complications of bacteremia (4.3%), catheter dislodgement (1.6%) and exit site skin infections (0.6%) were similar between cohorts with no statistical difference.

**Conclusion:** The more commonly used 23cm CVC is associated with more flow-related problems during hemodialysis requiring replacement. We recommend routine use of the shorter 19cm CVCs for hemodialysis in Asian patients.

PO21

### Complications of non tunelled central venous catheters

C. Lim, <u>K. Damodharan</u>, C. P. Wong, N. Soh, N. Venkatanarasimha, C. Sivanathan; Singapore/SG

**Purpose:** Central venous catheters (CVCs) are routinely inserted via the internal jugular vein nowadays, due to the reduced risk of complications compared to subclavian vein access. However, our local hematology unit prefers non-tunneled CVC insertion via the subclavian vein for administration of chemotherapy. We audited the performance of non-tunneled subclavian CVCs in these patients and their associated complications.

**Methods and Materials:** 233 patients underwent subclavian non-tunneled CVC insertion from January 2014 to December 2015. All procedures were performed by consultant interventional radiologists, under ultrasoud and fluoroscopy guidance. 124 patients had complete follow up data. We assessed the insertion complications, infection rate and the mean time to bacteremia.

**Results:** 41 patients (32.3%, 41/124) experienced catheter associated bloodstream infection (CABSI, with a rate of 29.9 CABSI cases per 10,000 catheter days). The mean catheter dwell time to bacteremia was 105.8  $\pm$  87.5 days. The duration of catheter dwell time was proportional to the rate of bacteremia – CABSI rate of 0.8%, 6.5% and 12.1% at 14, 30, and 60 days respectively. Complications during CVC insertion were uncommon – 0.4% (1/233) developed serious complication of pseudoaneurysm of right subclavian arterial branch. Other minor complications were tip migration (0.4%), minor arterial bleeding (0.4%) and exit site leak (0.8%). None of our patients developed a peri procedural pneumothorax.

**Conclusion:** The incidence of bacteremia observed with non-tunneled CVCs is higher compared with tunneled CVC's in the literature (29.9 versus 17.6 and 10 CABSI per 10,000 catheter days), but within the reported rates for non tunneled CVC's (8.7-58 per 10,000 catheter days).

### Comparing success of percutaneous declotting of thrombosed arteriovenous fistulae (AVF) and arteriovenous graft (AVG): A retrospective review

K. Damodharan; Singapore/SG

**Purpose:** The incidence of end-stage renal failure (ESRF) is high in Singapore. Locally, hemodialysis is the mainstay treatment, with arteriovenous fistulae (AVF) followed by arteriovenous grafts (AVG) as the preferred mode of access. One of the main complications is access failure secondary to thrombosis. Traditionally, AVF thrombosis is surgically treated while AVG thrombosis is percutaneously declotted; however, there are no comparative data to support this practice. We aim compare the treatment outcomes between percutaneously declotted AVG and AVF.

P022

PO23

**Methods and Materials:** This is a single-center, retrospective review of ESRF patients who underwent at least one percutaneous declotting of a thrombosed AVG or AVF between 2007 and 2012. The outcomes were accessed in terms of primary patency (intervention-free access survival), assisted primary patency (thrombosis-free access survival), and secondary patency (access survival until abandonment or surgical intervention).

**Results:** There were a total of 291 patients, 148 (i.e., 50.9%) of whom had AVF. Onset of access thrombosis is highly variable, with a median survival of around 630 days; however, AVF lasted longer than AVG, with respective medians of 757 and 469 days (p<0.01).

**Conclusion:** Although percutaneous declotting seems to produce better primary and primary assisted patencies in patients with AVF thrombosis, results are not statistically significant. The only statistically different outcome parameter is that of secondary outcome, in which percutaneously declotted AVG do better than AVF.

## Tip malposition of peripherally inserted central catheters: A retroprospective study to compare bedside insertion to fluoroscopically guided placement implanted by only one operator

M. Grange, A. Chouiter; Neuchatel/CH

**Purpose:** Peripherally inserted central catheter (PICC) implantation continue to increase, leading to the development of a blind bedside technique (BST) for placement. The aim of our study was to evaluate the efficacy of BST compared with the fluoroscopically guided technique (FGT), with specific regard to catheter tip position (CTP).

**Methods and Materials:** Between December 2014 and September 2017, 148 patients underwent PICC line implantation. Fifty-four patients were treated with BST and 94 with FGT. All procedures were done by the same interventional radiologist, included post procedural chest X-ray for the BST, and scoped image for FGT to assess CTP. Depending on the international guidelines for optimal CTP, patients were classified in three types: optimal, suboptimal not needing repositioning, and nonoptimal requiring additional repositioning procedures.

**Results:** For the FGT group, all PICCs were successfully inserted. In 2 cases, the implantation side change from left to right because of chronic thrombosis of the left sublclavian vein. Thirty-six (38%) of placements were optimal, 52 (62%) were suboptimal and none were nonoptimal.

In the BST group, 2 of 54 implantations failed because of tight stenosis in the subclavian veins. Three (5%) of placements were optimal, 45 (83%) were suboptimal and 4 (7%) nonoptimal.

**Conclusion:** Considering the international guidelines for optimal CTP, using blind BST for PICC line implantation by a well-trained operator is safe and efficient. In our series, a large number of nonoptimal positioning were found in the two groups and is easily explained by the unknown last international guidelines for optimal CTP by the operator.

Impact of CT Angiography Inferior Vena Cava Measurements on Mortality in Patients Undergoing Transcatheter Aortic Valve Implantation

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**Purpose:** To assess the association of inferior vena cava (IVC) measurements at pre-procedural ECG-gated CT angiography (CTA) with central venous pressure (CVP) in patients undergoing transcatheter aortic valve implantation (TAVI) and the impact of IVC measurements on post-procedural mortality.

**Methods and Materials:** 153 consecutive patients undergoing pre-procedural right heart catheterisation (RHC) and CTA before TAVI were included. Area measurements of the suprahepatic IVC were performed between diaphragm and right atrium.

**Results:** We found moderate correlation between axial IVC area measurements and CVP (r=0.47; p<0.001). For axial IVC area measurements, ROC analysis indicated an AUC of 0.77 (p<0.001) to detect CVP  $\ge$ 10mmHg and an AUC of 0.72 (p<0.001) to predict one-year mortality. A cut-off of 639mm<sup>2</sup> had a specificity of 80% and a sensitivity of 64% to predict elevated CVP and a cut-off of 665mm<sup>2</sup> had a specificity of 80% and a sensitivity of 60% to predict one-year mortality. Patients with pre-procedural IVC area  $\ge$ 665mm<sup>2</sup> had a significantly higher post-procedural one-year all-cause mortality (35% versus 9%, log-rank p<0.001) in Kaplan-Meier analysis of survival with a hazard ratio of 5.5 (95%CI:1.8-16.9) in multivariate Cox regression analysis. Patients with an IVC area  $\ge$ 665mm<sup>2</sup> had significantly higher mean pulmonary (p=0.010) and right diastolic ventricular pressure (p<0.001) assessed in RHC.

**Conclusion:** In patients undergoing TAVI, enlargement of the suprahepatic IVC at pre-procedural CTA can predict CVP with moderate strength, is associated with right heart dysfunction and a predictor of one-year mortality after TAVI.

PO25

## Pre-procedural MRI for anatomical assessment of pulmonary vein anatomy: Do we still need contrast?

<u>M. Pradella</u>, M. Kühne, P. Haaf, M. Zellweger, T. Reichlin, S. Osswald, C. Sticherling, B. Stieltjes, J. Bremerich, S. Knecht; Basel/CH

**Purpose:** Pre-procedural anatomical assessment based on cardiac Magnetic Resonance Imaging (cMRI) plays an important role in catheter ablation procedures. We evaluated a cMRI protocol without gadolinium contrast for the assessment of cardiac anatomy.

**Methods and Materials:** 85 consecutive patients with atrial fibrillation received preprocedural cMRI on a 1.5T Scanner (Siemens, Germany). 41 patients underwent a contrast enhanced, T1-weighted spoiled gradient echo sequence (contrast-enhanced group), 44 patients an ECG triggered, free-breathing motion-adaptive navigator gating, transversal 3D SSFP sequence (contrast-free group). Image quality was assessed as: excellent (without manual interaction); good (little manual interaction), moderate (extensive manual interaction); poor (not usable).

**Results:** Acquisition duration and 3D scan duration was both significantly longer for the contrast-free group (28.3±9.7 vs. 13.0±7.9 min, p=0.006 and 9.3±6.0 vs. 1.8±0.6 min, p=0.002, respectively). However all heart chambers and the esophagus were visible compared to left sided visualisation in the contrast-enhanced group. Segmentation quality was classified as excellent in 19 vs 29 patients (43% vs 71%), good in 16 vs 11 (36% vs 27%), moderate in 1 vs 2 (2% vs 5%) and poor in 7 (16%) and 0 patients, respectively. There was no difference between scans with adequate or insufficient image quality in any of the baseline or procedural data for both groups.

**Conclusion:** A contrast-free native MRI protocol for anatomical assessment is feasible in 79 % of the patients. Despite the longer acquisition duration, this protocol is especially useful for patients with renal insufficiency or when additional anatomical information is required.

#### Quantifying Cardiac Allograft Vasculopathy with Magnetic Resonance Imaging versus Optical Coherence Tomography

<u>V. Bianchi</u>, J. Yerly, G. Ginami, J. A. M. Bastiaansen, N. Lauriers, J. F. Iglesias, S. Degrauwe, R. B. van Heeswijk, R. Hullin, M. Stuber; Lausanne/CH

**Purpose:** To investigate whether coronary tunica thickness as assessed with optical coherence tomography (OCT) is linked to measures of the coronary vessel wall (VW) obtained with magnetic resonance imaging (MRI) in heart transplant recipients.

**Methods and Materials:** This consent-given retrospective study, approved by the institutional review board, involved N=8 heart transplant recipients (5 males, 54.2±14.0years). Patients underwent intracoronary OCT and MRI. MRI was performed on a 3T system (Siemens MAGNETOM Prisma) using a 2D radial double inversion recovery golden-angle gradient-echo sequence. For each patient, 90 VW images were reconstructed with different temporal durations (40-80ms) and positions within the cardiac cycle. The best-quality VW image was then visually selected and analyzed to quantify the eccentricity index, internal, and external border sharpness, visible circumference, circularity, and thickness of the coronary VW. These MRI-derived parameters were then correlated with thickness measurements of the VW intima (I) and media (M) by OCT, as well as their ratio (I/M).

**Results:** Six MRI datasets were available for analysis since two were discarded due to low-image quality. VW circumference on MRI did not significantly correlate with intima or media thickness measurements obtained with OCT, or with the I/M ratio (P>0.362). However, the internal border sharpness and the VW circularity correlated with I/M thickness ratio (P=0.013 and P=0.034 respectively). Mean VW thickness and eccentricity did not correlate with the OCT measurements (P>0.8).

**Conclusion:** In the heart transplant recipients with a propensity for cardiac allograft vasculopathy, OCT-derived measures of the coronary VW showed a promising link to border sharpness and circularity by MRI.

#### PO27

#### Comparison of cardiac and late-enhancement dual-energy CT with electro-anatomical maps in patients with implanted cardioverterdefibrillator before ventricular radiofrequency ablation

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**Purpose:** Compare characteristics of myocardial scar as assessed with cardiac and late enhancement dual-energy CT (DECT) during pre-interventional imaging with findings in electro-anatomical mapping (EAM) acquired during radio frequency cardiac ablation (RFCA).

**Methods and Materials:** 12 patients referred for catheter ablation of ventricular tachycardia (VT), not eligible for MRI due to incompatible implantable cardioverter-defibrillators (ICD's), were assessed for left ventricular wall thinning (WT), wall motion abnormalities (WMA) and for scarring on cardiac scan and late-enhancement images acquired using a DECT (Siemens Somatom Flash). Voltage maps were acquired during RFCA to identify myocardial segments with scar (Bipolar <1.5mV, unipolar <8mV). Using the 17-Segment AHA Model, segmental comparison between areas of WT, WMA and scar on CT and EAM was performed. Descriptive statistics and Cohen's kappa test were applied.

**Results:** WT was observed in 10/12 patients, WMA in 12 and scars in 11/12 patients on CT. Overall segmental concordance between CT and EAM was observed in an average of 11/17 segments ( $\kappa$  = 0.55), no concordance was seen for 2 segments. An average of 4 segments was not evaluable due to missing data points on EAM. CT identified segments characterized by low voltages with high sensitivity (84.6%), reasonable specificity (75.9%) and negative predictive value (75.8%).

**Conclusion:** Cardiac CT with late-enhancement dual energy phase is a valuable method to assess patients with a non-MRI compatible ICD prior to ablation and can provide a 3-dimensional characterization of VT scar substrate, wall thinning and disturbed wall motion in addition to an anatomic model of the heart.

#### P028

## Cardiac Magnetic Resonance Fingerprinting in Heart Transplant Recipients

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**Purpose:** In heart transplant patients, cardiac health is evaluated by histological assessment of endomyocardial biopsies, despite the invasiveness and apico-septal restricted sampling. Diagnosing and characterizing graft health non-invasively, with cardiac MRI, would be preferable.

Cardiac Magnetic Resonance Fingerprinting (cMRF) has emerged as a method for rapidly characterizing myocardial tissue through simultaneous  $T_1$  and  $T_2$  mapping. The technique is robust to varying heart rates, with high reproducibility, and therefore, we present the first use of cMRF in heart transplant recipients.

