Abdominal and Body Imaging

**Improved Image Quality of Virtual Non-Contrast Spectral CT in Comparison to Conventional Non-Contrast CT**

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**Purpose:** Virtual non-contrast images derived by Dual Energy CT (DECT) may potentially obviate the need for true non-contrast images. We evaluated the reliability and conspicuity of the abdominal organs on virtual non-contrast (VNC) images derived from single-source spectral DECT compared with true non-contrast (TNC) images.

**Materials and Methods:** Thirty patients who underwent triple-phase abdominal DECT (IQon, Philips Healthcare, Eindhoven, The Netherlands) between January and April 2017 were retrospectively reviewed. TNC images were performed using conventional single-energy mode at 120 keV. VNC images were reconstructed from the venous phase images of the conventional study. Hounsfield unit (HU) values of liver, spleen, right kidney upper pole and aorta were compared between TNC and VNC images. Qualitative assessments of the liver parenchyma, as well as the spleen, pancreas and the osseous of the celiac trunk were performed on the TNC and VNC images, and rated on a scale of 1-5 (5 being the highest). Paired t-test was used to assess the significance of the differences between the TNC and VNC images.

**Results:** The mean difference in HU values on VNC and TNC images was 1.8 HU. The difference ranged in various organs from -2.2HU to 3.8HU, and was not statistically significant in most organs. The mean score of the qualitative assessment based on VNC images was 4.45 compared to 3.53 on TNC images. This score was significantly higher (p<0.001) on the VNC images, in all anatomical locations.

**Conclusion:** Similar attenuation values were found between VNC and TNC. There is a significantly higher conspicuity of findings in the VNC images in all evaluated locations. This suggests that VNC images may replace TNC images, thus decreasing the radiation exposure to the patient and shortening the scan duration.
Abdominal and Body Imaging

The Normal Characteristics of the Prostate on Magnetic Resonance Imaging (MRI)

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Purpose: To identify the MRI characteristics of the prostate in a healthy population without clinically suspected prostatic carcinoma, that can be used as reference tool when screening for prostate cancer in specific high risk populations.

Material & Methods: Ninety eight asymptomatic BRCA carriers screened for prostate cancer, with normal PSA levels underwent multiparametric MRI on a 3 Tesla machine. Lesions suspicious for carcinoma were biopsied and patients with proven cancer were excluded. The MRI studies were evaluated by two readers with 10 (reader 1) and 2 (reader 2) years of experience in abdominal imaging for overall dimensions, peripheral zone (PZ) thickness and signal, central zone (CZ) distinction from adjacent tissue, transition zone (TZ) texture and dominant nodules, seminal vesicles (SV) distention, signal and symmetry, conspicuity of capsule and the PZ/TZ border, and neurovascular bundle (NVB) delineation. A third radiologist used dedicated software to measure PZ and TZ volumes and ADC values of PZ and TZ.

Results: Pulled average results for both readers showed homogenous or patchy T2 hypointensity in 70.2%, as opposed to previously reported homogenous T2 hyperintensity. Agreement was higher for the PZ pattern (78%) than the TZ texture (58%) This was partially due to a high proportion of examinations showing with tiny nodules described as nodular by reader 2 and heterogeneous by reader 1, and likely representing the normal sequelae of nodular hypertrophy. The central zone could be fully or partially distinguished from adjacent parenchyma in 64% of cases. The capsule was well defined in 89.5% of cases with good agreement (85%). There was poor agreement between readers regarding conspicuity of TZ/PZ border and NVB (62% and 48% respectively). Agreement on SV distention, T1 signal and symmetry was 78%, 92% and 86% respectively.

Results of objective measurements are shown in Table 1 and Figure 1. Subjective evaluations shown in Table 2.

Conclusion: In this cohort of healthy individuals, diffuse or patchy low T2 signal was a common finding in the PZ as opposed to sparse previously published data. Inter-reader variability was higher when classifying TZ texture and its border with the PZ, as compared to PZ signal classification, likely due to the development of a nodular pattern with time. We hope that additional data such as this will help as a reference tool when screening for prostate cancer in specific high-risk populations.
Volumes calculated from measured dimensions vs direct volume measurement by software

Table 1 – Size, volume, ADC – Average measurements

|                        | Reader 1 | Reader 2 | Software  
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Craniocaudal (mm)</td>
<td>43.7</td>
<td>39.3</td>
<td></td>
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<tr>
<td>Anteroposterior (mm)</td>
<td>34.6</td>
<td>30.4</td>
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<tr>
<td>Mediolateral (mm)</td>
<td>46.4</td>
<td>43.4</td>
<td></td>
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<tr>
<td>Calculated volume (cc)</td>
<td>38.4</td>
<td>30.2</td>
<td>31.2</td>
</tr>
<tr>
<td>PZ thickness – right (mm)</td>
<td>11.3</td>
<td>11.5</td>
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<tr>
<td>PZ thickness – left (mm)</td>
<td>10.9</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td>Right PZ ADC *10^{-3} mm²/sec</td>
<td></td>
<td></td>
<td>1.5 (SD 0.2)</td>
</tr>
<tr>
<td>Left PZ ADC *10^{-3} mm²/sec</td>
<td></td>
<td></td>
<td>1.4 (SD 0.2)</td>
</tr>
<tr>
<td>TZ ADC *10^{-3} mm²/sec</td>
<td></td>
<td></td>
<td>1.1 (SD 0.2)</td>
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<tr>
<td></td>
<td>Reader 1 (%)</td>
<td>Reader 2 (%)</td>
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<tr>
<td><strong>PZ signal intensity on</strong></td>
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<tr>
<td>T2</td>
<td></td>
<td></td>
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<tr>
<td>Homogenously hyperintense</td>
<td>15.2</td>
<td>14.7</td>
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<tr>
<td>Patchy hypointensity</td>
<td>53.3</td>
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<td>Wedge shaped hypointensities</td>
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<tr>
<td>Diffuse hypointensity</td>
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<tr>
<td><strong>Distinguished CZ from adjacent prostate</strong></td>
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<td></td>
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<tr>
<td>None</td>
<td>40.4</td>
<td>31.6</td>
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</tr>
<tr>
<td>Base only</td>
<td>29.8</td>
<td>65.3</td>
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<tr>
<td>Base to veromontanum</td>
<td>29.8</td>
<td>3.2</td>
<td></td>
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<tr>
<td><strong>TZ texture</strong></td>
<td></td>
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<tr>
<td>Homogeneous</td>
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<td>Nodular</td>
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<tr>
<td><strong>Dominant nodule in TZ</strong></td>
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<td></td>
</tr>
<tr>
<td>Dominant nodule present?</td>
<td>2.2</td>
<td>4.4</td>
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<td><strong>SV distention</strong></td>
<td></td>
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</tr>
<tr>
<td>Well distended</td>
<td>63.9</td>
<td>75.3</td>
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<tr>
<td>Collapsed</td>
<td>36.1</td>
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<tr>
<td><strong>SV signal on T1</strong></td>
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<tr>
<td>T1 homogeneously high</td>
<td>96.8</td>
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<td>T1 focal hyperintensities</td>
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<td><strong>SV symmetry</strong></td>
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<tr>
<td>Symmetrical glands</td>
<td>94.6</td>
<td>93.7</td>
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<tr>
<td>Asymmetrical glands</td>
<td>5.4</td>
<td>6.3</td>
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<td><strong>TZ/PZ border</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Well defined</td>
<td>52.1</td>
<td>32.6</td>
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<tr>
<td>Ill defined</td>
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<td>67.4</td>
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<tr>
<td><strong>Capsule</strong></td>
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<tr>
<td>Fully delineation</td>
<td>89.6</td>
<td>89.5</td>
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<tr>
<td>Partial delineation</td>
<td>10.4</td>
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<td><strong>NV Bundle</strong></td>
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<td>Individual elements not identified</td>
<td>37.0</td>
<td>39.8</td>
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<tr>
<td>Well delineated individual elements</td>
<td>15.2</td>
<td>16.1</td>
<td></td>
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<tr>
<td>Ill-defined individual elements</td>
<td>47.8</td>
<td>54.8</td>
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<tr>
<td><strong>Urethra</strong></td>
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<tr>
<td>Easily identified</td>
<td>75.0</td>
<td>75.2</td>
<td></td>
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<tr>
<td>Not well seen</td>
<td>25.0</td>
<td>24.8</td>
<td></td>
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</table>
Pancreatic Atrophy, Diagnosed by CT is an Immune Related Adverse Event of Checkpoint Inhibitors Immunotherapy

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²Ella Institute for Melanoma, Sheba Medical Center, Israel
³Department of Diagnostic Imaging, Sheba Medical Center, Israel

**Purpose:** Immunotherapy, recently approved for melanoma treatment, is associated with unique immunological adverse events. Pancreatitis is a known clinical adverse event, however, less documented radiologically. The purpose of the study was to assess the imaging findings of the pancreas in patients receiving immunotherapy and correlate them with clinical abnormalities.

**Material & Methods:** CT scans of consecutive melanoma patients, pre- and post- immunotherapy initiation in the years 2013-2016, were retrospectively evaluated for pancreatic changes. In the patients with pathological findings, clinical data was retrieved. IRB approval was obtained.

**Results:** 14/158 patients exhibited pancreatic radiologic changes, including pancreatic atrophy and peri-pancreatic fat stranding. A salient finding in 12 of these patients was a regressive diffuse atrophy of the pancreas, which, in two patients, was associated with prolonged diarrhea and steatorrhea, resolved with pancreatic enzyme replacement therapy, and was consistent with exocrine failure.

**Conclusion:** Pancreatic changes, particularly atrophy, previously not described on CT, are under-recognized adverse events of immunotherapy.
Abdominal Imaging

Is the Nephrographic Phase of CTU Reliable for the Detection of Renal Calculi?

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2Department of Internal Medicine, Hadassah Hebrew University Medical Center, Israel

Purpose: To retrospectively determine whether the nephrographic phase of CTU is reliable for the detection of renal calculi.

Patients and methods: IRB approved this study and informed consent was waived. Two radiologists retrospectively reviewed CTU examinations of 359 patients referred for evaluation of painless hematuria between 2015-2016. All examinations included unenhanced, nephrographic and delayed excretory phases. The examinations were reviewed using both soft tissue and angiographic windows. The nephrographic phase images were reviewed first followed by the “gold standard” unenhanced phase images. Number, size and location of stones were documented as well as the phases and CT window in which these stones could be seen. In case of discrepancy between the two readers, consensus was made with discussion. Sensitivity and specificity for renal stone disease was calculated on a per-kidney basis.

Results: Eighty-five stones were found in 50 patients on the unenhanced phase images. There were 33 males and 17 women (median age 60.3 years, IQR 52-70). Stone size ranged from 1.5 mm to 16 mm (mean 4.15mm). Among the patients who had renal calculi the mean number of stones per patient was 1.7 (SD 1.1). In the nephrographic phase, 80% and 82% of the calculi were identified in the soft tissue window respectively, and the angiographic window respectively. Sensitivity, specificity, PPV and NPV were 82.9%, 98.7%, 87.1% and 98.3% for the soft tissue window and 86.9%, 100%, 100% and 98.8% for the angiographic window respectively. All stones larger than 5 mm were detected.

Conclusion: The nephrographic phase of CTU is reliable for the detection of renal calculi. To reduce exposure to radiation in these patients, eliminating the unenhanced phase should be considered.
Abdominal and Body Imaging

Hyperpolarized $^{13}$C$_1$ Pyruvate Metabolism in Precision-Cut Mouse Liver Slices

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Radiology, Hadassah-Hebrew University Medical Center, Israel

Purpose: $^{13}$C$_1$ Pyruvate metabolites in a hyperpolarized state have been visualized in whole rodent liver in vivo and ex vivo. However, this approach does not permit the necessary radiology-histopathology needed to adequately evaluate the technique as a marker of the relevant biologic process. Precision cut liver slices have the potential to breach this obstacle. We aimed to validate the use of precision cut liver slices for hyperpolarized metabolic investigation in a mouse model. Following validation of the slices viability by $^{31}$P NMR spectroscopy and detection of ATP signals, hyperpolarized $^{13}$C$_1$ pyruvate was administered to the slices and its metabolism was followed.

Materials and Methods: Fresh normal livers were harvested from five mice. The livers were sliced with a microtome-tissue slicer to 500 μm thickness slices and placed in an ice-cold recovery medium. The slices were then placed in an NMR spectrometer (5.8 T, RS2D, France) and perfused continuously with oxygenated growth media at 37 °C. $^{31}$P spectra were acquired to evaluate the presence of ATP. After ATP production was observed, hyperpolarized $^{13}$C$_1$pyruvate was flushed into the NMR tube in the spectrometer, into the liver. Consecutive $^{13}$C NMR spectra were acquired immediately after the injection. Spectral analysis was performed using MNova (Mestrelab Research, Santiago de Compostela, Spain).

Results: The $^{31}$P spectra collected from each liver showed the characteristic signals of ATP, confirming the viability of the tissues slices in the spectrometer. After each of the $^{13}$C$_1$ pyruvate injections, both $^{13}$C$_1$ lactate and $^{13}$C$_1$ alanine signals were detected within 20 sec, for a duration of 1.5 min.

Conclusion: We were able to maintain and show the viability of precision-cut mouse liver slices in an NMR spectrometer as well as record hyperpolarized $^{13}$C$_1$ pyruvate metabolism for the first time. This suggests that it can be used for ex-vivo evaluation of liver metabolism. This strategy is translational to the study of human liver metabolism ex-vivo as very small amounts of tissue are required (less than 1 gram). This approach is likely to lead to more accurate assessment of intracellular processes in a personalized manner.
The Role of Diffusion Weighted Imaging in the Assessment of Jejunal Crohn’s Disease

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²Sackler School of Medicine, Tel Aviv University, Israel
³Department of Gastroenterology, Sheba Medical Center, Israel

Purpose: The added value of diffusion weighted imaging (DWI) for detection of inflammation in Crohn’s disease (CD) has been examined previously. However, its use in the evaluation of jejunal inflammation related to CD is uncommon. In this study we compared DWI, video capsule endoscopy (VCE), and inflammatory biomarkers in the assessment of CD involving the jejunum.

Methods: CD patients in clinical remission were prospectively recruited and underwent MR-enterography (MRE) and VCE. C-reactive protein (CRP) and fecal calprotectin (FCP) levels were obtained. MREs were evaluated for restricted diffusion (presence/absence) and apparent diffusion coefficient (ADC) measurements were obtained. The VCE based Lewis score was calculated. Associations between DWI, ADC, Lewis score, and inflammatory biomarkers were evaluated.

Results: This study included 51 patients were included. 27/51 (52.9%) of VCEs showed jejunal mucosal inflammation. Sensitivity and specificity of restricted diffusion for mucosal inflammation as determined by VCE were 59.3% and 37.5% for the 1st reader and 66.7% and 37.5% for the 2nd reader, respectively. DWI was not statistically associated with mucosal inflammation in the jejunum (p=0.813). ADC did not correlate with jejunal Lewis score (R=-0.091), or with inflammatory biomarkers (CRP: R=0.088; FCP: R=0.196).

Conclusion: DWI parameters were not associated with either VCE mucosal inflammation or with inflammatory biomarkers in jejunal evaluation for CD.
Abdominal Imaging

**Ovarian Metastases from Pancreatic Cancer: CT Features**

*Philip Lawson, Yael Inbar, Eyal Klang, Marianne Michal Amitai, Sara Apter, Eli Konen*

*Diagnostic Imaging, The Chaim Sheba Medical Center, Israel*

**Purpose:** To describe the radiological features of Krukenberg Tumors (KT) arising from the pancreas and compare them to KTs originating from gastrointestinal tract.

**Materials and methods:** The CT studies and clinical records of consecutive women (2011-2017) with pancreatic, colorectal (CRC) and gastric KTs were retrospectively evaluated. CT findings were reviewed in consensus by two radiologists. The CT features for both types of KTs were compared for the following features: unilateral vs. bilateral ovarian involvement, maximal tumor diameter, density (cystic vs. mixed cystic/solid vs. solid) and presence of septations in cystic lesions.

**Results:** The study sample included 5 pancreatic (4/5 biopsy proven), 11 CRC and 9 gastric KTs. All pancreatic KTs had similar CT characteristics: tumors were bilateral, bulky, averaging 7.5 cm, well-defined, and cystic with internal septations, and with mass effect depending on size. Similar to the pancreatic KT, most cases of non-pancreatic KT were found to be bilateral (p=0.289). Pancreatic KTs were larger than non-pancreatic KTs (pancreatic: 7.5±3.1 cm; CRC: 4.0±1.0 cm; gastric: 4.3±0.9 cm, p<0.001). While all the pancreatic KT were cystic, most non-pancreatic tumors were either purely solid or mixed solid and cystic. Whereas only 1/11 (9.1%) of the CRC KT and 1/9 (11.1%) of the gastric KT were cystic (p<0.001).

**Conclusion:** Pancreatic KTs appear as large, bilateral, cystic masses with septations, unlike CRC and gastric KTs which are usually smaller and solid or mixed. Findings of bilateral large cystic masses should raise the suspicion of pancreatic KT.
Session 10: Abdominal Imaging (Friday, November 03, 2017 11:30)

Oral

Abdominal Imaging

**CT Features that Distinguish between Viable and Necrotic Bowel in Mesenteric Ischemia**

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¹Diagnostic Imaging, The Chaim Sheba Medical Center, Israel
²Sackler Faculty of Medicine, The NY Program, Tel Aviv University, Israel

**Purpose:** Acute mesenteric ischemia is associated with high rates of morbidity and mortality and requires emergent treatment. Patients are critically ill, usually with severe co-morbidities and management may depend on the viability of bowel loops, as diagnosed by the radiologist. The aim of this study was to identify CT features that may distinguish between viable and necrotic bowel in mesenteric ischemia.