**Methods and Materials:** Heart transplant recipients (n=13) and healthy controls (n=5) were recruited and scanned with an ECG-triggered cMRF sequence and with commercial parameter mapping sequences (Siemens Myomaps). The mean per-slice myocardial  $T_1$  and  $T_2$  were calculated, both preand post-contrast (save controls). Pearson correlations and Bland-Altman plots were generated to compare sequences, and an unpaired student's t-test was used to compare patients and controls. Endomyocardial biopsy was performed in all patients as the gold standard measure of graft rejection.

**Results:** With cMRF, it was possible to simultaneously reconstruct T<sub>1</sub> and T<sub>2</sub> maps from a single-breathhold short-axis slice acquisition, vs. only T<sub>1</sub> or T<sub>2</sub> with Myomaps. Whole slice measurements correlated well between cMRF and Myomap. T<sub>1</sub> and T<sub>2</sub> were lower in controls than patients, though not always significantly.

Histology indicated no graft rejection in patients. The range of myocardial  $T_2$  values measured by cMRF (basal: 33.3-46.1ms; medial: 34.4-50.8ms) were nonetheless consistent with those previously reported in non-rejecting heart transplant recipients.

**Conclusion:** This study demonstrates the potential use of cMRF in heart transplant recipients.

#### PO29

#### CT Angiography versus Radial MRI: Theoretical Accuracy and Precision of Cross-Sectional Area Measurements for the Assessment of Coronary Endothelial Function

<u>I. Yerly</u>, F. Becce, D. Gubian, R. B. van Heeswijk, F. R. Verdun, R. A. Meuli, M. Stuber; Lausanne/CH

**Purpose:** Measurements of coronary artery vasomotor responses to endothelium-dependent stressors can be used to discriminate normal from abnormal coronary endothelial function (CEF). Computed tomography angiography (CTA) and magnetic resonance imaging (MRI) are non-invasive imaging modalities that may be used to assess CEF. However, the performance of these techniques has yet to be quantitatively compared. Because CTA offers higher spatial resolution than MRI, we hypothesized that CTA should also enable more precise and accurate measurements of cross-sectional areas (CSA) similar to those of coronary arteries.

**Methods and Materials:** Images of an in vitro phantom that simulates a physiological range of coronary artery CSAs were acquired using both CTA and radial MRI. CSAs were automatically measured and compared to the known nominal values to quantify the accuracy, precision, and limit of CSA change that is detectable with each imaging modality.

**Results:** Compared to CTA, radial MRI was significantly more precise (p<0.0001), and enabled the detection of significantly smaller CSA differences (0.16±0.06mm<sup>2</sup> vs. 0.52±0.04mm<sup>2</sup>; p<0.0001; corresponding to CSA percentage differences of 2.25±0.80% vs. 7.42±0.63% for a 3-mm baseline diameter), yet MRI was also less accurate (p<0.0001).

**Conclusion:** Radial MRI outperformed CTA for the detection of small CSA differences in vitro, and may be used to reliably detect changes that are well within the range of physiological vasomotor responses of proximal coronary arteries. While well supported by the results presented in this study, the poor precision and discrimination performance of CTA compared to MRI is counter-intuitive and leads to the rejection of our initial hypothesis.

## Coronary MRA in heart transplant recipients at 3T

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**Purpose:** In heart transplant patients, there is a high prevalence of cardiac allograft vasculopathy (CAV), which is usually detected on routine X-ray coronary angiography. The purpose was to investigate coronary magnetic resonance angiography (MRA) as possible alternative to invasive X-ray angiography for the visualization of proximal and mid segments of the coronary arterial system.

**Methods and Materials:** This prospective study, from March 2016 to January 2017, included institutional review board approval and written informed consent. A novel free-breathing self-navigated whole-heart MRA sequence was performed in cardiac allograft transplant recipients (n=23, 8 women, age=54±13y), ≥6 months after transplantation, during and after slow Gd infusion. Images obtained with self-navigated (SN) and compressed-sensing-based motion-correction (CS) were compared, and so were X-ray coronary angiograms and MRA. Coronary vessel sharpness (CVS) was calculated as a measure of MRA quality. Two-way ANOVA was performed on CVS, with "contrast" and "motion-correction" as factorials.

**Results:** Coronary MRA matched irregularities observed on X-ray coronary angiograms. MRA quality improved when CS was used. RCA CVS significantly increased using CS, both during Gd slow-infusion (from CVS=32.5% to CVS=49.1% p=0.0002) and post-contrast (from CVS=33.0% to CVS=43.8%, p=0.001). SN did not change CVS (p=NS) comparing slow-infusion (32.5%) with post-contrast (33.0%). Interestingly, application of CS showed significant (p=0.005) CVS increase during slow-infusion MRA (49.1%) compared with post-contrast (43.8%).

**Conclusion:** To the best of our knowledge, this is the first report of coronary MRA during and post Gd infusion in heart transplant recipients at 3T. Coronary MRA significantly improved when combined with CS and performed during slow Gd infusion.

## 3D Fusion of Coronary CT Angiography and CT Myocardial Perfusion Imaging: Intuitive Assessment of Morphology and Function

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**Purpose:** To support three-dimensional fusion of coronary CT angiography (CCTA) and CT myocardial perfusion (CT-Perf) data visualizing coronary artery stenoses and corresponding stress-induced myocardial perfusion deficits for diagnostics of coronary artery disease.

**Methods and Materials:** Twelve patients undergoing CCTA/CT-Perf after heart transplantation were included (56±12 years, all males). CT image quality was rated. Coronary diameter stenoses >50% were documented for CCTA. Stress-induced perfusion deficits were noted for CT-Perf. A software was implemented facilitating 3D fusion imaging of CCTA/CT-Perf data. Coronary arteries and heart contours were segmented automatically. To overcome anatomical mismatch of CCTA/CT-Perf image acquisition, perfusion values were projected on the CCTA left ventricle. Three resulting datasets (coronary tree/heart contour/perfusion values) were fused for combined three-dimensional rendering. 3D fusion was compared to conventional analysis of CCTA/CT-Perf data and to results from catheter coronary angiography.

**Results:** CT image quality was rated good-excellent (3.5±0.5, scale 1-4). 3D fusion imaging of CCTA/CT-Perf data was feasible in 11/12 patients (92%). One patient (8%) was excluded from further analysis due to severe motion artifacts. 2/12 patients (17%) showed both stress-induced perfusion deficits and relevant coronary stenoses. Using 3D fusion imaging, the ischemic region could be correlated to a culprit coronary lesion in one case (1/2=50%) and diagnostic findings could be rectified in the other case (1/2=50%). CCTA was in full correspondence with catheter coronary angiography.

**Conclusion:** A method for 3D fusion of CCTA/CT-Perf is introduced correlating relevant coronary lesions and corresponding stress-induced myocardial perfusion deficits.

## P032

PO33

## Overranging dose reduction by dynamic collimators: Evidence from clinical practice

#### N. N. Saltybaeva, H. Alkadhi; Zurich/CH

**Purpose:** Evaluation of dynamic collimators used in spiral CT was performed so far only on cylindrical phantoms with a limited scan length. The purpose of this study was to assess the efficacy of dynamic collimators in daily clinical routine.

**Methods and Materials:** The overranging dose was assessed for 1690 CT examinations performed on a third-generation dual-source CT scanner (Somatom Force, Siemens Healthineers, Germany). The data for three standard clinical protocols (abdomen, chest and heart) with pitch values of 0.6, 1.2 and 3.2, respectively, were collected by dose tracking software (tqmDose, Qaelum, Belgium). The overranging length was defined as the difference between actual scan length and length of reconstructed volume. The exposed range was calculated as ratio of reported DLP to the CTDI<sub>vol</sub>. The collimator efficiency for each of the exams was defined as percentage of overranging dose in terms of DLP which was blocked by the dynamic collimator relative to the total dose of the CT scan.

**Results:** The number of overranging rotations was inversely proportional to the pitch factor, while the absolute overenging length increases with the increase of pitch from 30mm for abdomen CT to 50mm for heart examinations. We found a strong correlation between relative dose reduction and pitch factor (p<0.005). The average efficiency of dynamic collimators was 6%, 11% and 20% for spiral CT examinations with pitch values of 0.6, 1.2 and 3.2, respectively.

**Conclusion:** In spiral CT, the dynamic collimator is highly efficient for radiation dose reduction especially in high pitch scan modes.

## In vitro culture and differentiation of human neurons for assessment of potential toxicity from gadolinium-containing MRI contrast agents

<u>D. V. Bower</u>, V. M. Runge, H. von Tengg-Kobligk, J. T. Heverhagen; Bern/CH

**Purpose:** Gadolinium from gadolinium-containing MRI contrast agents has been demonstrated to deposit in tissues throughout the body, including in the brain. Even in the absence of pathology that could disrupt the bloodbrain barrier, gadolinium accumulates in brain tissue, and particularly affects the dentate nucleus and basal ganglia. Baseline T1 signal intensity increases with increasing administrations of gadolinium-containing contrast agents. However, whether a toxic effect on neuronal function results from this gadolinium deposition has yet to be determined. We describe the differentiation and culture of human dopaminergic neurons in vitro to model certain neurons in the basal ganglia, such as the substantia nigra. This provides a useful system to evaluate for potential toxic effects from exposure to gadolinium-containing MRI contrast agents.

**Methods and Materials:** SH-SY5Y human neuroblastoma cells were expanded and differentiated into dopaminergic neurons in culture using retinoic acid and phorbol-myristate-acetate. Differentiation protocols with variable durations of incubation with differentiating factors were tested. Cell morphology and expression of dopaminergic neuron markers were assessed.

**Results:** SH-SY5Y cells differentiate in culture and express markers of functional dopaminergic neurons (dopamine receptors, dopamine transporter, and neuronal enzymes, microtubule proteins, and transcription factors). These cells can be maintained in culture for two or more weeks to test for effects of gadolinium-containing contrast agents on cellular function.

**Conclusion:** Human dopaminergic neurons can be differentiated from an established neuroblastoma cell line. The potential effects on cellular function from linear and macrocyclic gadolinium-containing MRI contrast agents are being evaluated using this model system.

# A simple method for low-contrast detectability, image quality, and dose optimization with CT iterative reconstruction algorithms and model observers

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**Purpose:** The aim of this work was to evaluate detection of low-contrast objects and image quality in computed tomography (CT) phantom images acquired at different tube loadings (i.e. mAs) and reconstructed with different algorithms, in order to find appropriate settings to reduce the dose to the patient without any image detriment.

**Methods and Materials:** Images of supraslice low-contrast objects of a CT phantom were acquired using different mAs values. Images were reconstructed using filtered back projection (FBP), hybrid and iterative model-based methods. Image quality parameters were evaluated in terms of modulation transfer function; noise, and uniformity using two software resources. For the definition of low-contrast detectability, studies based on both human (i.e. fouralternative forced-choice test) and model observers were performed across the various images.

**Results:** Compared to FBP, image quality parameters were improved by using iterative reconstruction (IR) algorithms. In particular, IR model-based methods provided a 60% noise reduction and a 70% dose reduction, preserving image quality and low-contrast detectability for human radiological evaluation. According to the model observer, the diameters of the minimum detectable detail were around 2 mm (up to 100 mAs). Below 100 mAs, the model observer was unable to provide a result.

**Conclusion:** IR methods improve CT protocol quality, providing a potential dose reduction while maintaining a good image detectability. Model observer can in principle be useful to assist human performance in CT lowcontrast detection tasks and in dose optimisation.

PO35

## Objective assessment of the detectability of a moving guidewire in fluoroscopically-guided procedures using a mathematical model observer

<u>N. Ryckx</u>, D. Racine, A. Viry, F. R. Verdun; Lausanne/CH

**Purpose:** Fluoroscopically-guided procedures are among the most irradiating medical interventions. A fair amount of pressure is thus put on reducing patient dose. The downside is a potential loss in image information content. To our knowledge, there is no existing quantity able to assess the visibility of moving structures in fluoroscopic images. This work proposes a new method to measure image quality using a clinically relevant detection task in dynamic conditions.

**Methods and Materials:** A PMMA plate was attached to a motion simulation engine, allowing the plate to move at velocities and motion amplitudes representative of coronary arteries. The plate supported a 0.014" guidewire. A series of PMMA slabs simulated patient thicknesses between 5 and 20 cm. Images were acquired using pre-defined fluoroscopy quality levels on two different units: One dedicated for interventional cardiology, the other for a broader purpose range. A channelized Hotelling observer computed a decision variable on each signal-absent and signal-present image. The signalto-noise ratio (SNR) between both decision variable distributions was taken as the figure of merit of the guidewire detectability.

**Results:** The SNR of the dedicated unit was 3.5, 4.1 and 4.9 for respectively low (reference dose rate), medium (dose rate x 1.6) and high quality (dose rate x 3.7) fluoroscopy settings (20 cm of PMMA). In comparison, the general purpose unit yielded a SNR of 2.0.

**Conclusion:** Further steps will include the fine tuning the model, and matching between human observer results, to define a threshold SNR, under which image quality is deemed insufficient.

## PO36

## Gadolinium retention in the brain: A consequence of gadolinium storage in bone tissue?

### R. Egli, I. Böhm, J. L. Cullmann, J. T. Heverhagen; Bern/CH

**Learning objectives:** To understand the role of bone tissue in the retention of gadolinium (Gd) in brain tissues after contrast enhanced MRI.