**Materials and methods:** A computerized search for consecutive patients that underwent surgery for mesenteric ischemia and had a CT angiography prior to surgery was conducted for the years 1/2012 – 7/2015. Two radiologists blinded to clinical data and surgery results, retrospectively analyzed in consensus all CT examinations with respect to the following imaging features bowel wall, enhancement, bowel dilatation, pneumatosis intestinalis, mesenteric stranding and free fluid. Specificity and sensitivity of each imaging feature for necrosis were calculated. Associations between viable and necrotic bowel in surgery and imaging features were evaluated (Fisher’s exact test).

**Results:** Twenty-four patients were included. Intestinal necrosis was seen in 14/24 (58.3%) patients. Specificity for necrosis was high for all investigated imaging features (non-enhancement of bowel wall 90.0%, increased bowel wall enhancement 100.0%, bowel dilatation 80.0%, pneumatosis intestinalis 100.0%, mesenteric stranding 90.0%, and free fluid 100.0%). High sensitivity for necrosis was seen only for bowel dilatation and mesenteric stranding (non-enhancement of bowel wall 21.4%, increased bowel wall enhancement 21.4%, bowel dilatation 78.6%, pneumatosis intestinalis 14.3%, mesenteric stranding 92.9%, and free fluid 28.6%). Only bowel dilatation (p=0.011) and mesenteric stranding (p=0.002) were significantly associated with necrosis.

**Conclusions:** While the presence of all investigated features suggest necrosis, only the absence of bowel dilatation and absence of mesenteric stranding suggest viable bowel, as those features have high sensitivity for necrosis. This data may help surgeons when making clinical decisions.
Abdominal Imaging

Missed Pancreatic Adenocarcinoma on CT Examinations: Frequency and Radiological Signs

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Diagnostic Imaging, The Chaim Sheba Medical Center, Israel

Purpose: Pancreatic adenocarcinoma is one of the cancers with the worst prognosis. The only chance for survival requires early detection, before the disease has spread. Abdominal CT examination is the mainstay of pancreatic imaging. The aim of this study was to assess the overall frequency of undetected pancreatic adenocarcinoma on CT examinations, compare the frequency on portal and pancreatic or triphasic CT examinations, and to evaluate the imaging signs of missed tumors.

Methods: Consecutive pancreatic adenocarcinoma patients were retrospectively collected using a computerized search in our department’s Radiological Information System (RIS) (12/2011-12/2015). Patients with abdominal or chest CT examinations performed up-to a year prior the diagnosis were included. Frequency of missed cancers was evaluated (number of CT examinations with missed cancer/number of CT examinations with either a new diagnosis of cancer or missed cancer) for the entire cohort and separately for portal phase and pancreatic/triphasic CT examinations. Fisher’s exact test evaluated statistical difference in missed detection rate between portal phase and pancreatic/triphasic CT examinations. Two radiologists retrospectively analyzed in consensus the CT examinations of missed cancer cases and registered radiological signs suggesting the presence of tumors.

Results: Overall 172 patients with a diagnosis of pancreatic cancer on CT examination were retrieved. 114/172 (66.3%) of the examinations were pancreatic or tri-phasic CT protocols, 49/172 (28.5%) were portal phase CT protocols and 10/172 (5.8%) were non-contrast CT. The overall frequency of missed cancers was 6/172 (3.5%). The frequency of missed cancers was significantly higher in portal phase CT examinations as compared to pancreatic/triphasic CT examinations [5/49 (10.2%) vs. 1/117 (0.8%), p=0.009]. The following CT signs were registered in missed cancer cases: 3 cases of small hypodense lesions, 2 cases with peri-pancreatic fat stranding, 1 case of dilated pancreatic duct with cut-off sign and 1 case with peri-pancreatic lymphadenopathy.

Conclusion: Pancreatic adenocarcinoma is undetected in 10.2% of portal phase CT examinations. Pancreatic or triphasic CT protocols should be used liberally in the appropriate clinical scenarios. Radiologists should be attentive to small hypodense lesions, dilated pancreatic ducts with cut-off sign and peri-pancreatic findings.
The Spectrum of CT Findings and Complications Following Gastric Banding

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Sackler school of Medicine, Israel

Purpose: Laparoscopic adjustable gastric banding (LAGB) is one of the least invasive bariatric operations. The surgeon places a band around the upper part of the stomach to create a small pouch resulting in early satiety. To the best of our knowledge there are no previous series summarizing the spectrum of complications after LAGB as seen on CT examinations. The aim of this study is to present the spectrum of CT findings of LAGB complications.

Methods: A computerized retrospective search for the term "gastric banding" in CT interpretations was performed in our institution’s radiological information system (RIS) (12/2011 – 4/2017) to identify patients who underwent CT examinations after LAGB. The clinical indications for CTs were retrieved. CT scans were reviewed to identify findings suggestive of complications resulting from gastric banding. The CT findings were divided into two groups: 1. symptomatic group in which the complication caused the symptoms and 2. complications were an incidental finding. The type of complications incidence in each group was calculated.

Results: 160 patients (M:F 48:112) who underwent CT after LAGB, with an average age of 51±12 years were retrieved. Overall, 85 findings suggestive of complications were identified in 69/160 (43.1%) patients. Examinations included 99 abdominal, 34 chest-abdomen, 25 chest and 2 spinal CT scans. When compared with the referral note, 30/85 (34.1%) of the complications caused symptoms and were the indication for the exam, whereas 56/85 (65.9%) were incidental findings. In the symptomatic group findings included: pulmonary, 10/30 (33.3%) (4 pulmonary abscesses, 4 consolidations, 2 empyema); abdominal abscess, 6/30 (20%); small bowel obstruction, 5/30 (16.7%); intragastric band erosion, and port site infection 3/30 (10.0%) each. Ring slippage, esophageal bezoar, strangulated hiatal hernia all had an incidence of 1/30 (3.3%). In the incidental group findings were: esophageal dilation, 46/55 (83.6%); tube disconnection, 4/55 (7.2%); pulmonary consolidation 3/55 (5.4%); intragastric band erosion and nasogastric tube coiling in the esophagus, 1/55 (1.8%) each.

Conclusions: Complications were found in 43% of CT scans of patients after LAGB. One third of the complications were symptomatic and the rest were incidentally identified. The most common symptomatic complications were pulmonary complications, abdominal abscess and small bowel obstruction. Incidental finding were mostly benign and mainly esophageal dilation, yet some had significant clinical importance.
Purpose: The diagnosis of early hepatic fibrosis, before it develops into cirrhosis, is crucial in patients with chronic liver disease, and allows for early treatment when the process may still be reversible. Compared to ultrasound-based elastography, MR elastography allows for evaluation of larger areas of the liver, and is being used in clinical practice. MR elastography sequences that have been validated by correlation to liver biopsy include gradient-echo (GRE) sequences, which sometimes yield a nondiagnostic scan, especially when iron deposition is present. Newer spin-echo (SE) echo-planar imaging (EPI) sequences have been developed and are proposed to allow for better stiffness evaluation. The purpose of the study was to compare the newer sequences to the traditional sequences, and evaluate whether SE-EPI sequences allow for evaluation of larger portions of the liver and whether the stiffness values measured on SE-EPI sequences are comparable to those measured on GRE sequences.

Materials and Methods: A retrospective single-center study was conducted, and included 35 consecutive patients with chronic liver disease related to various etiologies who underwent MR elastography with both GRE and SE-EPI sequences. Each sequence type was evaluated for the overall liver area that was visible for diagnosis, the liver area that yielded a diagnostic stiffness value and for the measured stiffness value.

Results: Statistical analysis was performed on 34 patients (1 was excluded because of giant hemangiomas). SE-EPI sequences had a higher rate of diagnostic scans than GRE sequences (100% vs. 94.1%), with a higher mean percentage of diagnostic slices (99.3% vs. 90.4%, p=0.026). SE-EPI sequences achieved a diagnostic stiffness value in a larger portion of the imaged liver (67.9% vs. 48.4%, p<0.001). Mean SE-EPI stiffness values were higher than GRE stiffness values by 0.37 kPa (4.697 kPa vs. 4.323 kPa).

Conclusion: SE-EP MR elastography sequences are able to image a larger portion of the liver at diagnostic quality, with a lower number of non-diagnostic scans. However, the difference in stiffness values compared with validated GRE sequences, although small, may cause incorrect fibrosis stage assignment. Therefore, further testing and validation of SE-EPI sequences is required before they can be entered into clinical use.
Session 1: Abdominal Imaging (Thursday, November 02, 2017 11:30)

Oral

Abdominal Imaging

**CT Assessment of Sarcopenia as an Independent Risk Factor for Delayed Gastric Emptying after Pancreaticoduodenectomy**

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**Purpose:** Pancreaticoduodenectomy (PD) is the mainstay of surgical treatment for localized pancreatic and periampullary malignancy. Post-operative morbidity affects up to 65% of patients. Delayed gastric emptying (DGE) is one of the leading causes of post-operative morbidity. Sarcopenia (decreased muscle mass) has been associated with increased complications after PD. The aim of this study was to correlate between preoperative sarcopenia and the incidence of DGE following PD for tumors of the pancreas by measuring the psoas muscle area on CT scans. This may help to identify patients at risk for DGE and potentially avoid this complication.

**Materials and Methods:** A prospective study including all patients who underwent elective PD for pancreatic or periampullary malignancy at Shaare Zedek Medical Centre between 12/2014 - 3/2017. Pre-operative, intra-operative and post-operative demographic, clinical and pathological related variables were collected. Patients were included in the study if a CT scan was performed and available less than 30 days preoperatively. The images were analyzed using a free-hand circumferential region of interest (ROI) of the borders of the psoas muscles in the axial plane, at the level of the superior aspect of L4. Area (mm²) was calculated for the psoas muscles on both sides. Sarcopenia was defined as an average area of 910 mm². An average value was used in the final analysis. Sarcopenia was defined as an average measurement in the lower one third of the cohort.

**Results:** Of the 57 patients included in the study (30 males, average age 72) 12 (21.1%) had DGE. 17 patients were defined as sarcopenic (13 females, 4 males). Of them, 7 had DGE (41.2%). 70% of patients with DGE had sarcopenia vs. 30% in the non-DGE group (70 vs 30%, p = 0.007). There was no significant difference in the gender, age, pre-operative body mass index or albumin.

**Conclusion:** Based on the assumption that a measured psoas muscle area correlates with the total body muscle mass, CT is becoming an effective tool for assessment of sarcopenia. As a result, the additional data that can be extracted from the CT scans is becoming a common practice. The female preponderance in the sarcopenic group may indicates the need for creating different cut-offs for males and females. In our study, sarcopenia was a first possible indicator of subsequent DGE after PD. In post PD patients, the ability to predict DGE allows tailored patient counselling and postoperative care. However, further research in this field is needed.
Abdominal Imaging

**Foreign Bodies in the Abdominal Gastrointestinal Tract: Clinical and Radiological Features**

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**Purpose:** To present clinical and radiological features associated with gastrointestinal foreign bodies.

**Materials and methods:** Consecutive patients with foreign bodies in their gastrointestinal tract were retrospectively collected (2009-2016). Clinical data was retrieved from medical records. Foreign bodies were divided into seven groups: medical devices; fish bones; elongated metal objects; dental related objects; drugs; intra-rectal objects; and glass. Two radiologists analyzed all radiological examinations in consensus, evaluating which objects were missed on X-ray and registering the foreign bodies’ shapes and complications (perforation, abscess, bowel obstruction). The different foreign bodies groups were statistically compared with clinical suspicion, X-ray visualization and presence of complications.

**Results:** Forty-two patients were included (4 medical devices, 3 fish bones, 3 drugs and 5 metal, 22 dental, 3 intra-rectal and 2 glass objects). Thirty-eight patients underwent X-ray and 14 underwent CT. Clinical suspicion was significantly higher for dental devices (p=0.002) and lower for fish bones (p=0.001) and metal (p=0.005) objects. Fish bones were significantly less likely to be identified on X-ray (p=0.005) compared to other groups. The complication rate was higher for medical devices, metal, fish bones and drugs and significantly lower for the dental group (p=0.002). The only mortality case was due to cocaine absorption in a “body packer”.

**Conclusion:** Different groups of foreign bodies present with different clinical and radiological features. Knowledge of those features is important when looking for foreign bodies and their complications.
DECT in Bowel Inflammation Assessment on Low KeV Images

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**Purpose:** Low mono-energetic images derived by Dual Energy CT (DECT) can enable greater attenuation of contrast and improve conspicuity. We hypothesized that low mono-energetic images will improve the reliability in the assessment of bowel inflammation. In this study we compared conventional abdominal contrast-enhanced CT images with the low mono-energetic and virtual-non-contrast (VNC) DECT images for contrast enhancement, contour and related findings in acute bowel inflammation.

**Materials and Methods:** Forty patients who underwent abdominal contrast enhanced DECT (IQon, Philips Healthcare, Eindhoven, Nederland) between January and April 2017, with radiological findings correlating to bowel inflammation were retrospectively reviewed. Contrast enhanced series were performed using conventional single-energy mode at 120 kV. VNC and mono-energetic (ME) images at 50 keV were reconstructed from the conventional study. Qualitative assessments of the inflamed bowel wall, mural or intra luminal findings, adjacent fat stranding and fluid were made on conventional, VNC and ME images and rated on a scale of 1-5 (5 being the highest). Paired t-test was used to assess the significance of the differences between the conventional, VNC and ME images.

**Results:** Bowel inflammation was caused by acute appendicitis (15%, 6/40), bowel obstruction (35%, 14/40), tumor (20%, 8/40) and colitis (30%, 6/40). The score of the qualitative assessment on the ME images at 50 keV (4.7) was significantly higher (p<0.001) compared to the score on the conventional image (3.9). The qualitative assessment had a lower score on the VNC image compared to the conventional image, with no significant difference.

**Conclusion:** Virtual low mono-energetic DECT images have the ability to significantly improve the conspicuity of acute bowel inflammation. Non-conclusive radiological studies may thus be turned into definite and clinically relevant findings.
Abdominal Imaging

**MR Guided Prostate Biopsy: Initial Experience in Israel**

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**Purpose:** Prostate cancer is the most commonly diagnosed solid tumor in men. The diagnosis, however, still relies on low sensitivity studies (PSA, digital rectal examination (DRE) and random TRUS directed biopsy). Active surveillance is an alternative option to manage patients with low-grade cancer. These patients need reliable tools for follow-up. MRI has become the best imaging modality for prostate cancer detection and local staging. Therefore, targeted MR guided biopsy seems as the most promising procedure for cancer detection. The purpose of our study was to determine the feasibility and reliability of in-bore MRI transrectal biopsy (MRGB) in detection of prostate cancer and reevaluation for active surveillance patients.

**Methods:** We retrospectively reviewed the hospital records of 66 patients between March 2016 and June 2017. All patients had a prior multiparametric MRI (mpMRI). Included were patients on active surveillance and those suspected to have cancer (based on PSA elevation, suspicious DRE, negative prior biopsies). All mpMRI studies were evaluated by a single experienced uro-radiologist, using PIRADS (Prostate Imaging Reporting and Data System) scoring. 22 patients were excluded for biopsy due to a time interval of 1 year since last mpMRI, PIRADS less than 3 and inappropriate images. Targeted and random biopsies were performed by an experienced urologist guided by the radiologist. Procedures were done under deep sedation by an anesthesiologist. Correlation between PIRADS score and Gleason score from the specimens, was evaluated.

**Results:** 44 patients with a mean age of 69 had MRGB. Mean PSA level was 8.8. 24 patients for detection (8 pre-biopsy, 16 prior negative biopsy), and 20 on active surveillance. 20 lesions scored PIRADS 3 (45.4%), 16 PIRADS 4 (36.4%) and 8 PIRADS 5 (18.2%). Clinically significant tumors, Gleason ≥7, were found in 3/20 (15 %) PIRADS3 lesions, 10/16 (62.5%) PIRADS4 lesions and 6/8 (75%) PIRADS5 lesions. Patients were discharged after short supervision without any immediate major complications.

**Conclusion:** In bore MRI guided biopsy is not a complicated procedure. It has very good accuracy for prostate cancer detection. These findings may have important clinical impact on the management of patients.
Is Portal Biliopathy Underdiagnosed? A Retrospective Comparison Study of CT, US and MRI

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Purpose: Portal biliopathy is the presence of bile duct abnormalities secondary to cavernous transformation, without other biliary tract disease or malignancy. It may be misdiagnosed as a tumor. Therefore, it is important to identify and correctly diagnose this pathology to prevent because the conglomerate of vessels may be misdiagnosed as tumor, and attempting biopsy of these structures is dangerous, with increased risk of hemorrhage also at ERCP. The purpose of this study is to evaluate whether portal biliopathy is underdiagnosed in patients with known cavernous transformation of the portal vein and whether US doppler is superior to CT or MR imaging in reaching the diagnosis.

Materials and methods: All patients diagnosed with portal vein thrombosis between 2005 and 2015 at the Tel Aviv Sourasky Medical Center were included. The CT, US and MR imaging examinations were evaluated for the presence of cavernous transformation and portal biliopathy. The diagnosis, or absence of diagnosis, of portal biliopathy was searched for in the original radiologist’s.

Results: There were 222 patients diagnosed with portal vein thrombosis, of whom 77 had cavernous transformation. Patients with malignancy or obstructing stones (n=28) were excluded. Of the remaining 49 patients, 16 were positive for portal biliopathy on retrospective evaluation. A correct prospective diagnosis was made in only 5 of these patients (3 on US and 2 on MRI, none on CT). In the remaining 11 patients the diagnosis was misdiagnosed; not reported (n=9) or incorrectly diagnosed as tumor (n=2).

Conclusion: Portal biliopathy was found to be an underdiagnosed entity. US appears to be a more sensitive method of detection of portal biliopathy. Portal biliopathy should be suspected in patients with the combined bile duct dilatation and a known cavernous transformation of the portal vein. Referral for US may yield better accuracy at diagnosis and save the patients unwarranted biopsies.
Background: Multiple studies have shown that obesity is associated with an increased incidence and aggressiveness of pancreatic cancer. The precise role that pancreatic fat plays in this process remains under investigation. We tested the hypothesis that pancreatic steatosis is associated with increased dissemination and reduced survival in patients with pancreatic cancer using non-invasive magnetic resonance imaging (MRI) quantification.

Methods: We conducted a prospective study of patients with pancreatic tumor, where each patient had both abdominal MR scan and free DNA sample at the time of diagnosis, as well as available clinical and laboratory parameters. Based on DIXON Quant scan we calculated the percentage of fat in the non-tumor pancreatic parenchyma and liver parenchyma.

Results: We investigated 31 patients with pancreatic tumor, (female=15), mean age 68.5 years, with average fatty infiltration quantities as high as 13.3 %, compared to 5.7 % in the control group (p < .001) who had abdominal MRI scan due to any other reason apart from cancer and with the same imaging protocol. The two groups were matched by age and gender. There was no significant difference in the presence of fatty liver and increased BMI between two groups (p>0.05). Free DNA level in study cohort was 1564.8 vs 800 considered normal.

Conclusion: Several studies have shown previously the correlation between pancreatic steatosis and ductal pancreatic carcinoma, based on the pathological evaluation of surgical specimens. In our study, there was a positive correlation between FI in the pancreas and pancreatic cancer. We present a modern imaging protocol, which may serve as a prognostic, non-invasive test as part of the routine work-up to predict the disease course and aggressiveness of the tumor.
Purpose: Abbreviated Breast MRI (AB-MR) is a recently introduced protocol for screening in high risk women. The protocol consists of only one pre- and one postcontrast acquisition and their derived images: first postcontrast subtracted sequence (FAST) and maximum-intensity projection (MIP) images, which are acquired in approximately 3 minutes. Using such a protocol, interpretation of screening MRI becomes a dichotomized process of either "normal" (return for routine screening in 1 year) or "further evaluation needed" – recall patient. The purpose of this study was to evaluate the estimated recall rate of screening MRI using AB-MR in a cohort of BRCA mutation carriers in first and second round screening.

Patients and Methods: Retrospective evaluation of screening breast MRI examinations in 50 consecutive healthy BRCA mutation carriers was performed. From these MRI examinations, only the first FAST and MIP images were extracted, simulating an AB-MR examination. Images were initially reviewed with no comparison to prior examinations, simulating first round screening and then evaluated with 1 prior comparison MRI (1-3 years; first FAST and MIP only) to simulate second round screening. Each examination was assigned an interpretation of either "normal" or "recall patient for further evaluation". Patients with prior history of breast surgery were excluded.

Results: Mean age was 48 years (29-68 yrs). Breast density was equally fatty and dense in the study cohort (50% each). BPE was predominantly mild to moderate (grade 1 or 2) with only 18% showing significant BPE. On the simulated first round screening recall was requested in 25/50 patients (50%), reducing to 11/50 (20%) on simulated second round screening. FAST detected all lesions initiating recall whereas 5/25 (20%) were obscured on MIP images. Lesions resulting in a recall were masses in 56% (ave size 0.6 cm) and Non Mass Enhancement in 44% (ave size 1.7 cm). All lesions initiating a recall in this cohort were benign on biopsy or long term follow-up.

Conclusion: If AB-MR is implemented, a significantly high initial first round screening recall rate of 50% can be expected, dropping to 20% on second round screening.
Background: MRI is the most accurate imaging modality for predicting complete pathological response (pCR) following neoadjuvant chemotherapy (NAC). However, residual disease in pathology specimens has been reported in up to 30% of cases whose MRI showed complete response (MR-CR), necessitating surgery to accurately demonstrate pCR. Treatment of HER2+ disease includes chemotherapy and biological therapy with Herceptin (HC). More recently, a new biological drug, Pertuzumab (Perjeta), has been added to the protocol (HPC) resulting in increased pCR rate. The purpose of this study is to evaluate the ability of MRI to accurately predict pCR in patients with HER2+ disease receiving Pertuzumab as part of their NAC protocol in comparison to those who did not receive the drug.

Patients and Methods: This retrospective study included 39 patients who underwent NAC for HER2+ disease. 18 patients received chemotherapy and Herceptin (HC) and 21 received the same with the addition of Pertuzumab (HPC). Pre-op MRI examinations were reviewed and categorized for residual disease: complete response (MR-CR), partial response (MR-PR) or no response. These findings were compared to pathological response as reported in the surgical pathology report. Statistical evaluation was performed using the Fisher’s exact test.

Results: Patient age (average 47 years) was similar in both groups. In the HC group, 33% (6/18) demonstrated pCR and 67% (12/18) had residual disease on pathology; with similar results for MR response assessment in this group. In the HPC group the rate of pCR was higher 57% (12/21) and 43% (9/21) had residual disease on pathology. MR-CR was seen in 52% (11/21) and MR-PR in 43% (9/21), one case (5%) showing no response to treatment on MRI. Correlation between MR assessment and pathology results was similar in both groups showing concordance in 83% for the HC group and 86% for the HPC group. The average size of MR residual disease was smaller in the HPC group: 1 cm vs 1.8 cm. MRI falsely estimated residual disease in 2 patients in each group. When MRI predicted no residual disease (MR-CR), disease was present on pathology in 1/18 patients (5.5%) in the HC group and 1/21 patients (4.8%) in the HPC group.

Conclusion: MRI prediction of pathological response is accurate in patients with HER2+ breast cancer, missing residual disease in only 5% of patients. MRI prediction is similar regardless of the addition of Pertuzumab to the treatment protocol.
What is the Yield of Breast MRI in the Assessment of Palpable Breast Findings?

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**Goals:** The use of breast MRI for the evaluation of palpable breast masses has not been supported in the literature. Despite this lack of data, magnetic resonance imaging (MRI) is occasionally used in practice to characterize a palpable finding, after conventional imaging was found to be non-contributory.

**Methods:** The breast MRI database at our center was queried for studies performed between January 2010 and December 2015 for the clinical indication of palpable breast finding with negative standard imaging. Medical files were reviewed for demographic data, clinical information, radiology and pathology reports. Benign versus malignant outcomes were determined by pathological result or 12 months of follow up.

**Results:** Investigation of palpable breast finding was the clinical indication for 167 of 7782 (2\%) exams performed. Thirty-two (19\%) women in the study had positive MRI findings. Most (20, 63\%) of these findings corresponded to the palpable area including 3 carcinomas. Only one carcinoma required MRI guided biopsy for diagnosis. Seventeen women with a negative MRI underwent US guided biopsy from the palpable area with a diagnosis of 1 carcinoma. One carcinoma was incidentally detected in another location. Within our population the sensitivity for detecting malignancy was 80\%, specificity 78\%, negative predictive value 99\% and positive predictive value 13\%.

**Conclusions:** Although cancer was found in 4 cases in the palpable area, only in one was the biopsy directed by MRI. A new palpable finding with non-contributory standard imaging should prompt a needle-guided biopsy and not further evaluation by MRI.
Session 5: Breast Imaging (Thursday, November 02, 2017 15:45)

Oral

Breast Imaging

**Diagnostic Workup of Incidental 18-F FDG PET/CT Uptake in the Breast and Axilla**

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**Purpose:** To assess the radiological workup outcome of incidental hypermetabolic findings in the breast and axilla, as detected on PET/CT examinations of patients without history of breast cancer.

**Materials and Methods:** The institutional review board approved this retrospective with a waiver for informed patient consent. A filtered computerized search of our institutional radiology information system (RIS) was conducted to find all patients who underwent breast imaging procedure between 2011-2016, and matched the word "PET". Patients with negative PET scans patients who were referred to PET scan due to radiological findings and patients with a history of breast cancer were excluded from the study. For the remaining final cohort, radiological reports, medical files and archived images were analyzed to summarize clinical and imaging characteristics. Statistical evaluation was applied to assess differences between features of benign and malignancy.

**Results:** The study included 43 patients (mean age 57.3 years) with abnormal hypermetabolic focal mammary or axillary FDG uptake on PET identified during the time span. The main indication for PET/CT was Lymphoma (n=14, 33%) and cervical carcinoma (n=7, 16%). 10 patients (23.2%) were diagnosed with breast cancer (7 IDC, 2 ILC and 1 DCIS). 7 more patients were diagnosed with metastatic disease. The remaining 26 patients without cancer had radiological clearance or benign findings, mostly reactive lymph nodes (n=5). Mean, max and normalized-to-liver SUV values of the cancer group were found to be significantly higher (p=0.05) than the respective values of the non-cancer group. Albeit, overlapping values were noticed.

**Conclusion:** Incidental breast or axillary focal uptake of FDG on PET performed for non-breast related indications is associated with significant rates of malignancy, in terms of primary or metastatic disease. Higher values of SUV may suggest malignancy, but lower values do not rule out cancer.
The Effect of Breast Density on the Accuracy of Breast Tumor Measurement: Comparison of Radiologic Versus Pathologic Measurement

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Background: Tumor size is an important parameter in breast cancer staging, and may affect clinical decision-making. Definite tumor size is determined by measurement of the pathological specimen after surgery, and prior to surgery the size is assessed by imaging: mammography, ultrasound and MRI. Discrepancy between imaging assessed and pathological size is not infrequent. We suspected that breast density may affect image based tumor size assessment.

Purpose: To compare tumor size as measured by imaging modalities to the pathological size as determined on the specimen, and examine whether increased breast density affects measurement accuracy.

Material & methods: This was a retrospective study of all patients diagnosed and operated for primary breast cancer at our institution during the years 2015-2016. We determined maximal tumor size by each imaging modality and compared it to the tumor size on pathological report, as well as breast density as determined by mammography.

Results: After excluding patients who underwent neoadjuvant therapy, patients who were not operated, and patients in whom data were missing, a total of 183 patients with 198 tumors were included in the study. Mean age was 66, 89% (176) were over the age of 50, and 11% (22) were younger than 50. In patients over 50, 56% (99) had fatty breasts (density category A+B) and 43.8% (77) had dense breast (category B+C), in patients under 50, 22.7% (5) had fatty breasts (category A+B) and 77.3% (17) had dense breast tissue (category C+D). Comparison of mean tumor size in each group (pathology, mammography, US and MRI) revealed that US underestimated the tumor size in all density groups compared to pathology, and mammography was less accurate in very dense breasts, and overestimated the tumor size. MRI overestimated tumor size only in breast density category B, and was accurate in the remainder.

Conclusion: Breast density is an important factor that affects tumor size assessment by imaging, with US underestimating the size and mammography overestimating size in very dense breasts. These inaccurate estimations may affect treatment planning.
Unenhanced Diffusion-Tensor Breast MRI during Pregnancy: Initial Experience

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Purpose: To investigate the feasibility and possible clinical utilization of unenhanced diffusion-tensor imaging (DTI) protocol in the diagnostic workup of pregnancy-associated breast cancer (PABC).

Material and Methods: This prospective study was approved by our institutional IRB, and a signed informed consent was obtained from all participants. Since November 2016, seventeen pregnant patients (median gestational age: 19 weeks, range:8-30w) were examined by unenhanced breast MRI protocol. Indications included: newly diagnosed PABC (n=6), follow-up of high-risk patients (n=10) and follow up of neoadjuvant-chemotherapy (NAC) treated patient (n=1). MRI protocol included T2-weighted and DTI sequences, recorded at 1.5T with a total scan duration of ~12min. DTI was acquired using 32 directional diffusion gradients and 0, 700 s/mm² b-values. DTI parametric maps of the principal diffusion coefficients (λ₁,λ₂,λ₃), mean diffusivity (MD), fractional anisotropy (FA) and maximal anisotropy index (λ₁-λ₃) were generated and analyzed at pixel resolution. Regions of interest (ROIs) of lesions and the normal fibroglandular tissue were delineated on λ₁ maps and were statistically evaluated.

Results: Technically, all scans were completed. One scan was paused due to positional discomfort that, although alleviated by extra supports still resulted in significant artifacts. All other (n=16) scans were of diagnostic quality and artifact-free. All six biopsy-confirmed tumors were detected by DTI maps of λ₁, λ₂, λ₃, MD and λ₁-λ₃ in agreement with their localization based on clinical/mammographic/sonographic findings. PABC exhibited substantial contrast compared with the apparently normal surrounding pregnancy breast tissue (p<0.001, for all). FA ROIs did not help in differentiating malignant and normal tissues (p=0.48). Scans of high-risk patients did not reveal any new suspicious findings, in agreement with US examinations. Tumor was not identified in the scan of the patient receiving NAC, in agreement with DCE MRI, done several weeks after delivery.

Conclusion: DTI examination is safe, non-invasive, fast and well tolerated by pregnant patients. The significant parametric contrast between normal and malignant tissues, suggests a promising role for DTI in the diagnostic workup of PABC.
Utility of Routine Breast Ultrasound Following Contrast Enhanced Spectral Mammography

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Purpose: To evaluate whether breast ultrasound should be routine practice following contrast enhanced spectral mammography.

Materials and Methods: Consecutive screening and diagnostic contrast mammography examinations with concurrent breast ultrasound were retrospectively collected (05/2012 - 02/2016). A radiologist assigned a separate Breast Imaging Reporting and Data System (BIRADS) score for contrast mammography and for ultrasound. BIRADS scores were grouped into three categories: benign appearing (BIRADS 1, 2); probably benign, short term follow-up (BIRADS 3); or suspicious appearing (BIRADS 0, 4, 5). Patients with a suspicious appearing lesion on either ultrasound or contrast mammography underwent biopsy. The associations between malignant pathology to either suspicious appearing contrast mammography or suspicious appearing ultrasound were calculated. The sensitivities and specificities of contrast mammography and ultrasound were calculated.

Results: Eighty-seven breasts was biopsied, 37 (43%) biopsies were malignant and 50 (57%) were benign. Among malignant biopsies, contrast mammography had a sensitivity of 97%, compared to 92% with ultrasound. None of the malignant biopsies were benign appearing with contrast mammography. One case of follow-up contrast mammography had a malignant appearing ultrasound and proved to be malignant in biopsy. Specificity of contrast mammography was 40%, significantly higher than ultrasound 8%.

While suspicious appearing contrast mammography was associated with malignant biopsies (p<0.0001), suspicious appearing ultrasound was not (p=0.985).

Conclusion: When contrast mammography is suspicious appearing, subsequent ultrasound and biopsy is appropriate. When contrast mammography score is BIRADS 3 we suggest correlation with ultrasound. If the contrast mammography is benign appearing, the routine use of ultrasound is questionable as it may lead to unnecessary biopsies.
Breast Imaging

Comparison of Background Parenchymal Enhancement and Fibroglandular Density at Breast MR in BRCA Gene Mutation Carriers and Non-Carriers

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Introduction: Magnetic resonance imaging (MRI) serves as a screening tool for breast cancer in high-risk populations. Background parenchymal enhancement (BPE) and breast density (BD) are normal properties of the fibroglandular tissue and are related to increased breast cancer risk.

Purpose: To compare the extent of BPE and BD at breast MRI: in BRCA gene mutation carriers and non-carriers, and to evaluate their effect on short term follow-up recommendation rate.

Materials and Methods: This was a case-control study. The BPE and BD in MRI studies of known BRCA 1 or BRCA 2 mutations carriers were compared to the studies of age matched non-carrier during the years 2011-2012.

Results: BPE was high in up to one third of women. 22% of the carriers had high BPE, versus 33% of the control group (p-value 0.013). Results were similar when non menstrual cycle timed MRI examinations were excluded. BD was high in most cases: of them 62% of the carriers had high BD versus 75% of the control group (p=0.004). BI-RADS 3 final assessment was more commonly assigned to cases with high BPE levels, and with higher frequency in the control group.

Conclusion: In our study, women who are BRCA mutation carriers had lower BPE and BD levels as compared to an age matched control group. Our results may highlight different risks causing distinctive breast cancer subgroups; hormonal enriched, and mutational defected DNA damage repair, and may affect future consideration upon preventive medical treatment considerations. MRI indication differences (screening in the mutations carrier group versus breast cancer evaluation in the control group) most likely accounted for the more frequent BIRADS 3 final assessment in high BPE levels seen within the control group.

Key words: Breast MRI, Breast density, Background parenchymal enhancement, BRCA gene mutation carriers
Male Breast Imaging Workup in Israel: An Institutional Experience

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Purpose: To summarize our institutional experience in the diagnostic workup of male patients referred for breast imaging, emphasizing on the clinical, histopathological and imaging characteristics.

Materials and Methods: A computerized search in our Radiological information system (RIS) was conducted, filtering male patients who underwent breast imaging between 2011 and 2016. The electronic medical files were investigated and archived imaging studies of the final cohort were reviewed. Subgroup dividing was generated and assessed statistically.