**Background:** Recent reports demonstrate retention of Gd after contrast enhanced MRI in tissues, especially in the brain. Even though an impact on the patients' health has not yet been proven these findings provoked US and European agencies to release saftey recommendations concernig the use of gadolinium based contast agents. Current efforts are focused on identifying potential effects of Gd retention in the brain. Even though of undisputable importance, it neglects the fact that within bone tissue up to 1000 times higher concentrations of Gd can be found. Thus, bone may be considered the storage compartment whereof Gd is released through bone modelling and remodelling exposing the body for years.

**Imaging findings or procedure details:** This educational poster reviews the sparse current knowledge of Gd interaction with bone tissue. We are currently initiating an interdisciplinary project and we will present our systematic approach to fill in the many gaps. This project will encompass the entire sequence of Gd administration, deposition in bone tissue, effect on bone cells, release from bone tissue, and systemic redistribution using *in vitro, ex vivo* an *in vivo* approaches.

**Conclusion:** Bone tissue may be a long-term storage compartment for Gd after contrast enhanced MRI. Therefore, targeting the interaction of Gd with bone tissue may be the pivotal pathway to reduce Gd retention in the brain. To that end increasing the knowledge of the interaction of Gd with bone tissue is essential.

## Photon Counting CT: High Resolution Imaging of Coronary Artery Stents

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**Learning objectives:** To compare computed tomography (CT) imaging characteristics of coronary stents using a novel photon counting detector (PCD) in comparison with a conventional energy-integrating detector (EID).

**Background:** Photon counting detector (PCD) technology differs from current energy-integrating detectors (EID) by counting individual photons and allocating them to predetermined energy thresholds and bins. PCD possesses improved spatial resolution by incorporating smaller detector pixels as compared to conventional EID systems. PCDs implement a direct conversion of incoming photon flux into an electrical signal. Thereby achieving higher dose efficiency at smaller detector pixels compared to EIDs at same pixel sizes.

**Imaging findings or procedure details:** In this in-vitro study, 18 different coronary stents, each of different material, were scanned in an experimental CT dual-source scanner setup with both an EID and PCD. Images were obtained from both detector systems at identical tube voltage (100 kVp) and tube current-time product (100 mAs), using the same reconstruction parameters (B46f). Two independent, blinded readers evaluated in-stent visibility and measured noise, intraluminal stent diameter, and in-stent attenuation for each detector subsystem. Differences in noise, intraluminal stent diameter, and in-stent attenuation where tested using a paired t-test; differences in subjective in-stent visibility were evaluated blooming and improved in-stent lumen delineation, lowered image noise, and improved overall image quality.

**Conclusion:** At matched CT scan protocol settings and identical image reconstruction parameters, the PCD yields superior in-stent lumen visibility and image characteristics of coronary artery stents as compared to conventional EID arrays.

PO39

### Interreader Agreement of a Disease-Independent Cancer Staging System

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**Purpose:** Purpose: To investigate the interreader agreement of a cancer grading system developed for facilitated comparison of the clinical stage and disease evolution between different cancers.

**Methods and Materials:** Methods: Five-hundred (500) reports from FDG-PET/CT examinations from the university hospital of Zurich were extracted from the radiological information system database. Four readers staged the cancer extent by the "impression" section of the report according to a five-tier system ranging from 0 = no signs of cancer to 4 = extensive disease. Interreader agreement was assessed for all readers in absolute agreement and by the concordance correlation coefficient (CCC), and pair-wise with Cohen's weighted kappa (k). Scores were interpreted as follows: slight (< 0.20), fair (0.20-0.39), moderate (0.40-0.59), substantial (0.60-0.79) and excellent (> 0.80) agreement.

**Results:** Results: In 43.2% of cases, all 4 readers assigned the same score, and in 84.8% of cases, the readers agreed within ±1 category. Pairwise absolute agreement ranged from 55.4% to 80.6%. Interreader agreement was excellent for all readers (CCC=0.86, 95%-CI: 0.83-0.89). Pairwise interreader agreement ranged from substantial (k=0.69; 0.56-0.81) to excellent (k=0.84; 0.70-0.97).

**Conclusion:** Conclusion: Cancer staging from radiology reports with a five tier grading system results in high interreader agreement. The system allows for fast and reliable estimation of total disease burden. The remaining disagreement may be the result of individual preferences in the interpretation of equivocal findings.

## Automated translation of radiologic reports with deep learning powered translation engines: A feasibility study

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**Purpose:** The quick, accurate and inexpensive translation of medical reports is a task of increasing importance in a globalised world with many patients crossing language borders during their treatment. Recently, deep learning powered translation engines showed impressive results translating prose texts. The purpose of our study was to assess the utility of such engines in a radiological context.

**Methods and Materials:** 20 German radiology reports of oncologic follow-up examinations generated between March and September 2017 were randomly selected. The impression section was translated into English, French and Italian by two deep learning powered translation engines (DeepL and Google Translate). The translations were then evaluated by three bilingual radiologists in the respective language (RH: English; NG: French; RW: Italian). Three error categories were labeled (stylistic error, content error without significance, potentially dangerous error).

**Results:** Overall, 79% of all words were translated correctly. However, only nine out of 120 translations were free of potentially dangerous errors and altogether 806 mistranslations were identified. Overall, the two translation engines showed a comparable performance. Of note, the quality of the translations into English was noticeably superior with 89% of all words correctly translated and 43% less potentially dangerous errors.

**Conclusion:** Deep learning powered translation engines in their current version are not suitable for automated translation of complex oncologic radiology reports. However, considering the fact that the performance of neuronal networks depends heavily on the data they were trained on, training on medical texts holds an enormous potential for better results in the near future.

Discrepancy rates between preliminary and final reports in teleradiology for emergency CT studies – What is missed at first reading?

<u>J. Weisser</u>, T. C. Treumann, J. E. Roos; Lucerne/CH

**Purpose:** To identify the accuracy and speed of preliminary reporting for off-hour emergency CT studies by radiology residents in a teleradiology setting.

**Methods and Materials:** Retrospective comparison of preliminary and final reports of >5000 off-hour CT scans over a 1-year period from Jan to Dec 2016 using the RADPEER scoring system (Score 0 = no discrepancy, 1 = minor (incidental to treatment/management), 2 = significant (affects treatment/management), 3 = major (affects outcome)). Differentiation between neuro and body CT imaging. Calculation of the turnover time (TOT) = interval between acquisition time and preliminary report time. For future quality assessment we developed an automated analysis of reports for findings and discrepancies.

**Results:** The major discrepancy rate (score 3) was 0.3% for all CT Scans and in off-hour duty. For neuro-imaging was 0.4% and for body-imaging 0.2%. The rate for significant discrepancies (score 2) was 3% in neuro-imaging and 1% in body imaging (total 2%). The TOT was 36 min (range 4 min to 5.5 hours). **Conclusion:** The discrepancy rates in our teleradiology network are low compared to results from corresponding international retro- and prospective studies.

PO41

# Survey regarding the demand for interdisciplinary further education of residents and already board certified physicians in radiology and nuclear medicine

<u>S. Y. Kim</u>, T. Xydias, J. T. Heverhagen, M. H. Maurer; Bern/CH

**Learning objectives:** To obtain an overview of the demand for interdisciplinary further education of residents and consultant physicians in radiology and nuclear medicine and the preferences about a possible future training curriculum in Switzerland.

**Background:** A 34-item questionnaire was sent electronically (SurveyMonkey online survey tool) to 1,244 radiologists and nuclear physicians (residents and consultant physicians) in Switzerland. The items asked about the motivation for a further education in each other's speciality and about present and future concepts of a further education curriculum in radiology and nuclear medicine.

Imaging findings or procedure details: Overall 345 questionnaires could be analyzed (345/1244, 28%). 280 (82%) of the participants were board certified physicians in either radiology (238/345, 69%) or nuclear medicine (42/345, 13%), whereas 65 (18%) were residents (radiology: 54/345, 15%; nuclear medicine 11/345, 3%). More than half of all residents (34/65, 52%) believed that the wide range of expertise in both disciplines can be fully guaranteed through adequate cross-curricular training. For participants already at a consultant level in radiology or nuclear medicine, the willingness for a further training in each other's speciality significantly increased with shortening the training period to two years. With regard to the training curriculum, two concepts were preferred: (1) Radiology training in 5 years plus 2 years further training in nuclear medicine, and (2) Radiology and diagnostic neuroradiology in 6 years and also 2 years further training in nuclear medicine. Conclusion: There is a high interest in a cross-curricular training curriculum in radiology and nuclear medicine in Switzerland, both in residents and already board certified physicians.

## PO42

## Switzerland as hub for AI in Radiology

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**Learning objectives:** Better awareness of the resources and activities taking place locally around AI in Radiology Understand how crucial imaging data are for large-scale projects like the Swiss Personalized Health Network **Background:** The general consensus at major radiology conferences (RSNA, ECR) is that AI-powered automation could take over up to 50% of radiologists workloads before 2025 and the daily work of a radiologist will look radically different in 10 years time. While a few renowned AI experts have predicted the end of radiology, this paradigm shift presents far more opportunities than threats. Particularly in such a volatile environment, it is important to take an active role in developing and forming the future through research projects, cross-clinic collaboration and partnerships with technology and research companies and institutions.

**Imaging findings or procedure details:** Switzerland provides an excellent ecosystem because of the well-built infrastructure of tightly interconnected institutes and large-scale initiatives for financing integrative projects. The closely-connected institutes facilitate collaborations between research hospitals and groups experienced in data storage and analysis. Many of these institutes have world-class reputations in imaging (ETHZ, EPFL, HES-SO). For financing such projects the Swiss Personalized Health Network has made over 68 MCHF available for collaborations on infrastructure and data analysis.

**Conclusion:** While Switzerland is much smaller than the current leaders in radiology innovation like the US, UK, and China, it benefits from many unique advantages in infrastructure and research opportunities. With these advantages and engagement from individual radiologists, medical institutions, health insurance, pharmaceutical manufacturers and medtech, we argue that Switzerland could be a world-leader in Radiology AI.

## PICC Team: Rational and steps for building an efficient multidisciplinary team

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**Learning objectives:** Shorten the time to care for patients who need a PICC Avoid overbooking the IR facilities dedicated for more complex procedures Keep the availability of physicians for other IR procedures

This report describes steps and the program of learning and training to build an efficient PICC team.

**Background:** The request to set up PICC (Peripheral Inserted Central Catheter) is increasing continually. In many countries, physicians usually did this intervention using frequently facilities dedicated for interventional radiology (IR) procedures.

**Imaging findings or procedure details:** A multidisciplinary team dedicated to perform PICCs that includes nurses, technicians in radiology and interventional radiologists was build. An educational program on vascular access focused on fundamental knowledge and practical training was designed with a validation process. An institutional approval for "PICC procedures by non physicians for selected patients under IR supervision" was obtained.

**Conclusion:** The PICC Team was borne in April 2017: three physicians, two nurses and three X-ray technicians. The Team performed 668 procedures with 362 (54%) done by non physicians.

## PO44

### Artificial intelligence applied on the national lung screening trial dataset: A radiomics study

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**Purpose:** To investigate the added value of radiomics applied on the National Lung Screening Trial (NLST) dataset in estimating solitary pulmonary nodule malignancy risk compared to the PanCan model.

Methods and Materials: Lung adenocarcinoma (n=227) and squamous cell carcinoma (n=94) with a long axis greater than 8 mm obtained from the NLST dataset were included and matched with benign lung nodules (n=299). Features extraction (n=124671) was retrospectively performed using an open-source python package after automatic segmentation of the 620 lung nodules from low-dose unenhanced computer tomography (CT). Benign versus malignant classification based on radiomics and clinical data was achieved via features selection, dimension reduction (using principal component analysis), and classification (using a support vector machine classifier). The demographic data, part of the NLST dataset and combined to the extracted features from the CT images for the radiomics analysis, were also evaluated solely according to the PanCan model. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the radiomics were calculated based on the histological diagnostic given in the NLST dataset. The diagnostic performances of the two models were compared on their area under the receiver operating characteristic curve (AUC) analysis.

**Results:** Radiomics model: sensitivity 96.9%, specificity 93.3%, PPV 93.9%, NPV 96.6%, AUC: 0.983. PanCan model: AUC: 0.797.

**Conclusion:** Artificial intelligence and data mining in chest CT raise the diagnostic confidence higher than any other models in the field of non-invasive characterization of lung nodules.

#### P045

Kerley-B-lines in the lung apex - a new CT sign for pulmonary congestion

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**Purpose:** Establish a new CT sign for pulmonary congestion: Kerley-B-lines in the lung apex in patients with cardiac or renal insufficiency.

**Methods and Materials:** 43 CT cases with cardiac, 17 with renal and 30 patients with mixed cardiac/renal insufficiency were retrospectively included. In addition, we selected 30 Interstitial-Lung-Disease patients with pulmonary fibrosis (ILD). The cardio-thoracic ratio, the diameter of superior and inferior vena cava were measured. Pleural effusion, peribronchial cuffing, Kerley-B-lines (interlobular septa), ground glass opacity and consolidation were analyzed for prevalence and distribution.

**Results:** The prevalence of Kerley-B-lines in the lung apex was 81.4%, 76.5% and 73.3% in the cardiac, renal and mixed insufficiency group respectively, which was significant more than in the ILD group (36.7%, p=0.0016). While their distribution in the insufficiency group was homogenously throughout the lungs, the amount of Kerley-B-lines increased to 90% towards the lower lobes in the ILD group. Peribronchial cuffing was significant more present in the cardiac than in the renal and ILD group with 67.4%, 29.4% and 0%, respectively (p=0.04 and 0.0004). The other cardio-pulmonary congestion signs did not vary between the cardiac and the renal group but dropped significantly in the ILD group, although ILD patients suffered more from GGO in the lower lobes (p=0.0004).