Results: Overall, we found 178 male patients who had breast radiological examination within the time span. The average age was 61±15 years. The commonest indication for breast imaging was for evaluation of palpable mass (88/178, 49%), followed by gynecomastia (26/178, 16%) and mastalgia (20/178, 11.2%). 13 patients (7.3%) had biopsy-proven breast cancer, with invasive ductal carcinoma the most commonly encountered (12/13, 92%). The main modality used was Ultrasonography (98%) alone, or in combination with mammography. All patients with breast cancer were older than 40 years, mostly presenting with a palpable mass (9/13, 69%), while none of the cancer manifested as breast enlargement or mastalgia. Additionally, five patients (2.8%) had metastatic disease to the breast. Overall, 56 biopsies were performed; 38 (68%) of which were negative for cancer. Using BI-RADS 4 and 5 as positive examinations and BI-RADS 1-3 as negative, imaging procedures had a sensitivity of 100% and a specificity of 83.8%. The positive predictive value was 41.9%.

Conclusion: Palpable mass is the most common cause for referral to breast imaging in male patients. Most findings are benign with specifically low likelihood of cancer diagnosis among young patients and in patients presenting with gynecomastia or mastalgia.
Monitoring Pyruvate Metabolism in Excised Xenograft Human Breast Cancer

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Purpose: In this MRS study, we aimed to demonstrate the feasibility of visualizing pyruvate metabolism in isolated viable xenograft breast tumor tissue using hyperpolarized [1-13C]pyruvate.

Materials and Methods: Xenograft MCF-7 tumors were grown in immunosuppressed mice. Tumors were harvested after they reached sufficient size (about 1 cm), and cut into precision slices. Each study used cumulative tissue from three mice. Slices were kept viable in an NMR tube in an NMR spectrometer using a perfusion system. Hyperpolarized [1-13C]pyruvate was injected into the NMR tube containing and metabolism of the slices was monitored. This was performed on 3 different occasions with consecutive injections. Lactate production was observed via 13C spectroscopy and the ATP level was monitored via 31P spectroscopy.

Results: Lactate signal was observed using tissues weighing between 587-983 mg per study. The ATP level was preserved for up to 10 hours within the spectrometer, and following consecutive injections. Lactate production was observed following repeated and consecutive injections of hyperpolarized [1-13C]pyruvate.

Conclusions: This study proves the feasibility of observing real time metabolism in viable xenograft tumor tissue. This study warrants future studies focusing on other metabolic tracers of specific enzymatic reactions, characterization of breast lesions, and monitoring the response to treatment.
Correlation between Heart Chambers Volumes and Heart Rate Using Cardiac Gated CT Angiography

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Background and Purpose: Currently, normal values of the cardiac chambers’ volumes are corrected only for gender and body surface area (BSA). Our aim is to investigate the association between the heart rate and the volume of each of the four cardiac chambers using cardiac-gated CT angiography (CCTA).

Methods: This is a prospective cross sectional study including 350 consecutive patients without known cardiac diseases or without significant (50%) stenosis who underwent CCTA for suspected CAD between 01/2009-06/2014. Cardiac volumes, adjusted to BSA, were determined using automated model-based segmentation analysis software of CCTA data, and correlated to patients’ mean heart rate during the scan. All volumes were Lan transformed, and linear regression was used for univariate and multivariate analysis controlling for age and co-morbidities when Pulse (5 beats/min), Age, Male, HTN, DM, Overweight, COPD / Asthma, Anemia, Beta Blocker

Results: There were 240 men and 110 women median age was 55 (47-61). Women were older 59.0 (53.7-64) vs. 52.0 (45.0-59.0), had higher prevalence of hyperlipidemia, diabetes mellitus, anemia, hypothyroidism, and higher median heart rates 64.0 (59.7-66.0) vs. 60.0 (55.0-65.0) (p0.001). Men had negative correlation between the volume of each cardiac chamber and the heart rate (r_age adj=0.27-0.4, p

The multivariate analysis showed that a decrease of 5 beats per minute was associated with an increase of approximately 4.6 % in volume of each chamber. There was no such association among females.

Conclusions: Decreased heart rate is associated with increase of each cardiac chamber volume in men. This association is not found in women. Thus, correction of normal cardiac chambers’ volumes to heart rate should be considered. Larger studies are required to further elaborate these gender differences.
Estimation of Myocardial Extracellular Volume Fraction with Cardiac CT in Patients Undergoing Transcatheter Aortic Valve Implantation

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Objectives: To evaluate the feasibility of computed tomography (CT) measurement of extracellular volume (ECV) fraction of the myocardium and to investigate the association between ECV and age, gender, and myocardial mass in patients undergoing CT prior to transcatheter aortic valve implantation (TAVI).

Background: The use of CT for estimation of ECV is a new technique for the evaluation of left ventricular (LV) myocardial fibrosis; however, its feasibility has not been studied in patients with severe aortic stenosis (AS).

Methods: Eighteen consecutive patients (79.1 ± 7.2 years, 12 male) with severe AS underwent pre-contrast and 7-minutes post-contrast ECG-gated 256 slice CT scan for estimation of ECV fraction within the myocardial septum. CT scans were reconstructed using iterative model reconstruction and ECV fraction was calculated as the ratio of the change in Hounsfield unit of the myocardium and the descending aorta blood in the pre- and post-contrast CT scan, multiplied by (1 - hematocrit).

Results: Mean ECV was 42.2 ± 7.6% (range 30.3 - 50.8%), and was not related to age (r = 0.32, P = 0.19) or LV mass (r = 0.33, P = 0.19). Mean ECV was similar in men and women, 42.5 ± 6.9% vs. 41.7 ± 7.6%, retrospectively; P = 0.8. The intra-observer CT measurement of ECV was good [Intra-observer difference with 95% limits was 1.1 ± 17.6 (-16.5, 18.7) and interclass correlation coefficient was 0.78].

Conclusion: CT estimation of ECV fraction, which was not related to age or gender, showed high intra-observer reproducibility. This ongoing study demonstrates the feasibility of CT for the evaluation of LV myocardial fibrosis, which may be part of a comprehensive cardiac CT examination for additional information in the pre-TAVI evaluation of risk in patients with severe AS.
Insights into Hypertrophied Hearts: A Cardiac Computed Tomography Study of Myocardial Crypts

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Objectives: To determine the prevalence of myocardial crypts in left ventricular (LV) hypertrophy secondary to aortic stenosis (AS), hypertrophic cardiomyopathy (HCM), and systemic hypertension (HTN) using cardiac computed tomography (CT).

Background: Myocardial crypts are discrete invaginations in LV myocardium. Recent magnetic resonance imaging studies suggest a higher prevalence of crypts in patients with HCM and also within small numbers of genotype positive but phenotype negative relatives. However, the prevalence of crypts in patients with LV hypertrophy of other etiologies is unclear.

Methods: Consecutive 80 patients with severe symptomatic AS, 42 patients with HCM, 40 patients with HTN, and 40 normal subjects underwent ECG-gated, contrast enhanced 256-slice CT. Crypts were defined as 50% invaginations into normal myocardium during diastole and their overall prevalence and location was investigated and compared between different patient groups with LV hypertrophy. LV mass was calculated in the mid-diastolic frame of the CT dataset.

Results: The prevalence of crypts was 41% (17/42) in patients with HCM, 33% (26/80) in severe AS, 15% (6/40) in HTN, and 5% (2/40) in the predefined normal control group. The highest prevalence of crypts was observed in patients with HCM (P < 0.001); however, their prevalence did not correlate with LV mass (r = 0.12, P = 0.21). They were most commonly located in the septum of the left ventricle (58.5%). Among the patients with LV hypertrophy crypts in the inferobasal segment were observed only in those with HCM.

Conclusions: Myocardial crypts are common in patients with LV hypertrophy, and especially in HCM. Inferobasal myocardial crypts may be characteristic of patients with HCM referred for cardiac CT.
In the modern evaluation of congenital heart defects (CHD) 3 major non-invasive modalities are used: echocardiography (echo), magnetic resonance imaging (MRI), and cardiac-gated computerized tomographic angiography (CTA). Echo and MRI have their limitation in demonstrating complex, vascular structures and precise three-dimensional anatomic relationships. The major disadvantage of CTA has been ionizing radiation.

The purpose of this study was to assess the radiation dosage using new generation CT machine for the evaluation of CHD.

Patients and Methods: 87 infants undergoing CTA during a 12 month period for congenital heart disease were included in the study. Scans of the heart and great vessels were performed under sedation, using the advanced CT scanner, GE Revolution, with axial technique, reduction of dose parameters (KV & MA) and using iterative reconstruction to reduce radiation and with coverage of 80-160 mm in one step. Anatomical and other clinically relevant data were recorded. CTA findings that affected clinical management were also recorded. CTA image quality was assessed by the ability to adequately see the coronary arteries. All scans were evaluated by a pediatric cardiologist and pediatric radiologist. Effective radiation dose was calculated for each scan.

Results: A total of 87 CTA scans were performed in 82 infants; mean age was 63 days (range: 1-270), mean weight was 3.65 Kg (range: 1.8-6.5). Diagnostic quality was excellent in 85/87 of the scans. In 81/87 (93%) of cases, CTA supplied additional information over echo, which helped planning for optimal surgical intervention. Calculated average radiation exposure was 0.3 mSv (range- 0.18-0.45) which is low compared to what is written in the literature.

Conclusions: CTA continues to be a promising, fast, non-invasive technique for assessment of infants with CHD. It supplies important complementary information to echo and may frequently obviate the need for catheterization. With the newest generation CT machines, we are able to reduce radiation exposure to a very low level.
Increased Epicardial Adipose Tissue Thickness in Diabetic Patients with no History of Coronary Artery Disease

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Purpose: To examine whether asymptomatic diabetic patients have increased epicardial adipose tissue thickness (EAT) compared with non-diabetic patients, and whether this cardiometabolic risk factor is associated with coronary artery disease in the diabetic group.

Methods: This study included 369 consecutive asymptomatic consecutive patients referred for cardiac CT angiography (CCTA). Data was collected retrospectively and compared between diabetic (n=73) and non-diabetic (n=296) patients.

Results: Patients with diabetes had a significantly higher mean EAT thickness compared with non-diabetic patients (2.82±1.56mm vs. 2.07±0.99mm, p=0.001). Patients with CAD had significantly higher mean EAT thickness compared with patients without CAD (3.14±1.81mm vs. 2.13±1.05mm, p=0.005). EAT thickness was higher in patients with CAD versus patients without CAD among the diabetic group (3.65±1.96 vs. 2.55±1.31, respectively, p=0.009) and not among the non-diabetic group (2.37±1.29 vs. 2.05±0.97, respectively, p=0.227). EAT thickness independently predicted CAD in the diabetes group (OR =1.73 [1.11-2.68], p=0.014).

Conclusion: EAT thickness is directly proportional to diabetes status, and can be used as an independent risk factor predicting CAD in asymptomatic diabetic patients.
Correlation of Cardiac and Hepatic T2* with Serum Ferritin in Thalassemia Major Patients as a Function of Liver Disease Severity

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Background: Thalassemia major, one of the most common genetic diseases worldwide, causes severe anemia early in life. Routine blood transfusions, the main treatment, are a cause of severe morbidity and mortality, due to systemic iron accumulation, most importantly in the heart and liver. Both serum ferritin and T2* MRI sequences can be used to assess iron overload.

Purpose: The aim of this study was to assess the correlation between cardiac and hepatic T2* values and serum ferritin levels in thalassemia major patients as a function of liver disease severity.

Materials and Methods: The study cohort included 43 thalassemia major patients, treated at the Hadassah hospitals, and having at least one cardiac and hepatic T2* MRI. Average cardiac and liver T2* values were retrospectively calculated for each patient. Severity of liver disease was estimated by clinical rating system – MELD score. Laboratory data retrieved from Hadassah medical records included ferritin levels, serum hemoglobin, liver enzymes (ALT, AST, AP) and viral status (HBV, HCV).

Results: Pearson correlation coefficients of serum ferritin, ALT and AST values for liver and cardiac T2* were as follows: ferritin -0.264 (p=0.091) and -0.448 (p=0.003) respectively, ALT -0.279 (p=0.074) and -0.415 (p=0.006) respectively, and AST -0.085 (p=0.615) and -0.318 (p=0.055) respectively. Multivariate linear regression model showed a significant independent association only between serum ferritin and cardiac T2* values (β=0.355, p=0.034). However, in a sub-group of 9 patients with significant liver disease (MELD score 10-19) Pearson correlation coefficient of serum ferritin for cardiac T2* values was 0.143 (p=0.714).

Conclusion: Serum ferritin levels appear to be a reliable marker for cardiac iron deposition patients with thalassemia major. However, in a subgroup of patients with significant liver disease serum ferritin seems to be less reliable.
Cardiac Imaging

**An Association between Volumes of the Cardiac Chambers and Troponin Levels in Individuals Submitted to Cardiac Coronary Computed Tomography**

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**Purpose:** Previous echocardiographic studies have revealed an association between enlarged cardiac chamber volumes and elevated troponin levels. An automatic 4-chamber volumetric analysis tool was adopted to investigate this association in patients who underwent cardiac-gated computed tomography angiography (CCTA).

**Hypothesis:** We hypothesized that troponin concentration within the normal range correlates with cardiac chambers’ volumes.

**Material & Methods:** Serum troponin was obtained from 157 ambulatory patients before undergoing CCTA for nonacute coronary artery evaluation. Volumes of the cardiac chambers and the left ventricular mass were automatically analyzed and indexed to body surface area. Patients with troponin levels within the upper quartile (0.007 ng/mL, n = 39) were compared to patients with troponin levels within the 3 lower quartiles (≤0.007 ng/mL, n = 118).

**Results:** None of the patients had a troponin concentration 0.05 ng/mL (the 99th percentile of the general population). There were no significant differences in baseline characteristics between the groups. There were significant correlations between troponin and ventricular volumes after adjustments for age and gender. In an analysis that included 107 patients without any known heart diseases, including those pathological findings in the current CCTA, there were significant correlations between troponin levels and left and right ventricular volumes after adjustments for age, gender, and baseline characteristics (odds ratio [OR]: 1.08, 95% confidence interval [CI]: 1.03-1.14, \(P = 0.002\) and OR: 1.11, 95% CI: 1.04-1.19, \(P = 0.002\); respectively).

**Conclusion:** By use of automatic volumetric analysis in individuals undergoing CCTA, an association between larger right and left cardiac chambers and higher levels of troponin levels was found.
Purpose: The differential diagnosis and prognostic implications of small left atria have not been explored extensively. We aim to evaluate the association between very small left atria (VSLA) on non-gated CT pulmonary angiography (CTPA) and mortality in patients without pulmonary embolism (PE).

Methods: Patients investigated for dyspnea who underwent non-gated CTPA between 2011-2015 in order to rule out PE, and had an echocardiogram within 24 hours of the CTPA, were retrospectively identified. The left atrial volume (LAV) of non-gated CTPA was calculated using automatic 4-chamber volumetric analysis (4 CVA) software. The association between the lowest 5th percentile of LAV, indexed to body surface area (BSA), and mortality was investigated after adjustment for age, gender, background diseases and laboratory values.

Results: The study cohort included 241 patients with a median age of 72 (IQR 54-81). The median LAV/BSA was 43.6mL/m² (IQR 33.3-57.2). Patients in the lowest 5th percentile of LAV/BSA had a volume/BSA of 24mL/m² (n=11), and were regarded as the VSLA group. Demographics and background diseases did not differ between the study groups. Median follow-up was 22.7 months (IQR 0.03-54.3). VSLA was an independent predictor of mortality (HR_{adj}=3.6, 95% CI 1.46-8.87; p=0.005), along with malignancy (HR_{adj}=2.28, 95% CI 1.32-3.93; p=0.003) and lower hemoglobin concentrations (HR_{adj}=0.86, 95% CI 0.76-0.99; p=0.032).

Conclusions: Our findings suggest that very small left atria on non-gated CTPA may serve as a marker for mortality. The use of CTPA volumetric analysis can help risk stratification in patients with dyspnea and no PE.
Comparison between the Ability of Cardiac Chambers Diameters and Volumes to Predict Mortality among Patients Undergoing CTPA with and without PE

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Purpose: Though increased right ventricular (RV) to left ventricular (LV) diameter ratio is considered a marker of increased risk among patients with pulmonary embolism (PE), it is known to have weak positive predictive value for mortality. Our aim was to investigate the ability of cardiac chambers’ diameters, and volumes to predict mortality among patients with and without PE.

Materials and Methods: We retrospectively analyzed 1006 consecutive patients who underwent non-gated CTPA for suspected PE between 1.1.2014 and 31.12.2014. We measured the diameter of the RV, LV and the volumes of the RV, LV, left atrium (LA) and right atrium (RA), using automatic volumetric analysis software with correction to body surface area (BSA). Each parameter was categorized by division into tertiles. The association between the RV/LV diameter ratio and the chambers’ volumes with mortality in 30 days was investigated after adjustment to age, gender and background diseases, using logistic regression.

Results: The final cohort included 862 patients with complete data, 142 (16.5%) of them had PE by CTPA. 98 patients (11.4%) died within 30 days of the CTPA date, 17 (12.0%) with PE, and 81 (11.2%) without it (p=0.05). RV diameters and volumes in the highest tertile were more common in patients with PE non-PE patients (31.7% vs 16%, P=0.001 for diameters, and 26.1% vs 17.1%. P=0.041, for volumes, respectively). In addition, the LA volumes were more often in the lowest tertile among the PE patients compared to non-PE patients (22.5% vs 19.6%, P=0.032). Following logistic regression, higher risk for 30-day mortality was found among patients with PE who had low LA and LV volumes (OR=15.3, P=0.003, OR=9.4, P=0.017 for LV). Similar results with a weaker statistical strength were found among patients without PE (OR=2.4, P=0.012 for LA, OR=1.88, P= 0.039 for LV). RV/LV diameter ratio and RV volumes did not correlate with mortality (non-significant among all groups).