**Conclusion:** Interlobar thickening (Kerley-B-lines) in the lung apex is a specific sign for pulmonary congestion, although not exclusive, but in combination with peribronchial cuffing and increased cardio-thoracic ratio it allows for differentiation between cardiac/renal insufficiency and pulmonary fibrosis.

#### Impact of added CT venography (CTV) performed in combination with CT pulmonary angiography (CTPA) on the detection of deep venous thrombosis (DVT) and relevant occult CT findings

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**Purpose:** To assess the additional diagnostic value of CT venography (CTV) simultaneously performed with CT pulmonary angiography (CTPA) in the context of thromboembolic disease for the detection of DVT and other significant CT findings, such as underlying tumors.

**Methods and Materials:** All patients older than 49 years addressed for suspected pulmonary embolism (PE) from January 2015 to December 2016 and undergoing CTPA combined with CTV were included in this monocentric retrospective study. While one radiologist reviewed clinical records of all patients, two other radiologists separately and blinded to all results analysed the CTV images in view of DVT of lower extremities and/or any other relevant pathological findings visible (such as pelvic tumors, enlarged pelvic lymph nodes, or inflammations), which were registered and classified as non-relevant or relevant with therapeutic consequences. The inter-observer agreement for the detection of DVT was evaluated using the Cohen's kappa coefficient.

**Results:** Our preliminary results with 400 patients (191 men, mean age 71.4) showed 66 PEs (16.5%) and 30 (7.5%) DVTs of which 9 (2.3%) were not associated to PE. Cohen's Kappa inter-observer agreement between the two readers was 0,75, thus substantial. The CTV examinations lead to change of management in 14 (3,7%) patients consisting of 8 DVTs without PE and 6 relevant findings with therapeutic consequences, among them five tumors. **Conclusion:** In patients with suspected PE, additional CTV performed simultaneously with CTPA mostly has a limited impact on the diagnosis of thromboembolic disease. However, it rarely enables the detection of significant, yet unknown, underlying pelvic lesions with therapeutic consequences.

PO47

## Volume perfusion CT for the differentiation of atelectasis, necrosis and vital areas in primary lung tumors in comparison to FDG-PET/CT

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**Purpose:** To evaluate the discrimination capability of primary lung tumor versus atelectasis as well as necrotic versus vital tumor areas using volume perfusion CT (VPCT) in comparison to FDG-PET/CT

**Methods and Materials:** 25 patients underwent FDG-PET/CT for tumor staging including a VPCT scan. According to PET and CT features, ROIs were placed in four different compartments: 1) atelectatic lung parenchyma; 2) whole tumor (maximum axial extension), 3) tumor regions suspected to be necrotic 4) assumed vital tumor areas. Perfusion parameters and SUV<sub>max</sub> were recorded for all 4 compartments

**Results:** 20 patients showed atelectasis. The following values were recorded for the tumor: BF 60±69 mL/100 mL/min, BV 4.2±3.8 mL/100mL, FED 20±15 mL/100mL/min and SUV<sub>max</sub> 12±11. The following values were recorded for atelectasis: BF 266±163 mL/100mL/min, BV 15±8.2 mL/100mL, FED 35 mL±38/100 mL/min and SUV<sub>max</sub> 2.1±0.8.

10 patients showed necrotic tumor areas. Following values were recorded for necrosis: BF 10±7.4 mL/100 mL/min, BV 0.7±0.7 mL/100mL, FED 4.1±4.2 mL/100mL/min and SUVmax 1.7±1.2. Following values were recorded for vital areas: BF 67±31 mL/100 mL/min, BV 5.0±2.1 mL/100mL, FED 27±15 mL/100mL/min and SUV<sub>max</sub> 14±18.

**Conclusion:** VPCT shows up to 4.5 times higher perfusion (BF) values in atelectasis compared to whole tumor ROIs. Furthermore, lower perfusion values and lower FDG-PET values were recorded for necrotic compared to vital tumor areas. By this, VPCT may provide auxiliary information to standard PET/CT protocols and improve staging accuracy and tumor definition for radiotherapy. Ongoing research will focus on cluster analyses for integration of all parameters into comprehensive tumor profiles.

## PO48

PO49

## Prospective quantification of Respiratory mechanics in COPD patients before and after Lung Volume Reduction Surgery on dynamic MRI

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**Purpose:** To prospectively evaluate respiratory mechanics in chronic obstructive pulmonary disease (COPD) patients with severe emphysema before and after lung volume reduction surgery (LVRS) using dynamic magnetic resonance imaging (dMRI).

**Methods and Materials:** 39 patients (15 female, median age 61y) with COPD and severe emphysema scheduled for LVRS were included prospectively in the study. On a 3T MRI-scanner dynamic sequences of the lung were obtained the day before and 3 months after surgery, herein termed as preand post-LVRS-MRI. Measurements were performed on sagittal planes lung in pre- and post LVRS MRI at fully inspiration and expiration: lung height, anteroposterior (AP) diameter, hemidiaphragm height and area as well as lung area and perimeter. Additionally dynamic changes in hemidiaphragmatic area and height were measured. Student-t-Test was used to test for statistical significant differences between pre- and post-LVRS-MRI.

**Results:** On expiration mean lung area on both sides ( $p_{right}$ =0.001 and  $p_{left}$ =0.016) as well as AP-diameter for the right lung ( $p_{right}$ =0.003) improved significantly after LVRS. Dynamic measurements showed significant differences pre- and post-LVRS on the right lung, but not on the left ( $p_{right}$ <0.001 and  $p_{left}$ =0.090). There were no significant changes in lung height for both sides, in hemidiaphragmatic height on the right as well as diaphragmatic area pre- and post-LVRS (p > 0.05). Except for hemidiaphragmatic height on the left (p=0.039), no significant differences were found on inspiration.

**Conclusion:** dMRI shows that LVRS improves significantly impaired respiratory mechanics by increasing the elastic recoil of the lung and restoring the diaphragm configuration.

## Multiphasic video esophagram: Demystifying a nearly forgotten yet powerful art

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**Learning objectives:** To review the indications and technical aspects of multiphasic videofluoroscopy studies in esophageal dysphagia. To discuss the characteristic findings seen in the most common entities causing esophageal dysphagia. To discuss pitfalls of image interpretation and how to avoid them. To provide illustrative examples of how to report videofluoroscopy studies in a standardized fashion

**Background:** Although esophageal disorders are common, the skill of diagnosing these entities is becoming a forgotten art in particular since cross-sectional imaging techniques have increasingly replaced conventional barium swallow studies for the diagnosis of a multitude of esophageal disorders. Nevertheless, multiphasic videofluoroscopy, which is widely available, affordable and associated with low to moderate irradiation, still constitutes the gold standard for the work-up of functional swallowing disorders.

**Imaging findings or procedure details:** We first present a systematic approach to the state of the art multiphasic video esophagram technique. We then discuss the etiology of esophageal dysphagia and provide illustrative examples of primary motor disorders of the esophagus and other neuromuscular disorders, structural causes of esophageal dysphagia, such as Schatzki ring, arteria lusoria, tight Nissen fundoplication, webs, diverticula, strictures, fistula and neoplasms. Correlation with cross-sectional imaging and endoscopy is provided whenever necessary. Emphasis is put on how to report the findings in a structured fashion and when to recommend further work-up.

**Conclusion:** This exhibit provides a systematic and demystified approach to the most common causes of esophageal dysphagia as revealed by multiphasic video esophagram studies.

## Imaging findings of invasive fungal pulmonary disease

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**Learning objectives:** Use of imaging modalities in the diagnosis of Invasive fungal pulmonary diseases (IFI).

Semiologic signs: interest of vessel occlusion sign (VOS)

**Background:** IFI are a major problem in immunosuppressed patients and have to be detected quickly in order to initiate the treatment as early as possible, and so imaging plays a substantial role.

**Imaging findings or procedure details:** Chest X-ray has low sensitivity and specificity so CT is the modality for diagnosis. It can detect many semiologic signs, any additional findings, guide further explorations and is the major modality for the follow-up. However, repeated exposure to radiation is an increasing concern, indicating the need of low-dose CT for follow-up and MRI, with the development of new sequences, is an alternative.

Among imaging findings of fungal infection, nodules > 1cm and masses are most common. Halo sign in a febrile patient with neutropenia is highly suggestive of angioinvasive pulmonary aspergillosis (IPA), but non-specific whereas vessel occlusion sign (VOS) is more specific and raise the interest of performing an angio-CT when IFI is suspected. The air crescent sign in IPA is caused by parenchymal cavitation and coincides with the return of neutrophil function. Alveolar consolidation or peribronchial anomalies, may also be seen, particularly in bronchoinvasive forms. The reverse halo sign suggests an IFI, primarily mucormycosis or IPA.

**Conclusion:** CT has a high added value in the diagnosis of IFI in immunocompromised patients, but with a limited specificity.

Interest of VOS and need of an angio-CT when IFI is suspected. Low-dose CT for the follow-up.

P051

## Lung Ultrasound (LUS): What the radiologist needs to know

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**Learning objectives:** Understand the physical basis of LUS Learn the fundamentals of LUS semiology

Review typical examples of the most common LUS diagnosis

**Background:** For most of radiologists aware of the physical basis of sonography, imaging the lung with this technique come close to nonsense, as the relative impedances of lung and thoracic wall will keep any useful image off. Far from these barriers, many physicians use LUS at the bedside in critical care and emergency settings to diagnose a wide panel of pulmonary diseases. LUS may be used in many clinical situations with a high diagnostic yield, even better than X-rays.

**Imaging findings or procedure details:** Most of imaging findings are artifacts related. The origin and significance of these artifacts will be reviewed and explained: A lines, B lines, lung point, seashore sign, and barcode sign. Some other signs are more familiar to radiologists, as they are linked to morphological changes: pleural fluid, and lung consolidation.

**Conclusion:** Despite large accessibility and excellent diagnostic yield, LUS remains poorly recognized in the radiological community, mainly related to psychological block.

## UltraSound Enhanced Thrombolysis (USET) for treating acute pulmonary embolism: From patient selection to patient management

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**Learning objectives:** The objective of this exhibit is to review recent definitions of acute PE and related risk stratification, review indications and recommendations for USET, and provide a comprehensive step-by-step procedure details and outcome. A specific regard is given to CT based indices to identify patients for USET as well as skills to achieve to perform USET for acute PE.

**Background:** Acute massive and sub-massive pulmonary embolism (PE) are a life-threatening event that requires immediate treatement. Mortality in the first 3 hours is as high as 15% if there is right heart failure and hemodynamic unstability. Ultrasound enhanced thrombolysis (USET) is a catheter based system that work with ultrasound to penetrate and fragment thrombus. USET is recently reported to allow significant reduction of thrombolytic agent (up to 6% the standard dose) that reduce drastically the complication rate and by the way enlarge its usage.

**Imaging findings or procedure details:** A specific regard is given to CT based indices to identify patients for USET as well as skills to achieve to perform USET for acute PE.

**Conclusion:** Radiologists and interventional radiologists should play a significant role in patient selection and in providing safe and efficient procedures in optimal conditions.

## P053

## Chemonucleolysis in disk herniation: Our experience in O2-O3 treatment and review of the literature

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**Purpose:** Based on the experience gained from interventions performed in our department, we wish to emphasize the effectiveness of intradiscal chemonucleolysis with injection of O2-O3 for the treatment of symptomatic intervertebral disc herniations. O2-O3 gas mixture has anti-inflammatory effects, it improves oxygenation and it leads to a dehydration and shrinkage of the disc. The rationale for O2-O3 therapy is that back pain is caused by mechanical compression of the nerve root associated with periganglionic and periradicular inflammatory responses

**Methods and Materials:** From 2007 to 2016 we performed chemonucleolysis procedures with intradiscal injection of O2-O3 on 823 patients with symptomatic vertebral disc prolapse. After interventions patients were contacted in a range time between 2 months and 3 years and tehy were subjected to a questionnaire to evaluate the outcome.

**Results:** The results were very satisfactory as the majority of patients has been successfully treated. No one of our patients showed side effects related to the procedure. Instead the few cases of failure (McNab 4) were mainly patients who already had a significant disc disease and who belonged to an age in wich it is easy to have concomitant factors that could cause or increase pain (arthrosis, accidents, heavy work).

**Conclusion:** The intradiscal chemonucleolysis is a minimally invasive technique that allows an effective pain control in patients with disc herniation, especially in the population belonging to a particular age group. However, as we can also find in the literature, this technique neither penalizes nor precludes the possibility to perform afterwards the more invasive surgery.

#### P054

Dose optimized computed tomography of the cervical spine with shoulder pulldown: Is image quality comparable with a standard dose protocol in an emergency setting?

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**Purpose:** To compare image quality of cervical spine (C-spine) CT performed with a dose-optimized (DO) protocol in patients with shoulder pulldown and with a standard-dose (SD) protocol in patients without shoulder pulldown in an emergency setting.

**Methods and Materials:** DO-CT (105 mAs/120 kVp) of the C-spine in trauma settings was performed if C5 was not superimposed by soft tissue on lateral topogram, otherwise SD-CT (195 mAs/120 kVp) was performed. 34 DO-CTs (mean age 68y; BMI: 24.2kg/m<sup>2</sup>±3.2) and 34 SD-CTs (mean age 70y; BMI 25.7kg/m<sup>2</sup>±4.4) with iterative reconstructions were subjectively evaluated at C2/3 and C6/7 by two musculoskeletal radiologists. Qualitative image noise and morphological characteristics of bony structures (cortex, trabeculae) were assessed on a Likert-scale. Subjective parameters, quantitative image noise and effective dose (ED) in both groups were compared using Mann-Whitney-U-test (p<0.05).

**Results:** At C2/3, DO-CT yielded higher quantitative noise (27.2 HU; SD 19.6 HU; p<0.001), but comparable qualitative noise (1.3; SD 1.0; p=0.18) and morphological characteristics. At C6/7, no difference was found for quantitative noise (DO 25.4 HU; SD 27.9 HU; p=0.24), but DO-CT yielded lower qualitative noise (1.9; SD 2.2; p=0.017) and higher visibility scores for cortex (1.4; SD: 1.0; p=0.001) and trabeculae (0.6; SD 0.4; p=0.03). DO-CT had a 52% lower radiation dose than SD-CT (EDDO 0.79 mSv; EDSD 1.63 mSv, p<0.001).

**Conclusion:** DO-CT of the C-spine in patients capable of shoulder pulldown revealed comparable (C2/3) or better (C6/7) qualitative image quality at half the radiation dose compared to SD-CT.

## Accuracy of the Cone-Beam Ct (CB-CT) for syndesmosis injury compared to conventional CT

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**Purpose:** Syndesmosis injury can lead to ankle mortise instability and early osteoarthritis. Several CT methods for measurement are developed. Conebeam CT (CB-CT) is an emergent technique with benefit of acquisition in upright position with lower dose. The purpose is to assess the accuracy of CB-CT in injured syndesmoses compared to conventional CT with instability confirmed via arthroscopic examination.

**Methods and Materials:** Three musculoskeletal radiologists prospectively analyzed over a period of 5 months 11 conventional CT and 8 CB-CT of the same traumatic ankles, with suspicion of syndesmosis lesion. They measured 10 methods in both sides. Syndesmosis is considered pathologic in correlation to arthroscopic exam in 4 patients.

Methods included were among others tibio-fibular (TF) distances, TF diastasis, antero-posterior translation (APT), fibular rotations, antero-posterior translation of the fibula, and TF surface.

Correlation between readers is evaluated with Pearson test (P< 0.05 was considered significant).

Capacity of discrimination was assessed by area under curves (AUC) for al methods.

**Results:** Inter-observer agreement was almost excellent for both CB-CT and conventional CT for the anterior TF distance (ICC=0.831), posterior TF distance (ICC=0.826), minimal TF distance (ICC=0.875) and the surface ((ICC=0.84). AUC were better for conventional CT compared to CB-CT respectively: posterior TF distance (ROC=0.7778 vs 0.6744), anterior TF distance (ROC=0.8687 vs 0.5548), TF surface (ROC=0.8917 vs 0.6435).

**Conclusion:** Conventional CT showed better ability to discriminate the pathologic syndesmosis compared to CB-CT, with the TF surface as best discriminant measurement, widening of syndesmoses in upright position may explain these results.

#### PO56

### Anatomy of the Chopart Joint and Imaging Findings in Midtarsal Injuries

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**Learning objectives:** To familiarize the radiologist with Chopart joint injury, an often-overlooked entity.

**Background:** Chopart joint, also known as the midtarsal joint, is composed of the calcaneocuboid and talonavicular joints. Injuries, including pure ligamentous tears and small avulsion fractures, can be missed clinically in up to 41% of cases, mimicking the more common lateral collateral ankle ligament pathology. A proper diagnosis of Chopart joint injury, however, is crucial to avoid midtarsal instability and functional limitations.

**Imaging findings or procedure details:** This educational exhibit will be subdivided into three parts:

A. Review of the normal anatomy of Chopart's joint, with emphasis on MRI features of the supporting ligaments including the dorsal calcaneocuboid, bifurcate, short and long plantar, spring, and talonavicular ligaments.

B. Discussion of clinical and imaging features of Chopart joint injuries. Ligamentous disruptions at Chopart joint are optimally visualized on fluid-sensitive axial and sagittal images. Subtle marrow edema at Chopart joint ligamentous insertions, particularly the dorsal calcaneocuboid and bifurcate ligaments, may herald an avulsion injury. Isolated fractures at the dorsal talonavicular joint or at the calcaneocuboid joint should raise a red flag to the possibility of more extensive Chopart joint injury.

C. Discussion of clinical relevance and treatment regimen. Chopart joint injuries, when overlooked, can lead to prolonged morbidity. The treatment varies but may require a more aggressive and lengthier immobilization than ankle sprains. Surgery may be indicated in cases of unstable midtarsal sprains.

**Conclusion:** Heightened awareness of the often-disregarded, imaging features of Chopart joint injury are important, as accurate diagnosis can significantly impact treatment regimen and clinical outcome.

## P057

## MRI features of inflammatory myopathies and added value of advanced techniques in daily practice

<u>A. Caruso</u>, A. Neroladaki, I. Bagetakos, M. Hamard, S. Boudabbous; Geneva/CH

**Learning objectives:** The purpose of this study is to illustrate the MR findings of myopathies confirmed by biopsy, and to assess the role of advanced MR techniques in clinical practice.

**Background:** Inflammatory myopathies constitute a heterogeneous group of autoimmune idiopathic myopathies. The most common subtypes are dermatomyositis, polymyositis, and inclusion-body myositis.

Muscle inflammation can also be due to infection, trauma, neoplasm, vasculitits, overuse, and autoimmune neuropathy.

MRI has a primordial role in the initial diagnosis, for detecting the muscle abnormality and guiding the muscle biopsy, and also in the course of disease. Advanced MR methods (diffusion weighted imaging, whole body MRI, perfusion MRI) aim to improve the characterization of myositis.

**Imaging findings or procedure details:** Retrospective study of MRI and clinical data of patients with myositis/myopathy reference in the radiological report during the past seventeen years were listed.

Clinical data and MRI features were analyzed.

214 cases with MRI features suggesting a myopathy were found and 57 of them were confirmed by biopsy (69.5%).

Among them 15.7% presented inflammatory myopathy such as dermatomyositis (14%), inclusion-body myositis (9%), polymyositis (7%).

The MRI findings were usually non-specific, however their distribution pattern sometimes was suggestive of some subtypes of this entity.

Cases of different forms of myopathy were also analyzed.

Advanced MRI methods, when performed, contributed to the diagnosis.

**Conclusion:** This educational study highlights the value of MRI in the diagnosis and management of myopathies and emphasizes the added value of advanced available techniques.

#### P058

#### Calcific Tendonosis of the Shoulder

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**Learning objectives:** To be familiar with some common and less common appearances of calcific tendonosis of the shoulder. To be aware of other calcifications around the shoulder girdle.

**Background:** Calcific tendonosis is common involving the rotator cuff of the shoulder (1,3). All tendons may be involved. Pain can be excrutiating so early diagnosis can be critical for best patient care, treatment and pain relief. Complications include tendon rupture and calcification extension into extra-, intra-articular and rarely intra-osseous spaces (2) and frozen shoulder. Reference:

1.Sansone V, Consonni O, Maiorano E, Meroni R, Goddi A. Calcific tendinopathy of the rotator cuff: the correlation between pain and imaging features in symptomatic and asymptomatic female shoulders. Skeletal Radiol. 2016. Jan;45(1):49-55.

2. Pereira BP, Chang EY, Resnick DL, Pathria MN. Intramuscular migration of calcium hydroxyapatite crystal deposits involving the rotator cuff tendons of the shoulder: report of 11 patients. Skeletal Radiol. 2016 Jan;45(1):97-103 3. Nörenberg D, Ebersberger HU, Walter T, Ockert B, Knobloch G, Diederichs G, Hamm B, Makowski MR. Diagnosis of Calcific Tendonitis of the Rotator Cuff by Using Susceptibility-weighted MR Imaging. Radiology. 2016 Feb;278(2):475-84.

**Imaging findings or procedure details:** Common and less common imaging clinical examples will be shown.

Multimodalities, with an emphasis on MRI will demonstrate findings.

Other calcifications examples, differential diagnosis, will also be included. **Conclusion:** Awareness of the imaging findings of calcific tendonosis will help with improved clinical diagnoses and patient care.

### Crystal arthropathies covered

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**Learning objectives:** To be familiar with classical findings of crystal arthropathies and presentations that may mimic infection or tumor.

**Background:** Crystal arthropathies are very common, but can be misdiagnosed or misinterpreted. We present some classic imaging findings using mutliple modalities, including radiographs, Computed Tomography and Magnetic Resonance Imaging. Crystal arthropathies can clinically present mimicking infection or tumor.

**Imaging findings or procedure details:** Varied clinical cases using radiographs, Computed Tomography and Magnetic Resonance Imaging will be demonstrated.

**Conclusion:** Awareness of some classical imaging features and clinical presentations of crystal arthropathies may assist with improved diagnoses and clinical care.

#### PO60

#### Cystic lesions around the knee

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**Learning objectives:** To be familiar with imaging appearances of common cystic lesions around the knee. To be aware of some differential diagnostic lesions for cystic structures around the knee.

**Background**: Cystic lesions are very common around the knee joint and can be divided into simple groups including: bursae, intra- and extra-articular and intra-osseous lesions (1,2). Some common cystic lesions include: prepatella and superficial infrapatella bursae, meniscal ganglion cysts, cruciate and other ganglion cysts, tibio-fibular cysts and intra-osseous cysts, geodes (2). Differential diagnoses for these cystic lesions around the knee include for example are vascular lesions, hemangioma, abscess, focal synovial chondromatosis and synovial sarcoma (3).

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Knee Surg Relat Res. 2015 Dec;27(4):255-62

2. MRI characteristics of cysts and "cyst-like" lesions in and around the knee: what the radiologist needs to know

Evangelos Perdikakis, Vasilios Skiadas

Insights Imaging. 2013 Jun; 4(3): 257–272

3. Cysts and cystic-appearing lesions of the knee: A pictorial essay.

Telischak NA, Wu JS, Eisenberg RL.

Indian J Radiol Imaging. 2014 Apr;24(2):182-91

**Imaging findings or procedure details:** Clinical case examples of the simple groups given above will be demonstrated. MRI will be the main imaging focuss. Surgical orthopedic correlation will also be included

**Conclusion:** Being familiar with common cystic structures around the knee may be helpful for improved diagnosis and patient care. Awareness of some differential diagnoses important.

Withdrawn

P061

## P062

## Dense breasts on screening mammography: Utility and futility of additional hand-held breast ultrasound

## <u>S. Junod</u>, C. Ducros, J.-L. Bulliard, J.-Y. Meuwly; Lausanne/CH

**Purpose:** High breast density (BIRADS 4/d) decreases the sensitivity of mammography and is also the most important breast cancer risk factor in normal risk women. Since 2012, the Vaudois program for breast cancer screening proposes to realise an additional ultrasound (US) to the women with BIRADS 4/d breasts.

The first objective of this study was to evaluate the impact of the recommendation in term of supplemental cancer detection. The second objective was to identify the reasons why the women were non-compliant.

**Methods and Materials:** The women identified with BIRADS 4/d breasts between January 2012 and December 2015 were included. In the retrospective part of the study, the women who have undergone the US were identified: normal results, requirement of additional examination, biopsy and cancers. The second part was prospective. The women that did not undergo the recommendation were questioned in order to identify the cause of their (de) motivation.

**Results:** Two thousand forty-eight women (2.4% of screened population) were identified. Additional US were performed in 1235 (60.3%) women. One hundred eighteen (9.6%) made one or more complementary exams. Seven supplementary cancers (5.7 ‰) were diagnosed.

Only 179 on 666 (27%) of non-compliant women reported on their motivations. The reasons for no adherence to the recommendation were in increasing order: the gynaecologist's opinion, the oversight, the personal's reasons and the financial burden.

**Conclusion:** Additional US in case of BIRADS 4/d breasts identified seven cancers, but nearly 40% of women did not follow the recommendation because the risk related to dense breast was trivialize.

#### PO63

### Spectrum of Technical Errors and Pitfalls in Female Pelvic MRI

A. Stolz<sup>1</sup>, <u>R. Perraut-Gattegno<sup>2</sup></u>, K. Kinkel<sup>3</sup>; <sup>1</sup>Neuchatel/CH, <sup>2</sup>Cluj-Napoca/RO, <sup>3</sup>Chêne-Bourgeries/CH

**Purpose:** MRI has now been established as an important diagnostic tool in gynecology whereas ultrasound has been proven to have limited capabilities. However, the imaging protocol varies according to the clinical situation. We present cases of patients in which inappropriate protocol of the MRI sequences lead to incorrect diagnosis.

**Methods and Materials:** During one year, we collected MRIs of the female pelvis from external radiology centers for which reinterpretation was requested by the weekly multidisciplinary gynecologic oncology tumor board conference. The quality of the protocol was evaluated by two radiologists (one expert and one confirmed) specialized in pelvic imaging. The definitive diagnosis was confirmed by histology of the operative specimens.

**Results:** Between October 2016 and September 2017, a total of 28 female pelvic MRIs were collected. Among these patients the imaging protocol was considered incomplete in 18 (64%), leading to an inaccurate diagnosis in 27% (5/18). A new MRI with complete protocol was required in 4 situations (14%), leading to a correct diagnosis in 75% (3/4) of cases.

**Conclusion:** In this paper, we highlight protocol errors encountered in daily practice. We will review current guidelines for imaging the female pelvis, update sequence settings to allow adequate detection and characterization of pelvic masses and avoid misinterpretation.

### Determination of mammographic Breast Density using a Deep Convolutional Neural Network

## <u>A. Ciritsis</u>, C. Rossi, I. de Martini, A. S. Becker, A. Boss; Zurich/CH

**Purpose:** Breast density is a risk factor for the development of breast cancer. The aim of this study was to develop a deep convolutional neural network (dCNN) for the automatic classification of breast density according to the American College of Radiology Breast Imaging Reporting and Data System (ACR BI-RADS) Atlas.