Conclusions: Although the RV diameters and volumes of PE patients were more commonly within the highest tertiles, mortality in 30 days among patients with and without PE undergoing CTPA, was associated with decrease in the LA and LV volumes. Further studies are required to evaluate the positive and negative predictive values of decreased LA and LV volumes for prediction of mortality among PE and non-PE patients.
Purpose: Right ventricular (RV) enlargement manifested as increased ratio between the right and left ventricular (LV) diameters ≥1 is considered an important imaging marker of increased mortality risk among patients diagnosed with acute pulmonary embolism (PE). Our goal was to assess the prevalence of increased RV/LV diameter and volumetric ratio among consecutive patients undergoing CT pulmonary angiography (CTPA), and to compare the prevalence of RV/LV≥1 between patients with and without PE.

Methods: We retrospectively analyzed 1006 consecutive patients who underwent non-gated CTPA due to clinical suspicion of PE between 1.1.2014 and 31.12.2014. Each CTPA was investigated by measuring the axial diameter of the RV and the LV and their volumes using an automatic four chamber volumetric analysis (4CVA) software.

Results: The final cohort included 862 patients with complete data, 344 males (39.9%), median age 70 (58-82 inter-quartile range). 142 (16.5%) of them had PE by CTPA. Diameter ratio of the RV/LV ≥1 was found in 553 (64.2%) of all patients, of them in 453 (63.3%) patients without PE and in 100 (70.4%) patients with PE (p=0.117). Volumetric ratio of RV/LV ≥1 was found in 796 (92.3%) of total patients, of them in 660 (91.7%) in the no-PE group and 136 (95.8%) in the PE group (p=0.092). On multivariate analysis, RV/LV≥1 of both diameter and volume showed a tendency of being more prevalent among patients with PE, but without a statistical significance (OR=1.6 {0.6-3.8 95% CI}, P=0.29 for volume, OR=1.29 {0.8-1.9 95% CI}, P=0.224 for diameter).

Conclusions: Diameter ratio of the RV/LV ≥1 is highly prevalent (64.7%) among patients undergoing CTPA, without a significance difference between those with and without PE. RV/LV ≥1 appears to be a limited marker of increased risk in PE, since it is highly prevalent in all patients undergoing CTPA. This factor should be considered when performing risk stratification.
Increasing the Threshold for Diagnosis of Pulmonary Hamartomas

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**Purpose:** For decades, the CT diagnosis of pulmonary hamartoma (PH) has been based on the presence of popcorn calcifications or fat (-40 to -120HU) limited to a smooth

**Materials and Methods:** We retrospectively assessed the CT scans of histologically confirmed: PH (histPH), pulmonary metastases and primary lung cancers as well as PH diagnosed by CT (CTPH). Their size, volume, average, minimum and maximum HU were assessed using an ROI of at least 8 pixels, placed in the lowest attenuation region of the nodule.

**Results:** There were 52 histPH, 41 metastases, 49 primary lung cancers, and 34 CTPH. PH average size and volume were 14.5mm and 2270.2mm³ and that of malignancies 26.5mm and 22,031mm³. Popcorn calcifications were seen in 2 (4%) histPH, 11 (32%) CTPH and in none of the malignant lesions. The average HU for histPH, CTPH, metastases, and primary lung cancers were: 3.99, -10.97, 25.53, 38.61 respectively. Of the malignant lesions, only 4 had an average of

**Conclusion:** By increasing the threshold for identification of fat in PH to –20 unnecessary surgical intervention may be prevented without misdiagnosing cancer as benign.
Identification of Pulmonary Hypertension Caused by Left Heart Disease (World Health Organization Group 2) Based on Cardiac Chamber Volumes Derived from Chest CT


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Purpose: Evaluations of patients with pulmonary hypertension (PH) commonly include chest computed tomography (CT). We hypothesized that cardiac chamber volumes calculated from the same CT scans can yield additional information to distinguish left heart disease-related PH (WHO Group 2) from other PH subtypes.

Methods: Patients with right heart catheterization (RHC)-confirmed PH and contrast-enhanced chest CT studies were enrolled in this retrospective multicenter study. Cardiac chamber volumes were calculated using automated segmentation software and compared between Group 2 and non-Group 2 PH patients.

Results: This study included 114 PH patients, of whom 27 (24%) were classified as Group 2 based on their pulmonary capillary wedge pressure. Group 2 PH patients exhibited significantly larger median left atrial (LA) volumes (118 vs. 63 mL, P < 0.001), larger median left ventricular (LV) volumes (90 vs. 76 mL, P = 0.02), and smaller median right ventricular (RV) volumes (173 vs. 210 mL, P = 0.005) than non-Group 2 patients. On multivariate analysis adjusted to age, gender, and mean pulmonary arterial pressure, Group 2 PH was significantly associated with larger median LA and LV volumes (P < 0.001 and P = 0.008, respectively), and decreased volume ratios of RA/LA, RV/LV and RV/LA (P = 0.001, P = 0.004, and P < 0.001, respectively). Enlarged LA volumes demonstrated high discriminatory ability for Group 2 PH (AUC=0.92; 95%CI, 0.870-0.968).

Conclusions: Volumetric analysis of the cardiac chambers from non-gated chest CTs, particularly with findings of an enlarged LA, exhibited high discriminatory ability for identifying patients with PH due to left heart disease.
Purpose: Evaluation of Superior vena cava syndrome (SVCS) with CT usually focuses on diagnosis of the condition, identifying the cause of obstruction and describing collateral pathways. While the contemporary literature discusses these features in small groups of patients, we sought to further describe the imaging characteristics of SVCS related to malignant causes in a large cohort.

Material & Methods: Retrospective review of chest CTs of 128 patients with SVCS. A radiologist with 4 year’s experience evaluated each of the following veins and structures: SVC, right and left brachiocephalic veins (RBeV, LBeV), right and left jugular veins (RJV, LJV), right and left subclavian veins (RScV, LScV), right atrium (RA), right ventricle (RV) and pulmonary arteries (PA). Degree of obstruction was classified as complete, near complete, partial or none. Type of obstruction was designated “invasion” in case of direct and irregular continuity of the tumor into the lumen. "External compression" was noted when tumor impressed or completely collapsed the adjacent vessel, without intraluminal irregularity. "Bland thrombus" was defined as a hypodense intraluminal filling defect which is not continuous with the tumor and is located in a synchronous site other than the level of the obstructing tumor. Collateral vessels, subcutaneous edema, skin thickening, pleural and pericardial effusions were also documented.

Results: Obstruction was more common in the SVC, RBeV and LBeV (94.5%, 70.3%, 66.4% respectively) than the RJV, LJV, RScV and LScV (19.5%, 13.3%, 7.0%, 3.9% respectively). Involvement of PA (64.1% of cases) was mostly due to external compression (77/82). Complete or near complete obstruction of at least one vein were noted in 43% and 38.3% of cases respectively, whereas in 18.8% of cases only partial obstruction was seen. In 21 cases (16.4%) there was evidence of a bland thrombus proximal to the site of tumoral invasion or compression, and separate from the tumor, 3 of which had concurrent pulmonary emboli. In cases with pleural effusion, right sided effusion (51.9%) was more common than bilateral (40.5%) or left sided (7.6%) effusions. Bilateral collaterals (58.6%) were more common than unilateral ones (41.4%).

Conclusion: This is the largest cohort (n=128) describing CT characteristics of malignant SVCS. Obstruction of the SVC and primary tributaries was common, while the jugular and subclavian veins were less frequently obstructed. Nevertheless, the common involvement of pulmonary arteries (64.1%) and substantial incidence of synchronous bland thrombi (16.4%) highlights the extensive nature of SVCS beyond the level of obstruction.
<table>
<thead>
<tr>
<th>Obstruction of any degree (%)</th>
<th>SVC</th>
<th>RBeV</th>
<th>LBeV</th>
<th>RJV</th>
<th>LJV</th>
<th>RScV</th>
<th>LScV</th>
<th>RA</th>
<th>RV</th>
<th>PA</th>
</tr>
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<tbody>
<tr>
<td>No obstruction</td>
<td>5.5</td>
<td>27.3</td>
<td>31.3</td>
<td>70.3</td>
<td>74.2</td>
<td>75.0</td>
<td>78.9</td>
<td>88.3</td>
<td>96.9</td>
<td>35.9</td>
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<tr>
<td>Partial</td>
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<td>40.6</td>
<td>28.1</td>
<td>13.3</td>
<td>7.0</td>
<td>3.9</td>
<td>0.8</td>
<td>11.7</td>
<td>3.1</td>
<td>35.9</td>
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<tr>
<td>Complete</td>
<td>6.3</td>
<td>10.2</td>
<td>21.1</td>
<td>1.6</td>
<td>6.3</td>
<td>1.6</td>
<td>3.1</td>
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<td>2.3</td>
<td>10.2</td>
<td>12.5</td>
<td>18.0</td>
<td>17.2</td>
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<table>
<thead>
<tr>
<th>Type of obstruction (%) of obstructed veins</th>
<th>SVC</th>
<th>RBeV</th>
<th>LBeV</th>
<th>RJV</th>
<th>LJV</th>
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<th>LScV</th>
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<td>60.0</td>
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<th>Subcutaneous edema</th>
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<td>49 (38.2%)</td>
<td>74 (57.8%)</td>
<td>80 (62.5%)</td>
<td>49 (38.2%)</td>
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<td>Present</td>
<td>67 (52.3%)</td>
<td>79 (61.7%)</td>
<td>54 (42.1%)</td>
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Predictors of Successful Endoscopic Removal of Submandibular Salivary Stones: A Retrospective Study

Avital Savir\(^3\), Gilat Hanna\(^1\), Rachelly Shifer Ovsiovich\(^2\), Eli Atar\(^3\), Gil Bachar\(^3\)

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\(^2\)Graduate of The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Israel
\(^3\)Department of Diagnostic Imaging, Rabin Medical Center Golda Campus, Israel

**Purpose:** This research examines various parameters based on CT imaging, which may assist in predicting the successful endoscopic removal of whole stones from the submandibular salivary gland area.

**Materials and Methods:** A retrospective study of patients who underwent cervical CT or CT sialography of the submandibular gland salivary tracts, between January 2014 to May 2016 in the Golda HaSharon Campus, Rabin Medical Center. Of the 168 patients who performed this CT scan, only patients with stone disease deep within the submandibular gland or around it were included. We identified 26 cases of sialolithiasis treated with sialendoscopy under general anesthesia during the research period, and underwent post-procedure follow up at one month. The research group included 7 females (26.92%) and 19 males (73.08%). The mean age of the subjects was 50.9 years, range 18 to 77 years.

**Results:** In 15 patients (57.7%) the stone or stones were removed in whole. In 11 of the remaining cases (42.3%) the stone remained in its place or was partially removed. Of the parameters examined, only the horizontal distance between the stone and the reference point in the mandible bone statistically significantly predicted success of endoscopic removal. For the other parameters examined including number of stones, anatomical position of the stone, its size and its depth in relation to the mandible bone, there was no statistical significance in the ability to predict successful removal of the stones.

**Conclusions:** When the horizontal distance of the stone from the mandible bone measures less than 14.25 mm, successful endoscopic removal of the stone in whole is highly likely.
Session 8: Innovation & Informatics (Friday, November 03, 2017 09:30)

Oral

Innovations and Informatics

**Ground Glass Opacity Detection Using Fully Convolutional Neural Networks**

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\(^1\)Zebra Medical Vision, Shefayim, Israel
\(^2\)Department of Radiology, Rabin Medical Center, Israel

**Purpose:** Ground Glass Opacity (GGO) is a radiologic feature which appears as a pulmonary opacity with vague boundaries without obscuring the underlying vascular and pulmonary markings on a Chest Computed Tomography (CT) scans. GGO is a non-specific sign seen in various pathologies, most commonly: alveolar inflammation, infection, hemorrhage, edema or cancer. Relative to more discreet findings, GGO is often considerably more fine and subtle and thusly at times overlooked.

We present an automated method for detection of GGO in CT scans based on a Fully Convolutional Neural Network.

**Material and methods:** We utilized segmentation of axial CT reconstructed images to reduce the number of CT studies required as training data to obtain high accuracy of GGO detection (96.9%) using a Deep Learning (DP) technique. We explore two architectures of Fully Convolutional Neural Networks: U-Net and Fully Convolutional DenseNet. DenseNet-like network is first applied to the Medical Imaging domain and achieves superior detection accuracy due to a higher layer connectivity within a network. We report results of GGO binary classification per axial slice and measurement of slice segmentation goodness (Dice score). The algorithm is constructed to be applicable to any Chest CT scan, allowing for variations in data acquisition protocols such as inspiration/expiration imaging and technical acquisition variations which may result in the appearance of the lung tissue.

**Results:** The best accuracy was achieved on the deepest FC-DenseNet (with 103 convolutional layers) - 96.9% (with specificity 98.3% and sensitivity 80.5%). Higher accuracy is obtained from a deep FCN with skip connections, which follows the principle that convolutional networks with skip connections are much easier to optimize than deep CNNs. The best Dice score, 72.5%, is achieved by U-Net with 97 convolutional layers, which is impressive considering the level of inconsistency in GGO tagging due to high vagueness in the opacity boundaries.

**Conclusions:** We accomplished an end-to-end approach for Ground Glass Opacity detection using Fully Convolutional Neural Networks. We explored several architectures of varying depth, U-Net- and DenseNet-like FCNs, and, as expected, the deepest networks showed the best performance. The best accuracy we achieved is 96.9%, which is promising, given the complexity of GGO detection and represents a significant improvement on similar prior endeavors.
Purpose: In the past years, great advances have been made in the way we diagnose various diseases. Most of the new approaches to medical diagnosis rely on imaging, and in large part imaging’s ability to compare different studies done at different times or from different modalities. However, finding anatomical or pathological changes over varying periods of time can still be difficult. Comparing studies can be quite challenging due to anatomical structure’s Complexity and changes in 3 dimensions that are hard to perceive. Using computational algorithms may lead to an improvement in the ability to compare between sets of images. In the current study an iterative study comparison algorithm was developed. The Algorithm includes a correlation in three planes and alignment between images shifted at different angles in the coronal and axial field of view.

Methods: An algorithm for matching non-contrast head CT studies was developed, the algorithm uses a multi-phase approach to matching studies. The first step of the algorithm organizes DICOM images into easily analyzed three-dimensional matrices. The algorithm creates a correlation on the x, y, and z-planes. The background of the images was removed using the Otsu thresholding method. The next step in analysis transforms axial images into synthetic coronal images to allow the algorithm to compute the error rate on that plane (Fig. 1). Angle corrections and comparisons of the studies is done iteratively until a minimal value of the mean square error between image series is reached. Using the algorithm analysis of 20 head CT scans of 10 patients (2 for each patient) were done and the mean square error was compared for each step of the algorithm.

Results: In the analysis of 10 series of two non contrast head CT studies showed a rate of mismatch between two different sets of images has decreased from an average of approximately 45% before analysis to 32% after the first step of iteration on the x, y and z planes. Adding the rotation correction algorithm with multiple iterations achieved a mismatch of less than 5% for all the compared scans.

Conclusions: Use of an iterative triple plane comparison algorithm is a feasible approach for comparison between two series of images of the same patient. Based on the results achieved thus far and with further improvements, this algorithm may be of future clinical use. Thus, Creating the basis for advanced study comparisons.
3[mm] Slices Co-registration:

Original main and secondary Images → XYZ-correlated Images

Axial images after Coronal Alignment → Axial Image after Axial Alignment
**Decision Support System for Categorization of CT Liver Metastases into Primary Cancer Sites**

Michal Marianne Amitai¹, Avi Ben-Cohen², Idit Diamant², Noa Rozendorn³, Stephen P. Raskin¹, Eli Konen¹, Hayit Greenspan², Eyal Klang¹

¹Department of Diagnostic Imaging, The Chaim Sheba Medical Center, Israel
²Biomedical Engineering, Tel Aviv University, Israel
³Sackler School of Medicine, Tel Aviv University, Israel

**Purpose:** In radiologist every day practice once a liver metastasis is detected on CT examinations, sometimes the primary site is unknown, necessitating a process of finding the primary site, which may be challenging, time-consuming and require multiple examinations. The aim of this study is to evaluate a computer algorithm that provides decision support for radiologists in the task of categorizing liver metastases into their primary cancer sites.

**Materials and Methods:** The suggested method is a learning based approach, using portal phase CT data as the input source. Consecutive examinations were retrieved retrospectively using a search for newly diagnosed liver metastases in portal phase CT images. The data set included 100 patients with 192 lesions with 4 types of primary cancers: melanoma, colorectal carcinoma, pancreas and breast. A development set was used to establish the proposed system and a separate evaluation set was used so we could test our system on a new dataset. The data was divided as follows: 29 patients with 50 lesions in the development set and 71 patients with 142 lesion cases in the evaluation set. Each metastasis was circumscribed by a radiologist in portal phase and in non-contrast CT images. Visual features were computed from these images, combined into feature vectors and classified using Support Vector Machine classification. A variety of different features were explored and tested. A leave one out cross-validation technique was conducted for classification evaluation.