**Methods and Materials:** In this study, 20.578 mammography single views from 5.221 different patients (58.3+-11.5 years) were downloaded from the picture archiving and communications system (PACS) and automatically sorted according to the projection and the ACR density of the corresponding radiological report. A dCNN with 11 convolutional layers and 3 fully connected layers was trained with 70% of the data, whereas 30% were used for validation. The model was finally applied to a "real-world" dataset of 1.732 mammographies.

**Results:** The "sweet spot" for training avoiding over-fitting required 91 epochs for medio-oblique lateral (mlo) projections (cc, cranio-caudal projection: 94 epochs). Accuracy for mlo projection obtained on the validation dataset was 90.9% (cc: 90.1%). In the "real-world" dataset, an accordance between radiological reports and mlo-model of 71.7% (cc: 71.0%) was reached for 4 classes, 88.6% (cc: 89.9%) for the distinction thin/dense breast.

**Conclusion:** dCNN allows for accurate classification of breast density based on the ACR BI-RADS system, reflecting the collective expertise of human readers. The intermediate accordance between human readers/model most probably reflects the ambiguity of human decision-making. The proposed technique may be useful for accurate, standardized, and observer independent breast density evaluation of mammographies.

#### PO65

## Endometriosis - All the radiologist needs to know

<u>M. Kaniewska</u>, R. Grabherr, M. Heubner, R. A. Kubik-Huch; Baden/CH

Learning objectives: To teach radiologists and radiology residents about appearance of endometriosis in MRI, explaining characteristic imaging features (e.g. T2-shading, dark spot sign).

To offer an exemplary MRI protocol for detection of pelvic endometriosis according to the recent ESUR (European society of urogenital radiology) guidelines.

To explain the nomenclature for this entity (endometriomas, superficial and deep infiltrating endometriosis).

To present predilection sites of endometriosis.

**Background:** The presence of ectopic endometrial tissue outside the uterus is described as endometriosis. This entity may cause pelvic pain and infertility and affects about 10% of women in reproductive age. For the diagnosis, laparoscopy is the reference standard procedure, however MRI helps in detection and characterisation of lesions. MRI is mainly used for the pre-operative planning, e.g. in patients with rectal wall invasion, when endometriosis has been already diagnosed. MRI also enables differentiation of endometriomas and deep pelvic endometriosis from other gynaecological entities.

**Imaging findings or procedure details:** We offer a protocol for MR examination of endometriosis with following components: T2-weighted sequences without fat suppression- regarded as optimal sequences for detection of pelvic endometriosis. T1-weighted sequences with and without fat suppression- to properly differentiate between endometriomas and teratomas and to depict peritoneal implants. T1-weighted sequences with fat suppression after intravenous Gadolinium- to evaluate the adnexal masses and suspected malignancies.

**Conclusion:** Endometriosis is a relatively frequent entity encountered in radiological practise and therefore its imaging features and common predilection sites should be recognised by radiologists. MR offers a comprehensive assessment of disease extension, which is essential for the pre-operative planning.

## Obstetric MR Pelvimetry, an accurate technique to determine the mode of delivery

<u>M. Y. Moshebah</u>, M. Picarra, D. Desseauve, J.-Y. Meuwly; Lausanne/CH

**Learning objectives:** Describe the indications of obstetric MR pelvimetry (OMRP).

Understand the technique of the procedure.

Illustrate various examples of normal and abnormal OMRP and their correlations with obstetric outcomes.

**Background:** Obstetric MR pelvimetry is a radiological technique used to evaluate the size and diameters of a pregnant woman's pelvis and aims to help the obstetricians to decide whether the women will be able to give birth vaginally or not.

Pelvimetry can be performed by clinical examination, or by conventional X-rays, computerised tomography (CT) scanning, or magnetic resonance imaging (MRI). The later is currently preferred, as it is a quick, safe and accurate method.

Pelvimetric MRI is intended also to identify a fœto-pelvic disproportion, which can cause dystocia. Fetal maternal morbidity and mortality increase with prolonged labor.

**Imaging findings or procedure details:** T1 vibe sequences in apnea are obtained on a 1.5T or 3T device with coupled body and pelvis antennas at three levels:

- Median sagittal plane to measure the space between the pubic symphysis and the sacral promontory, then between the symphysis and sacro-coccygeal junction
- Transverse plane to measure the distances between the sciatic spines on the one hand, between the ischia on the other hand.
- Oblique coronal plane connecting the symphysis to the promontory to measure the transverse diameter of the pelvis.

**Conclusion:** OMRP is a valuable, accurate and quick method used to evaluate the women pelvic diameter and helps in deciding the best way for the delivery, that would definitely reduce the risk of complications of vaginal delivery in various clinical situations.

## Soft-tissue vascular anomalies in children: Review of imaging characteristics according to current ISSVA classification

<u>M. C. Cristallo Lacalamita</u><sup>1</sup>, M. Laurent<sup>1</sup>, S. Toso<sup>1</sup>, L. Merlini<sup>2</sup>, E. Dorie<sup>1</sup>, G. La Scala<sup>1</sup>, S. Hanguinet<sup>1</sup>; <sup>1</sup>Genève/CH, <sup>2</sup>Geneva/CH

**Learning objectives:** Recognize clinical and imaging features of most common pediatric soft-tissue vascular anomalies Use the new nomenclature, according to the International Society for the Study of Vascular Anoma-lies (ISSVA) classification, updated in 2014.

**Background:** Soft-tissue vascular anomalies in children are a poorly known group of lesions affecting 10% of children, frequently diagnosed on the basis of clinical findings. Imaging might be required to assess lesion extent and to search for associated syndromes.

The inaccurate application of terminology in the past has sometimes led to inappropri-ate treatment.

**Imaging findings or procedure details:** Infantile hemangioma, venous or arteriovenous malformations are the most common vascular anomalies in children. We propose a simple and structured imaging approach of these lesions by pulsed Doppler ultrasound and MRI. Based on flow waveforms, it is possible to differentiate infantile hemangiomas, that gradually involute over year, from arteriovenous malformations, which require rapid embolization. Typical signs of venous malformations, are calcifications and slow venous flow on doppler and they are usually treated by sclerotherapy.

MRI is reserved for lesions with unclear deep extent at ultrasound or with particular locations to research associated anomalies.

Imaging features of other less common vascular anomalies included in the ISSVA classification (pyogenic granuloma, Kaposiform hemangioendothelioma, glomuvenous malformation, lymphatic malformations) are also described.

For each entity, when appropriate, we indicate typical locations, clinical characteristics, histological markers, possible associated anomalies and treatment options.

**Conclusion:** A good knowledge of the classification and clinical characteristics of vascular anomalies helps radiologists make correct diagnosis and propose the best imaging and therapeutic strategy.

## Imaging of thyroid diseases in the pediatric population: A pictorial essay

<u>M. C. Cristallo Lacalamita</u>, M. Laurent, S. Toso, L. Merlini, S. Hanquinet; Geneva/CH

**Learning objectives:** The aim is to provide a structured approach to imaging of pediatric thyroid diseases related to different clinical indications.

**Background:** Particular features distinguish thyroid diseases in children from those of adults. Knowledge of embryological development of the thyroid gland is essential to recognize most of the benign lesions in children.

We group the main clinical indications for thyroid imaging in pediatric patients as follows: congenital hypothyroidism symptoms and laboratory findings of dysthyroidism palpable thyroid or neck mass with or without thyroid blood test anomalies radiation exposure during childhood and screening of thyroid cancer in carriers of several genetic syndromes

**Imaging findings or procedure details:** Based on age and clinical indications, we suggest the most appropriate imaging strategy.

We describe different imaging characteristics of several pathologies, for example, in newborns with congenital hypothyroidism, we search for sonographic signs of thyroid dysgenesis.

In hypothyroidism presenting later in childhood, mostly caused by Hashimoto thyroiditis, we illustrate characteristic findings. Imaging in hyperthyroidism, most commonly secondary to Graves disease, is also described.

In children with a palpable thyroid or neck mass, congenital conditions need to be investigated (eg: thyroglossal cyst, ectopic thyroid gland, ectopic thymic tissue, 4th branchial arch anomaly).

We also propose a follow-up management strategy of thyroid nodules, especially for previously irradiated children or carriers of genetic syndromes. **Conclusion:** A systematic approach to thyroid imaging based on age and clinical indications can help the radiologist to easily recognize thyroid disorders in children, to distinguish between different diagnostic possibilities and to guide patient care.

Please note that abstracts appear as submitted to the online submission system.

### PITFALLS IN Ga-68-PSMA-IMAGING

H. W. Nagel, N. Rupp, S. Bacanovic, J. Müller, I. A. Burger; Zurich/CH

**Learning objectives:** To show the most important pitfalls in Prostate specific membrane antigen (PSMA) -imaging to improve confidence and specificity of the interpretation for these studies.

**Background:** Since the introduction in April 2016 PSMA-targeted PET-imaging is in widespread clinical use in nuclear medicine departments all over Switzerland already. Therefore, it is critical to be aware of the tracer's imaging characteristics. Not only the physiological distribution of the tracer is important but also the accurate characterization of uptake beyond physiological accumulation to prevent false-positive findings. Since the wide spread use of PSMA PET for the detection of prostate cancer recurrence a lot of incidental non-prostatic PSMA-active findings have been published. In fact, almost every month a case report for a new interesting finding beyond prostate cancer that shows PSMA-activity is presented.

**Imaging findings or procedure details:** We summarized the most important and/or interesting pitfalls and grouped them into 4 categories: A) PSMA positive neovasculature (e.g. thyroid cancer), B) PSMA positive neuronal structures (e.g. sympathetic ganglions), C) PSMA positive granulomatous lesions (e.g. sarcoidosis) and D) PSMA positive bone lesions (e.g. Morbus Paget).

**Conclusion:** The known false-positive findings in PSMA-imaging are important for accurate read out of PSMA PET to prevent false positive findings. This is especially important since PSMA guided radiotherapy of small lesions often relies on imaging alone, without histopathological confirmation. Therefore, it is mandatory to be aware of the most common pitfalls.

#### P070

PO69

## Immunotherapy: Is there a role for F-18-FDG-PET/CT? A pictorial review

C. Pozzessere<sup>1</sup>, <u>L. Haefliger</u><sup>1</sup>, S. Figueiredo Antunes<sup>1</sup>, M. Nicod Lalonde<sup>2</sup>, J. Prior<sup>1</sup>, N. Schäfer<sup>1</sup>; <sup>1</sup>Lausanne/CH, <sup>2</sup>Yverdon-les-Bains/CH

**Learning objectives:** The present exhibit aims to illustrate various F-18-FDG-PET/CT patterns in patients undergoing immunotherapy

**Background**: Immune checkpoint inhibitors (ICIs) such as anti-CTLA-4 (ipilimumab), anti-PD-1 (nivolumab, pembrolizumab), or anti-PD-L1 (atezolizumab) are monoclonal antibodies that enhance the immune system against cancer by blocking the T-cells "immune-checkpoint". Their introduction has dramatically changed the landscape of advanced cancer, showing a relevant increase of the overall survival in some metastatic cancers such as melanoma and non-small-cell lung cancer.

Imaging plays a major role in assessing response to immunotherapy, however, due to the distinct mechanisms of action of ICIs, a correct evaluation is challenging. In fact, differently to conventional chemotherapy, atypical patterns such as pseudo-progression, durable tumor shrinkage, dissociated response and hyperprogressive disease are common. For this reason, specific ICIs response patterns have been recently included in the iRECIST criteria.

**Imaging findings or procedure details:** F-18-FDG-PET/CT is a useful tool in the assessment of patients under systemic treatment as it adds metabolic information to anatomic details. The different F-18-FDG-PET/CT patterns in patients undergoing immunotherapy will be showed in order to correctly evaluate the response and avoid an over-estimation of the disease. The possible role of F-18-FDG-PET/CT in the light of the recently published response criteria iRECIST will be discussed. Finally, imaging findings of specific immunotherapy-related adverse event (irAEs) will be presented.

**Conclusion:** F-18-FDG-PET/CT is useful in the assessment of patients undergoing immunotherapy, however more needs to be known about what functional component adds to morhologic imaging.

## High-dose MIBG-therapy in a 4-year-old girl with metastatic neuroblastoma

### <u>A. Péporté</u>, O. Maas, J. Greiner, J. Schiefer, F. Forrer; St. Gallen/CH

**Purpose:** A phase II study (VERITAS) for treatment of metastatic neuroblastoma will open soon. We preliminary describe dosimetry guided radionuclide therapy with 2 cycles of <sup>131</sup>I-MIBG in combination with topotecan in a 4-year-old girl with metastatic neuroblastoma according to the VERI-TAS-protocol.

**Methods and Materials:** We treated the patient with two cycles of high dose <sup>131</sup>I-MIBG with the intention to achieve a whole body absorbed dose of 4 Gy. The patient was first treated with 444 MBq/kg body weight (6600 MBq) <sup>131</sup>I-MIBG. As a result of the calculated absorbed dose during the first therapy cycle, the second administration was 2500 MBq.

**Results:** Therapy was well tolerated. The whole body absorbed dose was 2.9 Gy for the first and 0.9 Gy for the second therapy cycle, resulting in a total absorbed dose of 3.8 Gy. The duration of hospitalization was 8 and 5 days respectively. The absorbed dose of the parents who stayed with the child and who took over the nursing including handling of the urine was 2.4 mSv for the mother and 2.0 mSv for the father.