**Results:** Experiments were conducted on a separate set of 142 lesion cases taken from 71 patients with four different primary sites. Multi-class categorization results (4 classes) achieved low accuracy results. However, the proposed system was found to provide promising results of 83%, and 99% for top 2, and top 3 classification tasks, respectively. Moreover, when compared to the radiologists’ ability to distinguish the different metastases, the system shows improved results.

**Conclusion:** Automated systems, such as the one proposed, show promising new results and demonstrate new capabilities that, in the future, will be able to provide decision and treatment support for radiologists towards more efficient detection and treatment of cancer.
Purpose: Automatic detection of liver lesions in CT scans poses a challenge for researchers. The purpose of this study was to evaluate a new deep learning approach that models the variability between metastases boundaries and interiors, and assess whether it can support an automated lesion detection system.

Materials and methods: This research was supported by the ISRAEL SCIENCE FOUNDATION (grant No. 1918/16). Convolutional neural networks (CNN), which are loosely based on the theory of biological neural networks, operates by propagating (“convoluting”) small matrices across the image to create a new filtered layer, this process is repeated to create many layers (deep learning), each layer is built on the previous one. In the end, a loss function provides probabilities from the last layer. A process of “back-propagation” optimizes the network using new images. In this study a multi-class CNN is proposed to categorize input image patches into sub-categories of boundary and interior patches, the decisions of which are fused to reach a binary lesion versus non-lesion decision. Consecutive portal CT examinations were collected and a senior radiologist with 8 years of experience marked the liver and metastases boundaries. True positive and false positive rates of lesion detection by the algorithm were evaluated per case for the entire data set and for lesions > 10 mm.

Results: For validation of our system, we used CT images of 132 livers with 498 2D marked liver metastases. True positive rate and false positive per case were 85.9% and 1.9 for the entire data set and 93.0% and 1.5 for lesions > 10 mm.

Conclusion: Our new deep learning approach algorithm shows promising results in liver metastases detection task. Using prior knowledge of medical data, such as differences between metastases interior and boundaries, may enhance CNN results.
Session 8: Innovation & Informatics (Friday, November 03, 2017 09:30)

Oral

Innovations and Informatics

Computerized Tumor Burden Evaluation and New Tumors Detection in Longitudinal Liver CT Scans

Leo Joskowicz¹, Refael Vivanti¹, Naama Lev-Cohain², Jacob Sosna²

¹School of Computer Science and Engineering, The Hebrew University of Jerusalem, Israel
²Department of Radiology, Hadassah Hebrew University Medical Center, Israel

Purpose: Radiological longitudinal follow-up of liver tumors in CT scans is the standard of care for disease progression assessment and for liver tumor therapy. Finding new tumors in the follow-up scan is essential to determine malignancy, to evaluate the total tumor burden, and to determine treatment efficacy. Since new tumors are typically small, they may be missed by examining radiologists.

Methods: We describe a new method for the automatic detection and segmentation of new tumors in longitudinal liver CT studies and for liver tumors burden quantification. Its inputs are the baseline and follow-up CT scans, the baseline tumors delineation, and a tumor appearance prior model. Its outputs are the new tumors segmentations in the follow-up scan, the tumor burden quantification in both scans, and the tumor burden change. Our method is the first comprehensive method that is explicitly designed to find new liver tumors. It integrates information from the scans, the baseline known tumors delineations, and a tumor appearance prior model in the form of a global convolutional neural network (CNN) classifier. The method is hybrid so to benefit from the advantages of both human-engineered and machine learning methods. It includes deformable liver and known tumors registration and candidate new tumors detection and segmentation. Unlike other deep learning based methods, it does not require large tagged training sets.

Results: Our experimental results on 37 longitudinal liver CT studies with 246 tumors, of which 97 were new tumors, with radiologist approved ground-truth segmentations yields a true positive new tumors detection rate of 86% vs. 72% with stand-alone detection, and a tumor burden volume overlap error of 16%.

Conclusions: New tumors detection and tumor burden volumetry are important for diagnosis and treatment. Our new method enables a simplified radiologist-friendly workflow that is potentially more accurate and reliable than the existing one by automatically and accurately following known tumors and detecting new tumors in the follow-up scan.
Innovations and Informatics

Tumors Delineation for Volumetry: A Large-Scale Clinical Study of Observer Variability

Leo Joskowicz¹, Dror Cohen¹, Nadia Caplan², Jacob Sosna²
¹School of Computer Science and Engineering, The Hebrew University of Jerusalem, Israel
²Department of Radiology, Hadassah Hebrew University Medical Center, Israel

Background: True volumetric measurements of tumors and pathologies in CT scans requires the delineation of the structure boundaries. It is well known that different radiologists generate different delineations. The delineations variations depend on many factors, e.g., the structure of interest, the resolution, contrast, and quality of the scan, the radiologist clinical experience, the time available for the task, and the radiologist patience and dedication, among others. To properly assess the algorithms and their performance, it is thus essential to quantify the inter and intra observer variability. While quantifying observer variability is recognized as a major issue by radiologists and technologists alike, very few large-scale studies have been conducted to actually quantify it.

Method: We conducted a large manual delineation study at the Hadassah University Medical Center to obtain ground truth segmentation variability data and to quantify the radiologists delineation variability. We retrospectively selected 18 CT studies, 5 from liver tumors, 5 from lung tumors, and 6 left kidneys from the Hadassah University Medical Center with dimensions 512x512x350-466 voxels and resolutions 0.76-0.98x0.76-0.98x1-3.3mm³. Manual delineations of 2,829 axial slices from the 18 CT scans were made by 8-11 clinicians with various levels of expertise. The data analysis focuses on the observer variability as a function of the number of annotators, on the variability by structure and by radiologist expertise, and on the radiologists annotations discrepancies. The structure area/volume variability is defined as the difference between the union (possible) and the intersection (consensus) of the voxels inside the delineations.

Results: The kidney, liver tumors, and lung tumors contour delineation variability is 7%, 14% and 16% for 3 observers and 13%, 26%, and 32% for 10 observers, respectively. The variability convergence rate volume reaches to 52%-56% for 3 annotators, up to 86%-89% for 7 annotators. Other quantitative measures by structure and by radiologist expertise as well as statistical confidence intervals have being computed from the delineation results.

Conclusion: The analysis of our results indicates that: 1) the observer variability may be larger than originally perceived; 2) two or even three observers usually do not suffice to properly quantify observer variability; 3) the observer variability converges more slowly than expected; 4) the variability difference between the radiologists according to their expertise and seniority is smaller than anticipated; 5) there are significant differences between the convergence rates for different types of structures, and; 6) there are significant variability differences from case to case.
Innovations and Informatics

3D Multi-Modal Fully Convolutional Neural Networks (FCNN) Architectures for Automatic Segmentation of Anatomical ROIs in Seeding Pre Surgical Brain Tractography

Arnaldo Mayer², Itzik Avital¹, Eli Konen², Galia Tsarfaty², Nahum Kiryati¹

¹Electrical Engineering, Tel-Aviv University, Israel
²Diagnostic Imaging, Sheba Medical Center, Israel

Purpose: White matter tractography has become an important tool for neuro-surgical planning and navigation. Generating accurate tracts in a brain deformed by a tumor may prove to be a challenging task. Beside a robust tractography algorithm, significant neuro-anatomical expertise is required to accurately delineate the fiber seeding ROIs. For example, an accurate tractography of the optic radiation requires the delineation of the Calcarine sulcus and the lateral geniculate nucleus (LGN). In addition to the neuro-anatomical knowledge, significant amount of time is required for the manual delineations of complex, non-planar 3-D structures like the Calcarine sulcus or the precentral gyrus in the motor cortex. Considering the limited amount of time often available for planning an urgent brain surgery, the automatic tools are badly needed for the delineation of anatomical ROIs.

Methods: The accurate segmentation of tractography ROIs usually requires information from both the anatomical scan, typically T1w, and the principal direction of diffusion (PDD), that is the RGB color-coded map. For this intrinsically multi-modal segmentation task, we propose two alternative FCNN architectures: the W-net and the Y-net. Each architecture implements a different approach to the combination of anatomical (T1w) and orientation (PDD) information.

Results: Both architectures are successfully validated on 3-D segmentations of the Lateral Geniculate Nucleus (LGN) and the Calcarine sulcus, namely the seeding ROIs (SROI) for the optic radiation tract. A dataset of 90 pre-surgical cases for which manual 3-D segmentation of the ROI was provided. The average Dice overlap coefficient, computed between manual and automatic segmentation, demonstrated the superiority of the proposed methods over state-of-the-art V-net architecture: W-net (Dice=0.79), Y-net(Dice=0.795) and V-net (Dice=0.73).

Conclusions: The presented method demonstrated the feasibility of automatic segmentation of complex neuro-anatomical ROIs jointly using multiple MRI sequences. In future work, the method will be further extended to motor and languages ROIs.
Session 8: Innovation & Informatics (Friday, November 03, 2017 09:30)

Oral

Innovations and Informatics, Other

Emergency Department CT Usage Variability Over Days of the Week and Calendar Months

Shelly Soffer¹, Eli Konen¹,², Arik Beytelman², Mohamad Yassin¹,², Jacob Or¹,³, Orly Ohana¹, Eyal Klang¹,², Eyal Zimlichman¹,⁴

¹Sackler School of Medicine, Tel Aviv University
²Department of Diagnostic Imaging, Chaim Sheba Medical Center
³Department of Emergency, Chaim Sheba Medical Center
⁴Hospital Management, Chaim Sheba Medical Center

Purpose: Emergency department (ED) CT utilization rates are steadily increasing. The aim of this study is to evaluate ED CT usage variability over different days of the weeks and calendar months.

Materials and Methods: All one tertiary hospital’s adults (≥18) ED visits were collected during a time frame of two calendar years (1/2015 – 12/2016). Data was retrieved from the hospital’s computerized records and included patients’ demographics, date of ED visits and documentation of CT usage for each patient. The days of the week (Sunday to Saturday) and the calendar months (January to December) were retrieved using Microsoft Excel formulas. One-way ANOVA with Tukey post hoc test evaluated distribution differences between groups.

Results: Overall, during the study period there were 223,438 ED visits and 45,674 CT examinations. This constituted a CT utilization rate of 20.4% (number of CTs/number of ED visits). The average number of daily ED visits was 305.7±55.8 (176 - 443). Highest number of daily ED visits were observed in the first weekday (Sunday) 375.2±34.5 (p<0.001) and lowest in the two weekend days, Friday 255.9±21.8 (p<0.001) and Saturday 222.2±17.2 (p<0.001).

The average number of CTs per day of the week was 62.3±12.9 (26 - 95). A peak of CT usage was seen during the first weekday (Sunday) with 71.5±11.1 CTs (p<0.001), and a trough was seen in the two weekend days, Friday 57.7±9.0 (p<0.001), and Saturday 45.0±8.4 (p<0.001). CT utilization rate was significantly higher on Fridays with a rate of 22.6% (p<0.001) in comparison to an average daily rate of 20.5%.

The average monthly ED visits rate was 9,309.9±370.8 and the average monthly number of performed CTs was 1,896.5±88.1. There was no statistical difference between months for both ED visits (p=0.391) and number of CT examinations (p=0.311).

Conclusions: The highest numbers of ED visits and performed CTs were seen on the first weekday versus the lowest numbers seen in the two weekend days can be explained either by the tendency of religious patients to avoid when possible driving to medical facilities or by lower referrals from Family Physicians during weekends. There were no significant differences between the calendar months, both for ED visits and for performed CTs. Higher CT utilization rate on the weekend could be explained by lower patient load and by the fact that staff on weekends usually is less experienced compared to weekdays. Analysis of large data sets can help in the management of facilities’ resources, and also identify potential over usages.
Philip Lenard (1862–1947) and Johannes Stark (1874–1957) were outstanding German physicists whose groundbreaking research significantly contributed to creating the foundations of modern physics necessary for the development of the field of radiology. Lenard received the Nobel Prize in 1905 for his research on cathode rays and their properties. Stark received the Nobel Prize in 1919 for his discovery of the Doppler Effect in canal rays and the splitting of spectral lines in electric fields (known as the Stark effect). Till his death, Lenard considered himself the Mother of X-rays as he had “laid all the ground work” for the discovery made by William Röntgen in 1895.

Lenard and Stark were fervent Germans nationalists and early proponents of the Nazi ideology, unequivocally supporting Adolf Hitler as early as 1924. They became the most notable leaders of the Deutsche Physik movement which reached its peak under the Nazi regime, with Lenard serving as Chief of Aryan physics. Together they led a campaign to “cleanse” German physics departments from “foreign” (euphemism for Jewish) influences in an effort to Aryanize the field of physics. They believed that the priority of scientists should be to serve the people (Volk), focusing on practical fields of research that could help German arms production and industry. They proposed that all scientific leadership positions in Germany should be held by pure-blooded Aryans. Therefore, major targets of their attack were the field of theoretical physics in general, and Albert Einstein in particular. In 1920 Lenard led an anti-Einstein campaign, against Einstein’s theories (Einsteinismus) of relativity and then against Einstein himself. The campaign escalated to death threats, mobs of brown-shirts around Einstein’s home and violent disruptions of his lectures.

Lenard and Stark’s campaign was effective in depleting German university departments of their outstanding theoretical physicists, who fled Nazi Germany. In an ironic twist, the work of these persecuted theoretical physicists was instrumental in the development of the atomic bomb by the Allied Forces. As radiologists, we have a special duty to learn about the dangers to our basic science of physics when it is compromised by political ideology.
Doxorubicin Eluting Intra-Arterial Therapy for Pediatric Extra-Abdominal Desmoid Fibromas – A Cases Series

Eldad Elnekave1, Eli Atar1, Elchanan Bruckheimer3, Shifra Ash2

1Radiology, Rabin Medical Center, Israel
2Oncology, Schneider Children's Medical Center
3Cardiology, Schneider Children's Hospital

Purpose: Desmoid tumors (aggressive fibromatosis) are locally aggressive lesions associated with substantial morbidity and mortality due to invasion of adjacent neurovascular structures and vital organs. The disease is unpredictable and enigmatic. While 5-15% of cases are seen in patients with Familial Adenomatous Polyposis (FAP) syndrome, the vast majority arise sporadically. The etiology of desmoids remains poorly understood and the therapeutic approaches in their management remain diverse. Surgical resection is curative in less than 50% of cases and residual recurrence tends to be increasingly aggressive and infiltrative. We evaluated the efficacy of intra-arterial doxorubicin eluting bead embolization for extra-abdominal desmoid fibromas.

Materials &Methods: Three patients aged 6–16 years underwent between 2-4 sequential treatments of Doxorubicin-eluting microspheres (100um-300um) at doses of 50-100 mg per treatment. All treatments were performed using super-selective angiographic technique.

Results: Tumor volumes were reduced by greater than 90% in all cases. There were no clinically significant adverse treatment effects, with the exception of transient lower extremity neuropathy in one patient.

Conclusion: These are the first cases of selective arterial chemo-embolization for desmoid fibromas described in the English literature; our results suggest a safe and effective new treatment option for non-operable candidates or as a neo-adjuvant option.
Session 3: Vascular Interventional Radiology (Thursday, November 02, 2017 11:30)

Oral

Interventional Radiology

Revascularization for Limb Salvage of Native Femoropopliteal Vasculature after Chronic Occlusion of Bypass Graft

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¹Diagnostic Imaging, Sheba Medical Center, Israel
²Vascular Surgery, Sheba Medical Center, Israel

Purpose: This study evaluates the feasibility of limb salvage revascularization of chronic total occlusion of native infrainguinal arteries in patients with chronically occluded lower limb bypass grafts.

Methods: A retrospective review of patients who underwent revascularization of native vasculature after failure of femoropopliteal bypass graft in critical limb ischemia. Age, gender, occluded vasculature, date and type of bypass surgery, date and method of revascularization were recorded. Technical success was assessed.

Results: Between the years 2014-2017, 13 patients and 14 limbs have undergone endovascular revascularization of the native femoropopliteal vasculature. In 14 of cases the native vessels were occluded for 86.4 months ± 73.8 months. The procedure was successful in all cases.

Conclusion: Revascularization of native vasculature after long standing occlusion is feasible and should be considered as a limb salvaging treatment option before amputation.
Introduction: Primary Hyperaldosteronism (PH) is a condition of excess of aldosterone production and occurs secondary to adrenal cortical adenoma, bilateral adrenal hyperplasia, or rarely, adrenal carcinoma. In some cases of PH, adrenal venous sampling (AVS) is considered mandatory to differentiate between unilateral and bilateral adrenal disease, to decide whether the patient will benefit from unilateral adrenalectomy (AE).

Mainly due to technical difficulties and lack of experience this procedure is not commonly performed.

Aim: To share our experience with AVS.

Methods: Five patients underwent AVS. All had screening and confirmatory test consistent with PH, but with doubt as to surgical treatment. CTV of the abdomen was performed before AVS, to identify venous anatomy.

During AVS, both adrenal vein were sequentially catheterized during continuous ACTH infusion and sampling simultaneous with peripheral blood. Successful adrenal vein cannulation was confirmed based on selectivity index >5 (adrenal/peripheral vein cortisol concentration ratio >5). We used lateralization index (LI)>4 to identify unilateral disease.

Results: Two patients with positive LI were referred to unilateral AE: The first is a 42 y.o. male, with a 24 mm Rt. adrenal mass and only mild LT adrenal hyperplasia, but following AVS lateralization he underwent Lt. AE. The second is a 55 y.o. male, with a small 13 mm Lt. adrenal adenoma. We were uncertain upon surgery based on morphology alone. After AVS lateralization however, we were definite regarding Lt. AE. In both patients after surgery, hypokalemia resolved and hypertension significantly improved.