**Conclusion**: MIBG-Therapy according to the VERITAS-protocol is feasible with reasonable effort. The duration of the hospitalisation comfortable with the directive for radiation protection was reasonable.

In young children it is mandatory that parents or other close relatives take over the nursing. In our setting the absorbed dose for the parents was acceptable despite the close and constant contact with our young patient. Close collaboration with and support of medical oncologists specialised in

close collaboration with and support of medical oncologists specialised in children is necessary.

P072

## Measurement of residual activity in healthy and necrosed jaw bone, 5 weeks after 1st administration of Ra-223 dichloride

<u>G. Amzalag</u><sup>1</sup>, P. Froidevaux<sup>2</sup>, I. Dojcinovic<sup>2</sup>, M. Wissmeyer<sup>1</sup>, V. Orcurto<sup>1</sup>, S. Tual<sup>1</sup>, M. Straub<sup>2</sup>; <sup>1</sup>Neuchatel/CH, <sup>2</sup>Lausanne/CH

**Purpose:** Evaluation of Ra-223 residual activity in healthy and necrosed jaw bone of a stage IV castration resistant prostate cancer patient reported for osteonecrosis of the maxilla 6 months after chemotherapy, showing bone progression on bone scan and referred for Ra-223 therapy.

**Methods and Materials:** Indication for Maxillary surgery was scheduled after the first administration of Ra-223 (55Bq/Kg), inciting us to delay the second administration to 5 weeks and plan surgery accordingly. Surgeons retrieved 2 bone samples of 9g and 250mg respectively in the necrosed and healthy neighbor maxillary region. The samples were sent to IRA (Lausanne), and treated according to Froidevaux et al. (2015). After dissolution, radium was traced with Ra-226 and co-precipitated with BaSO4. After dissolution with EDTA and separation of radium from the other alkaline-earth cations with DCTA on a cationic exchange resin (Bio-Rad AG 50w, 8 ml), the radium fraction was electrodeposited on an Ag<sup>o</sup> disk and the alpha radiations counted on PIPS detector in an Alpha Analyst spectrometer (Canberra). Optical Emission Spectroscopy was performed on an aliquot of the samples to evaluate the amount of calcium (results in Bq/g Ca).

**Results:** Residual Ra-223 bone activity was approximately 5 times higher in healthy bone (56.3±9.9 Bq/g Ca) than necrosed bone (10.9±2 Bq/g Ca).

**Conclusion:** Detection limit of the method is approximately 0.5 mBq/g Ca, therefore adapted to measure Ra-223 residual activity even at later times or with smaller bone samples. Residual activity although easily detectable with alpha spectrometry, is minor after 5 weeks and does not expose surgical teams to significant radiation.

## Evaluation of liability of new quality control kits for radiopharmaceutical quality control

## <u>A.-S. Verrey</u>, L. Soutter, M. Straub; Lausanne/CH

**Purpose**: Reliable and fast determination of radiochemical impurities in radiopharmaceuticals is indispensable for product release. Quality control methods of most kit radiopharmaceuticals are based on thin layer or paper chromatography. Companies registering a product on the market submit a validated method for radiochemical purity testing, approved by the competent authority. Unfortunately, sometimes methods are time consuming and complex to perform. Efforts to overcome this were made by the companies Biodex and CellTech. They developed systems promising easy and fast applicable controls. The system from CellTech is based on a fully furnished kit with chromatography paper, tanks and pre-prepared solvents ready to use. Biodex suggests only chromatogram papers, the hardware (tanks and solvents) are to be purchased and prepared separately. Both companies promise fast migration due to paper specifications shorter and less wide than in the official methods.

**Methods and Materials:** In collaboration with the FOPH in Switzerland, we performed a study to investigate the liability of these systems and we tested them for different 99mTc-radiopharmaceuticals. Results were compared to radiochemical purities obtained by the official methods.

**Results:** Several concerns have been observed. Peaks are not always sufficiently resolved to identify the radiochemical purity correctly (risk of under or overestimation of radiochemical purity). The solvents proposed seem questionable, impurities were detected by gas chromatography measurements, and volumes suggested for the quality control sample may lead to interaction with the solvent base and dilution of the sample in the solvent. **Conclusion:** We conclude that the official methods remain the reference methods for the quality control of these radiopharmaceuticals.

#### P074

#### Radiochemical impurities in Lu-177 therapeutics

M. Straub, C. Pilloud, A.-S. Verrey, M. Leresche; Lausanne/CH

**Purpose:** In Switzerland, Lu-177 for therapeutic applications can be obtained on a special authorization. The patients are hospitalized in rooms responding to radiation safety requirements and the wastewater from these rooms must be collected in tank systems. Its disposal is under obligation of an authorization and the maximum activity to be released is defined by the competent authority.

**Methods and Materials:** In collaboration with the FOPH in Switzerland, we performed a study to identify potential radionuclide impurities in the Lu-177 preparations. Measurements were done employing gamma spectrometry by HPGe and the total activity of impurities found was reported in LE (limit of exemption) per GBq of the product. In the specifications of the radiopharmaceutical, the presence of Lu-177m £ 0.1% is mentioned, a radionuclide with a half life of 160.9 days. We measured five different batches of Lu-177 to identify the potentially occurring radionuclide impurities.

**Results:** We confirmed the presence of the single impurity of Lu-177m. The activity measured meets the specifications as mentioned by the company and is below the  $\pm$  0.1% of the total activity. We found around 16 LE of Lu-177m per 1 GBq of Lu-177 (1 LE of Lu-177m corresponds to 600 Bq).

**Conclusion:** As the product is used for therapeutic applications and several GBq are applied at each administration, the quantity of Lu-177m needs to be taken into account for elimination of the wastewaters. Before implementing this therapeutic application in routine use, special attention should therefore be given to evaluate the needs of the hospitals wastewater management.

## New registred kit Netspot: Optimization of labelling and control

<u>J. Delage</u>, J. Caputo, O. Fabre, M. Da Mota, C. Julien, J. de Figueiredo, J. Prior, F. Sadeghipour; Lausanne/CH

**Purpose:** Netspot is used in our radiopharmacy for the PET diagnosis of neuroendocrine tumors and the frequency of this exam increase a lot.

Our aim was to optimize the labelling process and the control of this kit in order to give the nuclear medicine unit a product with good quality, good volumic activity and to optimize the operator's radioprotection.

**Methods and Materials:** For the production, three processes were tested: manual labelling, automatized labelling with simple elution and automatized labelling with fractionated elution.

For the control two methods were compared (56 controls): ITLC-SA, Ammonium Acetate1M/Methanol (1:1 V/V), 10cm developing (method proposed in the Summary of Product Characteristics) and our method ITLC-SG, Ammonium Acetate1M/Methanol (1:1 V/V), 7cm developing.

We also compared quality controls made after cooling the kit down at room temperature from approximately 10 minutes and just after the heating of the kit.

**Results:** For the production the radioprotection was increased with the automatization of the method and a fractionated elution was preferred (less volumic activity lost in the cartridge and the filter).

For the quality control the two methods gave the same results (average deviation of 0.55%). The same results were also observed with and without cooling down the kit.

The SPC method and our method take respectively 40 minutes and 10 minutes.

**Conclusion:** The Netspot labelling and control optimization were very useful in terms of radioprotection and the time gain for this short time isotope allows to have adequate activity for the patient injection.

P076

## External radiation exposures and contamination measurements in 177Lu-DOTATOC therapy

<u>I. Reichmann</u><sup>1</sup>, D. Wild<sup>1</sup>, R. Menz<sup>1</sup>, L. McDougall<sup>1</sup>, R. Linder<sup>2</sup>, N. Stritt<sup>2</sup>, T. Flury<sup>2</sup>; <sup>1</sup>Basel/CH, <sup>2</sup>Bern/CH

**Learning objectives:** To estimate the patient radiation exposure and the therapy related contamination in patients with neuroendocrine tumours treated with <sup>177</sup>Lu-DOTATOC.

**Background:** Radiation safety is an important aspect of the <sup>177</sup>Lu-DOTA-TOC therapy in patients with neuroendocrine tumours. The purpose of this study is to give an estimation of the external radiation exposure and the environment contamination to protect patients, staff members, family and the public.

**Imaging findings or procedure details:** In cooperation with the BAG we conducted several radiation surveillance measurements in 24 patients treated with <sup>177</sup>Lu-DOTATOC (4.1-7.1 GBq) in the Nuclear Medicine Clinic of Basel University Hospital. Exposure rates ( $\mu$ S/h) at 1 m were determined at the level of thorax immediately, and at 4, 17, 20, 27 and 42 hours after application of the radiopharmaceutical. Contamination measurements of the patient environment including the room furniture, toilet, bed linen and personal belongings were performed after 48h.

**Conclusion:** Our findings demonstrate that patients receiving a <sup>177</sup>Lu-DOTA-TOC treatment can be safely discharged after 48 h, with a measured dose rate below 5µSv/h, which is in line with the current guidelines. Only three patients had a value above 5µSv/h (7,7µSv/h, 6,6 µSv/h and 5,3 µSv/h) 48 h after injection of 7.1 GBq 177Lu-DOTATOC. However patient basic personal hygiene is important to avoid contamination of the furniture, toilet, bed line and personal belonging. In our experience with detailed patient information relevant contamination can be avoided.

## Benign Mediastinal Findings on 18F-FDG PET/CT Imaging

M. D. Sugi, B. Nguyen; Scottsdale/US

**Learning objectives:** Illustrate commonly encountered benign entities with increased 18F-FDG radiotracer uptake on PET/CT. Recognize the specific imaging features of these entities on non-contrast CT that help to distinguish benign from malignant etiologies. Identify key associated imaging findings that may lead to an accurate diagnosis while limiting further unnecessary evaluation.

**Background:** A number of normal and benign entities in the mediastinum may demonstrate increased 18F-fluorodeoxyglucose (18F-FDG) uptake on PET/CT imaging. These include not only normal anatomic variants and benign lesions, but also iatrogenic conditions related to surgery, radiation and implanted devices. Recognizing the unique non-contrast CT imaging features as well as the key characteristics on PET can help to differentiate these entities on routine PET/CT imaging.

**Imaging findings or procedure details:** Conditions and entities that may be covered include:

Cardiac

- Postradiation cardiac change.
- Atrial clip.
- Cardiac bland thrombus.
- Pericardial perforation by pacemaker lead.
- Cardiac valve prostheses.
- Interatrial septal lipoma.
- Thoracic
- Superior vena cava hemangioma.
- Hilar IgG4 autoimmune sclerosis
- Mediastinoscopic tract
- Talc pleurodesis
- Esophageal leiomyoma.

**Conclusion:** Distinguishing benign and malignant etiologies of hypermetabolic entities in the mediastinum is important for clinical care. Recognizing key imaging features on non-contrast enhanced CT, in combination with clinical history, can help to distinguish many of these entities, limiting unnecessary further evaluation for indeterminate findings.

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P078
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## Glucagon-like peptide-1 (GLP-1) receptor imaging in patients with post gastric bypass hypoglycemia

<u>P. Wiesner</u>, K. Antwi, C. Cavelti-Weder, M. Hepprich, M. Fani, M. Donath, D. Wild; Basel/CH

**Purpose:** Months to years after Roux-en-Y gastric bypass surgery, post gastric bypass hypoglycemia (PGBH) can occur after food intake. The incretin hormone GLP-1 may play a role in the development of PGBH. <sup>68</sup>Ga-DOTA-exendin-4 is a specific tracer for GLP-1 receptors in PET/CT. The aim of this study is to investigate the GLP-1 receptor expression of the pancreas in vivo in patients with PGBH.

**Methods and Materials:** <sup>68</sup>Ga-DOTA-exendin-4-PET/CT was performed in 5 patients with PGBH. The sum of the SUV of the voxels of the pancreas was measured and compared to a control group consisting of 5 insulinoma patients. Only the tumour-free pancreatic tissue was measured in the control group.

**Results:** The SUV sum of the pancreas in the PGBH group was 4631 (range 2207-7419) and in the control group 2004 (range 1287 – 2802). The expression of GLP-1 receptors in the pancreas in patients with PGBH is significantly higher than in the normal pancreatic tissue of patients with insulinoma, as shown by the two-sample, two-sided t-test (p-value 0.03).

**Conclusion:** There are three possible explanations, why the pancreas in the PGBH group shows significantly more GLP-1 receptors than the normal pancreatic tissue of patients with insulinoma: I) increase of the  $\beta$ -cell mass in patients with PGBH, II) downregulation of  $\beta$ -cell mass in the normal pancreas in patients with insulinoma and III) a combination of both. Recruiting of normoglycemic post bariatric subjects is currently in progress at our institution to further evaluate a possible upregulation of the  $\beta$ -cell mass in patients with PGBH.

#### P079

## Paternal cold exposure induces brown adipose tissue functionality and metabolism in offspring

<u>C. Zellweger</u>, A. S. Becker, S. Bacanovic, W. Sun, C. Wolfrum, I. A. Burger; Zurich/CH

**Purpose:** To investigate whether cold exposure in the parent generation could lead to more brown adipose tissue (BAT) activation in the offspring generation.

**Methods and Materials:** In this retrospective study, FDG PET/CT scans of 8440 patients examined August 2005 – 2016 at the university hospital of Zurich were included. For all patients, BAT activity was rated as either negative or positive with an intensity score from 1-3. Body weight and size was extracted from the PET data and BMI was calculated. BAT activity and BMI were compared between patients conceived (birthdate minus 9 months) in the cold months (October-February) and warm months (April-September).