Two patients (57 and 62 y.o), with negative lateralization on AVS had not been referred to surgery despite having 10-15 mm unilateral adenomas. In one 62 y.o male, catheterization of the right adrenal vein failed. No complications were observed.

Summary: Our initial experience shows that AVS can be done successfully with no complications. In some cases AVS can help clinicians choose the appropriate treatment.
Interventional Radiology

Cystic Duct Embolization With or Without Gallbladder Sclerosation in High Risk Patients as an Alternative to Surgical Cholecystectomy

Tal Friehmann\textsuperscript{1,2}, Sergey Litvin\textsuperscript{1,2}, Gil Ohana\textsuperscript{1,2}, Eli Atar\textsuperscript{1,2}

\textsuperscript{1}Radiology, Rabin Medical Center, Israel
\textsuperscript{2}Imaging, Tel Aviv University, Sackler School of Medicine

**Purpose:** to check if embolization of the cystic duct with or without gallbladder embolization, via a preexistent percutaneous tract is a safe and efficient alternative to cholecystectomy in high risk patients.

**Materials & methods:** From 2013 to 2017, 5 patients, 2 female and 3 male age 76-91 years (average 78.8) with existent gallbladder drainage who were not candidates for surgical cholecystectomy because of severe comorbidities underwent intervention. Cystic duct embolization via the drainage tube tract was performed in all and in 4 patients additional sclerization of the gallbladder with 3\% Aetoxysclerol was added. Follow up was prior to the safety drain removal after 2-3 weeks and ultrasonographic and clinical follow up.

**Results:** No major nor minor complications at the early follow up period were recorded. One patient developed one year after the procedure bile leak through the old drainage tract, that was successfully recannulated and resclerosed. No patient developed signs of acute cholecystitis during follow-up period.

**Conclusion:** Cystic duct embolization +¬ gallbladder embolization is a safe and efficient alternative to cholecystectomy in high risk patients.
Interventional Radiology

**Mesenteric Ischemia in Hemodialysis Patients - Is There a Role for Endovascular Intervention?**

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**Purpose:** to report our short and long term results of endovascular intervention in hemodialytic patients with chronic abdominal angina

**Materials and methods:** during 10 years, 5 patients (3 female and 2 male, age 52-87) underwent 7 endovascular interventions at our institution in the SMA or Celiac arteries. Primary stenting of the stenotic lesions in one vessel was performed in all patients and secondary intervention with balloon angioplasty. Patients underwent clinical, laboratorial and imaging follow-up.

**Results:** No major or minor complications had occurred, immediate clinical, laboratory and gain weight was achieved in all. In 2 patients clinical symptoms recurred due to in-stent restenosis that were retreated successfully.

**Conclusions:** Chronic Mesenteric Ischemia is not rare in HD patient and should be included in the differential diagnosis of chronic abdominal pain in these patients. Endovascular intervention should be considered as a first option even in this high-risk group of patients and can be repeated.
New Classification of Abernathy Syndrome

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³Tel Aviv University, Sackler school of Medicine, Israel

Purpose: To report our data demonstrating that all type 1 Abernathy syndrome are actually type 2 when direct angiographic maneuvers are used, thus sparing them from liver transplantation

Material and methods: During 15 years, 8 children with Abernathy syndrome underwent angiographic interventions to close the congenital shunt. Of them, 7 were considered as Abernathy type 1. Angiography performed while obstructing the shunt to detect remnant portal system was performed. The shunt was gradually occluded by serial sessions.

Results: In all 7 patients that went 2 gradual shunt closures with stents and coils untill complete shunt occlusion a normal portal system was developed with return of ammonia levels to normal without need for liver transplantation.

Conclusions: In all Abernathy syndrome patients the portal system exists and can return to normal after serial percutaneous procedures thus there is only one type of Abernathy syndrome- all are treatable percutaneously.
Interventional Radiology

What is the Right Timing for Renal Mass Biopsy Before Ablative Treatment?

Ayelet Wandel, Elias Sorin, Ami Sidi, Alexander Tsivian

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Introduction: The timing of renal mass biopsy during ablative treatment remains controversies. On one hand, biopsy performed simultaneous with the ablative procedure, in one setting reduce patient anxiety and financial burden. On the other hand the procedure is performed without histological evidence of malignancy and increase the risk of bleeding that may impair the ablative efficacy. In a staged procedure, with biopsy performed at a different timing before the ablation, the treatment is performed on a proven malignancy, but it requires two hospitalizations with increased cost and patient’s anxiety. At our institute until 2014, renal mass ablation performed simultaneous with the biopsies. Since 2014, the procedure is staged.

Purpose: The purpose of our work is to summarize our experience and to compare the two approaches.

Material and methods: From April 2012 to August 2016, 43 ablative procedures on renal masses were performed, in 41 patients (32 males, 9 females, average age 67, age range 47-89). At this work we included 38 patients who underwent both biopsy and ablation treatment, Group I: 16 patients – underwent simultaneous biopsy and ablation. Group II: 22 patients - underwent biopsy at a prior date before the ablation. At this period of time we performed 49 biopsies, 2 of them oncocytoma, 1 angiomyolipoma, 6 non-renal tumor (18%).

Results: Group I: one patient with post biopsy bleeding and ineffective ablation. Histological result: oncocytoma. Group II: one patient with post biopsy bleeding needed treatment with blood transfusion.

Conclusion: After more than 4 years of experience with thermal ablation we believe that there is advantage in dividing the biopsy and the ablation to separate dates. We perform ablation only on histologically proven tumor and by this preventing unnecessary invasive procedure.
Interventional Radiology

The Application of Thermal Ablation Treatment for Recurrent and Residual Renal Cell Carcinoma (RCC)

Ayelet Wandel\textsuperscript{1}, Sorin Elias\textsuperscript{1}, Ami Sidi\textsuperscript{2}, Alexander Tsivian\textsuperscript{2}

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Introduction: The management of recurrent and residual RCC after prior treatment is challenging. The most common treatment strategy includes radical or partial nephrectomy.

Purpose: To describe percutaneous radiofrequency ablation (PRFA) as a treatment modality for recurrent and residual RCC.

Material and methods: Between April 2012 and August 2016 PRFA was performed in 14 (11 males and 3 females) patients with recurrent or residual RCC. The average age was 59 years (range: 42-76).

Results: Percutaneous radiofrequency ablation was performed in 5 patients with recurrent disease after nephron sparing surgery and in 3 patients with residual disease (2 after PRFA and 1 after nephron sparing surgery). 4 additional patients underwent the procedure for metachronous tumors in the contralateral kidney (2 in a single kidney after radical contralateral nephrectomy and 2 after partial nephrectomy). In 2 patients with recurrence after partial nephrectomy, PRFA was not carried out due to colonic adhesions and proximity of the ureter to the lesion, which were not amenable to separation with Hydro-dissection. One patient underwent partial nephrectomy and the second laparoscopic cryo-ablation. There were no complications in all PRFA patients. During a follow-up period of 7-63 months (average 29) no recurrence has been detected.

Conclusions: Percutaneous radiofrequency ablation appears to be an effective treatment for patients with recurrent or residual RCC and should be included in the treatment arsenal of this challenging situation.
Interventional Radiology

Reduced Periablational Inflammation of Microwave Ablation (MWA) Compared to Radiofrequency (RF) and Irreversible Electroporation (IRE)

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Purpose: To determine the extent of variable post-ablative inflammatory response in the periablational tissue when using microwave (MWA), radiofrequency thermal ablation (RFA), and irreversible electroporation (IRE).

Materials and methods: Wild type C57b 9-10 month old mice (n= 27) were anesthetized and subject to laparotomy to enable direct liver ablation. For MWA (n= 27), 10 W were applied for 12 seconds [AMICA MWA system]. RF liver ablation was performed by using a clinical RF coagulator (CC-1, Cosman Coagulation System; Radionics, Burlington, Mass) 5 minutes and was adjusted to 70°C 6 1, IRE liver ablation was performed by using a clinical IRE generator (Nanoknife; Angiodynamics, Marlborough, Mass). The exposed lobe of the liver was placed between a pair of 10- cm diameter circular flat-plate electrodes (Tweezeroide 522; BTX, a division of Genetronics, San Diego, Calif) adjusted to 500 V/cm, a 70-sec pulse length, and 90 pulse repetitions.

The mice were sacrificed at day 1, 3, 7, 14, 21 to permit analysis of the dynamic inflammatory changes in the border zone. Activated inflammatory cell populations in the border zone assessed including Polymorphonuclear cells (Ly-6B.2), Macrophages (F480), and Activated Myofibroblasts (αSMA).

Additionally, cells Entering G1 Phase (CDC47) were measured, counted and compared among the three methods of ablation in both the periablational and distant regions of the liver.

All data were expressed as means and standard deviations and were compared by using two-tailed t tests and analysis of variance for selected group comparisons.

Results: Overall, the border zone was less extensive in MWA (37 cm) (stdev=10.4) than (RF) (82 cm) (stdev=8.6), and (IRE) (108 cm)(stdev=10.3), (p<.01). Although similar amounts of activated Myofibroblasts (αSMA) were seen between day 1 and day 7 for the three methods of ablation MWA 2.6-121.6 cells (P<.009), for RF 6.6-113.6 cells (P<.05), for IRE 1.1-27.7 cells (P<.000) respectively, fewer Macrophages (F480) were seen in the inflammatory response between day 14 and day 21 for MWA 16-17 cells and IRE 16-20 compared to RF 40.3-43 (P<.05) for both time points.

Furthermore, there were fewer percentage of hepatocytes cells that entering G1 Phase (CDC47) in MWA (35%) in the distant liver compared to either RF (44%) or IRE (60%).

Conclusion: MWA produces less of an inflammatory response than RF or IRE. Reduced recruitment and activation of these potentially tumorigenic cell populations potentially may lead to a reduced chance to develop distant liver tumor after MWA.
Interventional Radiology

Chemoembolization of Uterine Arteries for Treatment of Nontubal Ectopic Pregnancy with Positive Cardiac Activity

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Imaging, Rabin Beilinson Medical Center, Israel

Purpose: To review and share our center experience with combined endovascular-pharmacologic treatment of nontubal ectopic pregnancy with positive fetal cardiac activity.

Materials and Methods: We conducted a retrospective study on all cases of non-tubal ectopic pregnancy with positive fetal cardiac activity treated with uterine artery embolization via local methotrexate (MTX) injection and subsequent systemic MTX treatment in our university-affiliated, tertiary medical center from January 2000 to March 2014. Data on patient demographics, endovascular procedure, imaging, adverse effects and follow-up were retrieved from the patient’s computerized medical files.

Results: The study group comprised 14 women. Treatment was successful in 93% of cases with beta-human chorionic gonadotropin returning to undetectable levels within 12-147 days (mean, 61.2 days). In one woman with cervical pregnancy, fetal cardiac activity remained two days after protocol completion. Mild adverse effects included abdominal discomfort (30%), groin or leg pain (11%), and local puncture site irritation (10%). No serious adverse events were observed. Among 8 women who stated that they were interested in becoming pregnant, 6 (75%) had a subsequent pregnancy, although 2 of them (30%) had spontaneous abortions.

Conclusion: Intra-arterial MTX followed by temporary bilateral uterine artery embolization combined with systemic MTX treatment, is a safe, effective and fertility preserved technique in the management of advanced non-tubal ectopic pregnancy with positive fetal cardiac activity.
Ultrasound Guided Renal Intervention Training Using Anatomically Realistic Kidney Simulator

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3Radiology, East Tallinn Central Hospital, Estonia
4Sackler School of Medicine, Tel Aviv University, Israel

**Purpose:** Use of image guided percutaneous renal interventions (i.e. biopsy, tumor ablation and/or nephrostomy) is growing worldwide, whereas methods of resident training have recently not been developed. Our aim was to evaluate the role of the anatomically realistic and economically affordable kidney simulator in resident training.

**Materials and Methods:** 1 day training of urology residents and 5 days training of radiology residents were conducted using anatomically realistic kidney simulators made from disposable bio-soluble material based on 3D data sets of CT (SafeToAct Ltd., Estonia). The physical content of the phantom material and its ultrasound properties are similar to human tissue. 10 urology trainees in Moscow and 12 radiology residents in Tallinn were trained by two experienced interventional radiologists. Following hands-on training, trainees completed validated questionnaires regarding their previous experience in ultrasound-guided interventions, simulator ultrasound properties and overall usefulness, and rated their confidence in performing renal interventions prior to and following the training (1-40 scale).

**Results:** The confidence of urologists’ performance increased by 14% after 1 day training and the confidence of the radiologists increased by 26% after 5 days group training. All trainees regardless their previous experience reported that they would recommend such training to colleagues and it should be available for their daily practice. Moreover, respondents emphasized the importance of real time feedback and simulators for other anatomic regions.

**Conclusion:** The survey revealed that anatomically realistic simulators should be included into the resident training program for renal interventions. Development of real-time performance feedback software and simulators of additional anatomies is under way.
Session 3: Vascular Interventional Radiology (Thursday, November 02, 2017 11:30)

Oral presentation

Interventional Radiology

**Identification of New Combination and Configuration of Radiation Attenuation Elements for Personal Radiation Shielding Garment in Interventional Radiology**

Gideon Waterman\(^1\), Bruce Zwiebel\(^2\), Kenneth Kase\(^1\), Oren Milstein\(^1\)

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\(^2\)Vascular and Interventional Radiology, Tampa General Hospital, USA

**Purpose:** The purpose of this project is to alleviate the burden incurred by current radiation protection equipment on interventional radiology physicians and staff leading to orthopedic and musculoskeletal issues resulting in missed work days and shortened careers. This is being accomplished through the efficient use of advanced shielding materials combined with an ergonomic system which comfortably provides protection over the entire diagnostic range.

**Material and methods:** Energy absorption coefficients from National Institute of Standards and Technology (NIST) for all elements with \(Z > 45\) were ranked for discrete energies incrementally ranging from 20 keV to 150 keV. Elements which are feasible for use with the highest absorption coefficients for specific energies over this range were compared to Lead (Pb) shielding at the specific x-ray energies corresponding to their superior absorption coefficients. Multiple homogenous distribution and layered configurations of including those elements were designed based on optimizing results for 150 kV quality, and MCNP (Monte Carlo N-Particle Transport Code) simulations were carried out to measure transmission compared to 0.5mm Pb and the current state of the art at 100 and 150 kV to identify configurations that had the greatest reduction in photon fluence and dose transmission compared to Pb on a per mass basis. Secondly, a polymer sheet was configured in a hollow honeycomb core design filled with cell voids filled with radiation attenuating materials to calculate the mass savings achieved compared to conventional apron designs which have much higher proportions of polymer materials.

**Results:** Based on the absorption coefficients and MCNP results showing percent dose transmission, the greatest potential for improvement in protection over Pb near 80 keV, just below its K-edge. Especially near 80 keV, several elements included in our design offer more efficient protection compared to Pb. Based on MCNP simulations, the layered geometry designs performed much better than 0.5 mm Pb, homogenous geometry and the current state of the art apron at both 100 kV and 150 kV. Lastly, using a hollow honeycomb core filled with pure radiation attenuating material resulted in mass reduction of 31.7% while maintaining 0.5mm Pb equivalent protection.

**Conclusion:** We have identified new combinations of elements that can provide better protection compared to 0.5 mm Pb and the current state of the art solution. We are now working towards replicating our simulation results with experimental testing and incorporating the materials identified into a lightweight and ergonomic personal radiation shielding device for interventional staff.
Medical Education in Radiology

**CT and MR Recall Rate in a Large Ambulatory Center - When and Why: The Assuta Experience**

Michal Guindy  
*Medical Director of Imaging Services, Assuta Medical center, Israel*

Assuta Medical Centers performs CT & MR studies in 5 centers throughout Israel.

Between the years 2015-16 we conducted more than 35 K studies. The protocol for each study based on pre-authorization committee when such a recommendation exist.

Clinical information included in the referral letter plays an important part in forming the right protocol. The decision ultimately is taken by the performing technician who can consult with radiologist on his discretion. Most studies are adequately performed but there is seldom a need for recall.

In 900 cases (less than 3%) there was a need to recall patients for further evaluation due to various reasons.

The reading radiologist assess the study and requested further workup describing briefly what was missing and what was necessary to add.

In this study we analyze the reasons leading to recall. Looking at the initial study data the kind of exam involved, i.e. body/neuro etc., name of technician and his profile, time of day the study was performed, as well as the reading radiologist.

Finding: of this study are presented in this paper.
Purpose: In the 2016-2017 school year, our Medical School embarked on a new 6-year curriculum. Core principles of the new curriculum include system-based learning and integration of pre-clinical and clinical studies. In the course "Introduction to the Healthy Human Body", the students were given 6 hours of lectures on the physical principles of imaging, including plain films, CT, ultrasound and MRI. The purpose of our online exercise was to provide clinical examples, to illustrate the physical principles outlined in the lectures.

Materials and Methods: The exercise was presented on Moodle, which is a free and open-source software learning management system, used by many academic institutions, including the Hebrew University. It included 3 video clips: (1) Introduction, (2) an interactive exercise presented on an EDPuzzle platform and (3) a final clip presenting the radiological interpretation to the questions in the exercise. All video clips were prepared at the Medical School’s Multimedia Studio. The interactive exercise included 9 cases, each with 1-6 images. Questions related to the images included identification of anatomic structures and obvious pathological findings. Answers were typed by the students in a provided space and were submitted electronically. Students performed the exercise at home and were instructed to use all available reference materials including textbooks, atlases, articles and the Internet. The interpretation video was available for viewing only after the submission deadline for the exercise. After completing the exercise and viewing the answers’ clip, the students were asked to provide feedback for the exercise.