**Results:** We found that patients with active BAT were 3.2% more likely (p<0.001) to be conceived in the cold period (average temp. 2°C) while patients without active BAT were more likely conceived in the warmer period (average temp. 13°C). Furthermore, among patients conceived in the cold period of the year (n=3793), BAT positive patients had a significantly lower BMI (mean 20.9 vs. 22.8; p<0.001) compared to age- and gender matched controls without active BAT.

**Conclusion:** Cold exposure of humans prior to conception might increase BAT activity in their offspring up to adulthood.

## Radioprotection opérationnelle pour la réalisation des scintigraphies myocardiques aux Hôpitaux Universitaires de Genève

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**Purpose:** Optimiser la radioprotection des patients et du personnel soignant lors de la réalisation des scintigraphies myocardiques au MIBI-TC<sup>99m</sup> aux Hôpitaux Universitaires de Genève (HUG).

**Methods and Materials:** Simuler et valider les débits de doses ambiants auxquels sont exposés les Technicien-e-s en Radiologie Médicale (TRM), médecins et patients lors de la réalisation de scintigraphies myocardiques au MIBI-Tc<sup>99m</sup> selon 3 situations rencontrées en routine clinique aux HUG : Standard (3 patients/jour/TRM) Forte affluence (6 patients/jour/TRM) TRM au contact rapproché d'un patient (patient à mobilité réduite, difficile, etc.). Les simulations ont été réalisées à l'aide du logiciel RayXpert : Modélisation des locaux, du matériel utilisés et d'un patient (fantôme simulant la distribution du MIBI-Tc<sup>99m</sup> selon les organes). Simulation des différents débits de doses ambiants pour les activités injectées à l'effort (250 MBq) et au repos (750 MBq).

Les validations des différentes simulations ont été effectuées par la mesure du débit de dose effectif à l'aide d'un compteur Geiger Müller.

| <b>Results:</b><br>Situations               | Salle d'effort<br>(µSv/jour)  | Salle d'imagerie<br>(µSv/jour) | Salle d'attente<br>(µSv/h) |
|---|-------------------------------|--------------------------------|----------------------------|
| Standard                                    | 0,83                          | 4,2                            | <17                        |
| Forte affluence                             | 1,66                          | 8,4                            | >34                        |
| TRM au contact<br>rapproché d'un<br>patient | 1.14                          | 8,4                            | <17                        |
| Recommanda-<br>tion ORAP                    | < 55 (µSv/jour)<br>(20mSv/an) |                                | <25                        |

**Conclusion:** Les différentes simulations ne mettent pas en évidence de problèmes particuliers de radioprotection lors de la réalisation des scintigraphies myocardiques au MIBI-TC<sup>99m</sup> aux HUG. En outre, en cas de forte affluence en salle d'attente après les activités injectées au repos, il est préférable d'éviter d'avoir plusieurs patients en même temps.

## Evaluation of Myocardial Perfusion Imaging protocol: A multidisciplinary optimisation study

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**Purpose:** Myocardial Perfusion Imaging (MPI) allows for non-invasive evaluation of coronary artery disease by detecting flow-limiting disease and providing risk stratification. It is one of the most ordered nuclear medicine (NM) exam. The used protocol parameters should be evaluated in order to optimise the information retrieved from the image and reduce the introduction of image artefacts. The aim of this work was to evaluate current MPI protocol at Kantonsspital Olten in respect to both acquisition and reconstruction parameters.

**Methods and Materials:** For this study a PTW NEMA phantom was used with a dedicated cardiac insert to mimic structures present in the MPI study. The phantom was acquired for different acquisition (time) and reconstruction parameters (filters and iteration/ subsets). Evaluation was performed qualitatively by an experience physician and by measurement of uptake and resolution of different myocardial wall thickness.

**Results:** The current clinical protocol performed very well in respect to these tested scenarios. It obtained high signal recovery and one of the lowest (38mm) resolution for the larger myocardial wall (25mm). The only few acquisitions that improved the results obtained by the clinical parameters were found by reducing current Gaussian filter applied during the post processing to match current pixels size used (6.28mm).

**Conclusion:** In terms of optimisation strategy for MPI studies the work done covered different aspect that influence the final image quality. The results showed that current clinical protocol is already optimised for most parameters evaluated (acquisition time, reconstruction number of iteration and subsets) with just a fine tune on the post-processing filter applied.

### PET 18F amyloid : Comparaison des algorithmes de reconstruction itératif et temps de vol dans la quantification des dépôts de plaques amyloïdes dans le cerveau

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**Purpose:** PET <sup>18</sup>F amyloid : Comparer et déterminer quel algorithme de reconstruction utiliser entre itératif (IT) et temps de vol (TOF) pour la quantification des dépôts de plaques amyloïdes dans le diagnostic précoce de la maladie d'Alzheimer (MA).

**Methods and Materials:** Comparer la moyenne des SUV obtenue en IT et en TOF des six régions cérébrales clés caractéristiques chez les patients atteints de MA (Average) et les mettre en cohérence avec l'interprétation visuelle (rapport médical). 100 patients investigués pour des troubles cognitifs ont réalisé un <sup>18</sup>F amyloid PET (64 examens positifs, 36 négatifs). Logiciel de quantification *syngo*.PET Amyloid Plaque Siemens : Normalisation des valeurs SUV des six régions cérébrales clés (Average) par l'activité du cervelet (Ratio Average = Average<sub>suv</sub> / Cerellum<sub>suv</sub>). Comparaison des Ratios Average IT et TOF et détermination des valeurs seuils afin d'obtenir la meilleure cohérence avec l'interprétation visuel (Ratio valeur seuil IT et TOF calculées à partir des courbes ROC).

| Results:<br>N = 100                   | IT     | TOF    | Coefficient<br>Corrélation<br>IT / TOF | Bland &<br>Altman<br>IT / TOF |
|---------------------------------------|--------|--------|--|-------------------------------|
| Ratio<br>Average                      | 1.20   | 1.14   | 0.993                                  | 0.05 + 0.04                   |
| Ratio<br>valeur seuil<br>(ROC CURVES) | >1.085 | >1.040 |  |                               |
| <b>Spécificité</b><br>VN / (VN+FP)    | 100%   | 89.1%  |  |                               |
| <b>Sensibilité</b><br>VP / (VP+FN)    | 97.2%  | 87.5%  |  |                               |

**Conclusion:** Le coefficient de corrélation entre les 2 algorithmes de reconstruction est excellent. En outre, pour la quantification des dépôts de plaques amyloïdes dans le diagnostic précoce de la maladie d'Alzheimer, les valeurs obtenues à partir des reconstructions itératives (IT) offrent une sensibilité et une spécificité légèrement supérieures aux reconstructions temps de vol (TOF).

## La séquence Twist-vibe en imagerie hépathique

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**Purpose:** En imagerie hépatique, le défi des Techniciens en Radiologie Médicale consiste à visualiser précisément le temps artériel après l'injection d'un produit de contraste. Chaque patient ayant son temps artériel propre, il est devenu nécessaire d'obtenir une séquence plus rigoureuse. En outre il ne faut pas manquer une information artérielle capitale non visualisée sur les images, cela risquerait de donner un diagnostic incorrect. Une nouvelle séquence multiphasique a fait récemment son apparition chez Siemens : la Twist-Vibe. Cette séquence est constituée d'un Vibe, d'une imagerie 3D, d'un mode Dixon et d'un facteur d'accélération CAIPIRINHA. Contrairement à la séquence Vibe utilisée en IRM, l'intérêt de la Twist-vibe consiste à acquérir plusieurs phases artérielles en une seule acquisition par séquence.

**Methods and Materials:** Nous comparons le principe de la séquence Twist-Vibe avec la séquence Vibe standard. Nous mettons en évidence les avantages et les limites de cette séquence en imagerie hépatique à travers une étude de cas.

**Results:** Le choix d'imager trois phases artérielles au CHUV, permet d'obtenir parmi ces dernières, une véritable phase artérielle. Dans le foie, la détection des prises de contrastes suspectes précoces peuvent être observées contrairement à l'utilisation d'une simple séquence Vibe post injection de contraste où ces lésions n'auraient pas été détectées.

**Conclusion:** Grâce à l'utilisation de la séquence multiphasique Twist-Vibe, le diagnostic réalisé est facilité pour le radiologue car elle permet de mettre en évidence, certaines lésions prenant le contraste plus précocement et la mise en place d'un éventuel traitement pour le patient.
## Impact of introduction of 68Ga-Dotatate in clinical practice: Comparison with Octreoscan™

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**Purpose:** The high affinity of DOTATATE for SSTR2, the possibility of using a <sup>68</sup>Ge/<sup>68</sup>Ga generator and the existence of a "cold kit" for the preparation of <sup>68</sup>Ga-DOTATATE (*Netspot*<sup>™</sup>) makes this molecule very appealing for imaging NET and other SSTR2 expressing pathologies. We made a comparison of our procedures using <sup>111</sup>In-pentetreotide (*Octreoscan*<sup>™</sup>) as the "former" available imaging agent versus <sup>68</sup>Ga-DOTATATE in terms of difference in handling, availability and clinical use.

**Methods and Materials:** We recorded the number of patients imaged with *Netspot*<sup>TM</sup> in 2017 after its introduction in 2016 and compared to the number of examinations with *Octreoscan*<sup>TM</sup> before and after this period. We also listed how many times we were unable to perform the scans due to preparation problems.

**Results:** In 2017, we performed 83  $Netspot^{TM}$  examinations and 18  $Octreoscan^{TM}$  for the same time period. Before  $Netspot^{TM}$  introduction, the medium number of  $Octreoscan^{TM}$  examinations was 60/year. The number of examinations that were re-scheduled, due to  $Netspot^{TM}$  preparation non-conformities, was seven (8.4%).

**Conclusion:** We noticed that after Netspot<sup>TM</sup> introduction the demand for *Octreoscan*<sup>TM</sup> heavily decreased, but the number of the two combined examinations increased by about 70%, confirming a real utility in clinical routine. The number of *Netspot*<sup>TM</sup> radiolabelling non-conformities is still high, but this number should decrease with accumulated labelling operator's experience.

## Moins d'anesthésies en radiopédiatrie grâce à un simulateur d'IRM ludique

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**Purpose**: Notre étude évalue la performance d'un simulateur d'IRM sous forme de jeu pour préparer des enfants à l'IRM au lieu de subir une anesthésie.

**Methods and Materials:** Nous avons fait passer une IRM en jeu à 282 enfants âgés entre 3 et 13 ans sur une période de 4 ans. Avec ce simulateur, l'enfant est soumis aux inconvénients de l'IRM comme le bruit, l'immobilité et l'espace réduit. Allongé, il entend les bruits produits par l 'IRM. Une caméra filme l'enfant qui voit ensuite son enregistrement et juge de sa capacité à rester tranquille. Les parents sont présents pendant le test. Ensuite il est dirigé vers la vraie machine pour subir son examen.

**Results:** Sur les 282 enfants, le taux de réussite approche les 90%. Le personnel qui fait passer le test doit être à l'aise avec les enfants, avoir un bon contact et un langage approprié à leur âge. L'attitude des parents peut aussi influencer le comportement des enfants. Le passage par le simulateur prend environ 20 min et se fait immédiatement avant l'IRM ce qui augmente la réussite.

**Conclusion:** En fonction de l'âge, il est important à la prise de rendez-vous de discuter avec les parents le bénéfice d'une IRM jeu pour l'aider à rester tranquille pendant son IRM et éviter une anesthésie. Notre expérience avec ce simulateur a permis de réduire les anesthésies. Le flux de patients à l'IRM s'en trouve amélioré, l'équipe IRM gagne du temps et l'enfant ne subit pas les effets des drogues.

## : TeamSTEPPS : stratégies et outils pour améliorer la performance d'équipe et la sécurité des patients

J. Flury<sup>1</sup>, <u>D. Prudent<sup>2</sup></u>; <sup>1</sup>Cully/CH, <sup>2</sup>Monthey/CH

**Learning objectives:** Résumé d'où viennent les stratégies et outils Team-STEPPS. Descriptions des principes clés, des outils et des stratégies Team-STEPPS qui ont pour but d'améliorer la performance d'équipe et la sécurité des patients. De plus, mise en avant d'exemples purement radiologiques. **Conclusion:** Le but de se poster est de titiller la curiosité des participants au congrès sur cette nouvelle tendance qu'est TeamSTEPPS.

En effet, TeamSTEPPS est en train de se développer dans la radiologie. D'une part chez les étudiants, mais aussi dans divers services. Pour exemple, le service d'Imagerie Médicale de l'Hôpital Riviera Chablais est en train de former tous ces collaborateurs (TRM, radiologues, secrétaires).

## Etude de la statique avec EOS

D. Ratheau, J. Granger; Meyrin/CH

Learning objectives: Equipement d'un plateu technique d'imagerie médicale.

Technique qui étudie la statique de la colonne vertébrale et des membres inférieurs dans leur totalité.

Imagerie reproductible, de part une acquisitipn 3D, une dose réduite, et un temps d'examen très cours.

Des techniques de calculs éprouvées grâce à des logiciels de post-traitement, qui permettent des diagnostics précis afin de proposer des tratements conservateurs ou chirurgicaux.

Possibilité de calculs 3D, et de reconstructions pour la conception de prothèses personnalisées.

**Background:** Etude de la statique, avec une bonne réduction de dose, un temps d'acquistion très court et des possibilités diagnistiques optimisées. **Imaging findings or procedure details:** 

**Conclusion:** Etude de la statique, avec une bonne réduction de dose, un temps d'acquistion très court et des possibilités diagnistiques optimisées.