Results: 247 students submitted the exercise successfully, and no major technical flaws occurred. In their feedback, some students felt that lack of background knowledge in anatomy and pathology limited their ability to answer the questions properly. Nevertheless, altogether the feedback was encouraging, and the students felt that the exercise was engaging, challenging and interesting.

Conclusions: An online exercise for first-year Medical Students in Radiology is feasible and facilitates active participation. Students should be prepared to expect self-learning in order to successfully complete the exercise. This method allows the student to look at clinical problems at home and obviates the need for multiple instructors and special computer classes. We intend to use a similar method for pre-clinical Radiology teaching in various organ systems (e.g. the gastrointestinal system).
Purpose: The aim of this study is to analyze longitudinal trends of adult emergency department (ED) CT utilization in one large tertiary hospital.

Materials and methods: This study retrospectively analyzed data from one adult ED (age>18 years) of a large tertiary hospital. Numbers of ED visits and CT examinations over five years (2012 – 2016) were retrospectively retrieved from the hospital’s computerized records. Annual CT utilization rate in the ED (annual number of patients that performed CT/annual number of ED visits) was calculated for each year. Linear trend between calendar years and CT utilization rate was evaluated (Spearman’s rank order correlation). CT examinations were grouped according to nine body regions: head, abdomen (including non contrast renal colic protocol), chest (including CT pulmonary angiography protocol), chest-abdomen, spine (cervical, thoracic and lumbar), extremities (upper and lower), pelvis, CT angiography (cervical, extremities, aorta) and miscellaneous (other CT examinations not included in previous groups). The percentages of each group from the total of CT examinations were calculated. One way ANOVA with Tukey post hoc testing evaluated differences in CT utilization between the groups.

Results: Overall, there were 467,109 ED visits of which 73,113 patients underwent CT examinations during the study period. A statistically significant strong linear (r=0.9, p=0.037) increase of 13.2% of CT utilization rate was observed during the study period (2012 – 2016), with an average annual increase of 3.3%. The percentages of each of the nine CT groups were: 65.9%, 10.2%, 2.4%, 2.6%, 8.2%, 2.6%, 1.3%, 5.2% and 1.6% from the total number of performed CT examinations, thus making head CT the largest group with 65.9% (p<0.001).

Conclusion: ED CT utilization rate showed an average annual increase of 3.3% over the last five years. Head CT constitutes by far the largest group of performed CT examinations. Clinical decision protocols aimed at reducing ED CT utilization rate may a Pareto have the highest yield when targeting head CT.
Background and Objective: Diffuse idiopathic skeletal hyperostosis (DISH) is characterized by ossification and calcification of paravertebral ligaments and peripheral entheses. DISH is associated with metabolic risk factors such as obesity, type 2 diabetes mellitus, hyperlipidemia, and hypertension. Ankylosing spondylitis (AS) is an additional enthesitis based disease of which obesity is a known feature.

Visceral adipose tissue (VAT) is a hormonally active component of total body fat, that influence several normal and pathological processes. Abnormally high deposition of visceral adipose tissue is known as visceral obesity. This body composition phenotype is associated with medical disorders such as metabolic syndrome, cardiovascular disease and several malignancies. Currently, the gold standard for the quantitative assessment of visceral adipose tissue is CT and MRI.

We aimed to evaluate whether DISH subjects would differ in their visceral adiposity composition from healthy age and gender matched controls and also from AS patients and by this may have a potential role as a surrogate marker for metabolic syndrome in DISH.

Methods: Archived records of 43 DISH subjects (male/female (M/F): 29/14, mean age: 71.74±7.35 years) (Resnick radiographic criteria) and 23 AS patients (M/F: 29/2, mean age:56.1±16.54 years) (Modified New-York Criteria) that had an abdominal CT were included in the study. 43 age- and gender-matched controls (M/F: 27/15, mean age: 72.71 ±8.59 years) with whole spine (to exclude DISH) and abdominal CTs were included. Subcutaneous adipose tissue (SAT) and VAT areas were measured on mid- L3, L4, L5 levels (GE AW server). The average VAT, SAT and VAT/SAT in each level was compared between all groups. Multivariate analysis (ANOVA) was used to eliminate effect of age differences between subjects.

Results: Average VAT was significantly larger in DISH subjects compared to healthy controls on all 3 levels (L3: 24.34 vs 18.43 mm2, P<0.05; L4:23.85 vs 18.05 mm2, P<0.05; L5: 19.09 vs 14.24 mm2, P<0.05). This did not change after correction for age. Average VAT/SAT on L3 vertebral level was also significantly larger in DISH compared to controls (1.26 vs 1.01, P<0.05). No significant difference was seen between average VAT of DISH and AS subjects.

Conclusion: Visceral adiposity, a known marker for obesity was significantly higher in DISH subjects compared to controls substantiating it as a potential surrogate marker for metabolic syndrome. No such difference was detected between DISH and AS, despite significant age differences of these two groups, suggesting a potential shared pathogenic pathway for these two diseases.
Whole Spine and Sacroiliac Joints MRI of Psoriatic Arthritis Patients: Descriptive Study of the Spine and Sacroiliac Joints Involvement

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Background: Detection of axial disease involvement in patients with Psoriatic Arthritis (PsA) has important implications. Data on the structural changes of the spine and sacroiliac joints (SIJ) in PsA is mainly based on plain radiographs and MRI of SIJ. The prevalence and distribution of spinal changes as detected by MRI is largely unknown.

Objectives: To evaluate acute and structural changes in spine and SIJ by whole spine MRI performed in a consecutive clinical cohort of PsA patients.

Methods: Adult PsA (CASPAR criteria) patients were enrolled and underwent clinical exam, CRP, HLA-B27 tests, and MRI of the entire spine and SIJ (spinal sagittal T1-W, STIR and SIJ semi-coronal T1-W and T2-W with fat saturation sequences). The spine was scored for the presence of syndesmophytes, bone marrow edema (BME)/fatty corners and enthesitis. SIJs were scored (Berlin score) for the presence of BME, fatty replacement, erosions, sclerosis, and ankylosis. Findings were further categorized into active sacroiliitis (ASAS), structural sacroiliitis, and spinal findings compatible with PsA (≥3 BME or ≥4 fatty corners). All MRIs were evaluated by an experienced musculoskeletal radiologist, blinded to clinical data.

Results: Ninety six patients completed the study (average age: 50 years old, M:F: 50:46). Active/structural/total sacroiliitis was detected in 26%/11.5%/37.5% of patients, respectively. Spinal PsA was demonstrated in 15.6% (Table 1). Isolated spinal changes were detected in 2.1% of the cohort. Presence of inflammatory back pain (IBP) by ASAS correlated with the prevalence of active sacroiliitis (p 0.024) and PsA (axial/SIJ) (p 0.003). The extent of psoriasis severity (PASI) correlated with both SIJ and whole spine PsA changes. (p 0.02 for both) Gender differences or biologic therapy did not affect the prevalence of SIJ or spine involvement.

Table 1. Whole spine MRI findings.

<table>
<thead>
<tr>
<th>Active Inflammatory Lesions</th>
<th>N/% patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥1 BME corner</td>
<td>22 (23%)</td>
</tr>
<tr>
<td>≥1 posterior elements enthesitis</td>
<td>4 (4%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structural Lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥1 corner erosion</td>
</tr>
<tr>
<td>≥1 fatty corner</td>
</tr>
<tr>
<td>≥1 syndesmophytes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distribution of inflammatory lesions</th>
<th>Cervical 2.1%</th>
<th>Thoracic 18.8%</th>
<th>Lumbar 14.6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution of structural lesions</td>
<td>Cervical 10.4%</td>
<td>Thoracic 32.3%</td>
<td>Lumbar 25%</td>
</tr>
</tbody>
</table>

Conclusions: In the present PsA cohort, active and structural sacroiliitis was more prevalent vs typical spinal SpA changes. In particular, there was a paucity of PsA changes in the cervical spine. The most prominent
axial findings included fatty corners and syndesmophytes. IBP presence and extensive skin disease correlated with PsA axial and SIJ changes.
**Quadratus Femoris Muscle Edema in the Pediatric Population**

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**Purpose:** Ischiofemoral impingement (IFI) is defined by hip pain related to narrowing of the space between the ischial tuberosity and the femur. The presence of quadratus femoris muscle (QF) edema on MRI is a sensitive imaging finding for IFI. Its prevalence in asymptomatic adults is as low as 1.5%, however the prevalence in pediatric population was not yet reported. In our practice we seem to relatively often encounter QF edema in pediatric pelvic MRI examinations. Therefore, the purpose of our study was to assess the prevalence of QF edema in children.

**Material and Methods:** In this retrospective study, pediatric (1-18 years) pelvic MRI examinations performed at our institution between 03/2012 - 05/2017 were retrieved. In each examination axial T2 with fat saturation sequence (ax-T2-FS) was evaluated independently by two musculoskeletal radiologists for the presence of edema in the right and left QF space. In case of reader’s disagreement a consensus was reached by an additional reading session. Studies without axial-T2-FS sequence and studies of reduced quality were excluded.

**Results:** 212 pediatric pelvic MRI studies were identified. A total of 57 studies were excluded (38: no axial-T2-FS sequence, 8: the QF space was not included in the axial-T2-FS, 10: reduced quality of of one study after reconstructive surgery of the pelvis). The remaining 155 MRI studies of 130 children (M:F 1:28, average age 12±3) were evaluated (154 right QF, 154 left QF). Twelve patients had more than one exam. Discrepancy between readers was found in 3 muscles out of 308 evaluated (0.97%). QF edema was identified in 48 muscles of 25 children: in 40 QF muscles (20 right, 20 left, 25 exams, 20 children) isolated QF edema was found and in additional 8 muscles (1 right, 7 left, 7 exams, 5 children) QF edema resulting from a nearby pathology was detected. In 8 other studies a linear high signal, potentially representing a blood vessel, was detected anterior to the QF muscle (5 right, 8 left). In the 12 children with repetitive studies: six had no QF edema in all studies, two had edema appearing on the same side in all studies and in four, edema presence was inconsistent.

**Conclusion:** The prevalence of isolated QF edema in children is 13%, the clinical significance of this finding requires further evaluation.
Neuroradiology

Neurodegenerative Effects of HIV Infection on Volumetric Measures of Brain Structures

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²Clinic for Infectious Diseases, Clinical Center of Vojvodina, Serbia

Introduction: By introducing antiretroviral therapy, the prevalence of most neurological diseases that accompany HIV infection has been reduced, with the exception of the HIV associated neurocognitive disorder (HAND), whose prevalence continues to rise. Conventional MR imaging has proven insufficiently sensitive in detecting subcellular damage to the central nervous system in HIV infection.

Purpose: The objective of this study was to determine the neurodegenerative effect of HIV infection on the brain by comparing the volume of brain structures in HIV positive patients to a healthy control group, and to determine whether there is a correlation between the obtained volumetric dimensions of brain structures with the level of CD4 lymphocytes and the duration of therapy.

Material/methods: In this study we included 40 HIV positive patients on antiretroviral therapy and 25 healthy subjects. Conventional MRI was performed in all subjects, with the subsequent determination of volumetric dimensions of brain structures (intracranial cavity, cerebrum, cerebellum, brainstem, lateral ventricles, deep gray matter structures and white matter). The differences between the two groups were compared with the Student’s t-test, and the relationship between the variables was determined using the Pearson correlation coefficient.

Results: Comparing the volume of brain structures it was found that there was a statistically significant decrease in the total volume of the putamen (p 0.05), thalamus (p 0.05) and nucleus accumbens (p 0.05), as well as statistically significant increase in the total volume of the lateral ventricles (p 0.05) and the cerebrospinal fluid (p 0.05) in the HIV positive group compared to the healthy controls. Correlation analysis showed a positive correlation between CD4+ lymphocytes count and the total volume of nucleus accumbens, as well as correlation between the duration of therapy and the total volume of lateral ventricles. A negative correlation between the total volume of the putamen and the duration of therapy was also found.

Conclusions: Reduction in volume of subcortical structures is in favor of HAND as a type of subcortical dementia, and the increase in volume of cerebrospinal fluid is also expected due to existing atrophy in HIV patients. Positive correlation of the CD4+ count and the total volume of nucleus accumbens reflects the process of neurodegeneration caused by the activation of immune mechanisms, while positive correlations between the duration of therapy and the increase in lateral ventricular volume is a reflection of the greater impact of the years of life on brain atrophy than the HIV infection itself.
HBOT and the Rejuvenating Brain

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²Segol Center of Hyperbaric Therapy, Assaf Harofeh, Israel

Purpose: To determine the effect of Hyperbaric Oxygen Therapy (HBOT) on Dynamic Susceptibility Contrast-Enhanced (DSC) and Diffusion Tensor Imaging (DTI) MR sequences and memory function in the elderly.

Materials and methods: 15 elderly subjects above the age of 65 underwent diffusion tensor imaging (DTI) and dynamic contrast enhancement (DSC) of the brain in three time points: twice before (baseline) and once following HBOT as well as neurobehavioral tests. Preprocessing included motion correction. Calculation of DSC maps was performed using WiseImage software written in Matlab. Calculation of DTI maps was performed using Explore-DTI software. Paired t-test was performed using voxel based analysis. Cognitive evaluation was performed by objective computerized battery (NeuroTrax).

Results: Statistical analysis revealed an increase in FA following HBOT in the white matter adjacent to the hippocampus, however no change was found in this regions between the two baseline scans. Average FA increased from 0.32 in the baseline scans, to 0.34 post-HBOT (p = 0.0093). Additionally, average CBF in the hippocampus increased from 38.3 ml/min/100gr to 55.7 ml/min/100gr, and average CBV in the hippocampus increased from 4.5% to 5.8%. HBOT induced a significant increase in memory cognitive score (p=0.02).

Conclusions: HBOT may induce memory function increase in the elderly. The clinical improvement correlated with improvement in microstructural integrity of the brain, as well as with increase in cerebral blood flow and blood volume, reflecting the occurrence of neuroplasticity and angiogenesis respectively.
Retrospective Evaluation of Glioblastoma Contact with Sub-ventricular Zone and its Associated Influence on Patients’ Survival

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Background: Recent literature has focused on the effect of glioblastoma contact with neural stem cells rich zones (i.e., lateral ventricles sub-ventricular zone), and the influence on overall survival, tumor multifocality and distal spreading. The results of these studies are controversial. We therefore sought to address the influence of tumor location, among other imaging and clinical features, with our glioblastoma patient’s survival. Here, we present a retrospective data analysis of glioblastoma patients’ cohort, treated in Soroka University Medical Center in the last decade. All patients included in this work were diagnosed with glioblastoma before 70 years of age and received multimodality treatment which includes tumor resection surgery, radiotherapy, with/without concomitant adjuvant chemotherapy. Data collection and analysis was done for selected clinical and imaging parameters and correlated with patient’s survival.

Methods: Retrospective cohort including 56 GBM patients diagnosed between 2006-2015. Cranial neuronavigation software was used in order to get an accurate approximation of the tumors’ volume. We analyzed all available pre-op MRI (N = 52) and assessed:

1. Multifocality
2. Tumor and edema volume
3. Tumor and edema contact with the subventricular zone (SVZ) and cortex: Tumors (pre-op) were classified into four groups according to their anatomical contact with the SVZ (lateral wall of the lateral ventricle) and cortex.

Results: Tumors and edema with SVZ contact did not have statistically significant effect on survival, but were found to have larger tumor and peritumoral edema volumes at diagnosis. Comparing overall survival (OS) of all patients with edema SVZ involvement revealed that patients with tumor SVZ contact had lower OS than patients without tumor SVZ contact.

Conclusions: Tumor and peritumoral edema relation to the SVZ were not found to be statistically significant risk factors for OS, but demonstrated characteristics depicting a more invasive and aggressive GBM subtype.
Neuroradiology

Acute Brain Injury Following Illicit Drug Abuse in Adolescent and Young Adult Patients: Spectrum of Neuroimaging Findings

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Purpose: The use of illicit drugs is currently a major medical problem among adolescents. The clinical manifestation of adolescents with acute drug-induced neurotoxicity is often characterized by nonspecific symptoms and findings. We report on clinical and neuroimaging findings in 7 adolescents with acute brain imaging following illicit drug intoxication.

Materials and Methods: Clinical data and results of laboratory investigations were collected from review of the clinical history. All imaging studies were evaluated retrospectively for supratentorial and infratentorial abnormalities.

Results: All patients presented with acute altered mental status, 1 patient had seizures, 1 patient showed extrapyramidal signs and 1 patient had spinal cord related symptoms. Opiates were the most common substance. Neuroimaging findings included symmetric subcortical white matter involvement in all patients, multiple foci of acute ischemic infarctions in 1, and both patterns of brain injury in 1. Four patients had cerebellar involvement including diffuse symmetrical cerebellar edema in 3 patients and multiple foci of cerebellar ischemic infarctions in 1. In 4 patients, there was involvement of the basal ganglia, either as diffuse edema or multiple foci of acute ischemic infarctions. The thalami and cerebral cortex were spared in all patients. When diffusion-weighted imaging was obtained, white matter T2 edema also showed restricted diffusion, both in infratentorial and supratentorial white matter.

Conclusions: Our patients reveal 2 main neuroimaging patterns of brain injury: diffuse symmetric subcortical white matter injury with preferential cerebellar involvement (leukoencephalopathy pattern) or multiple foci of ischemic infarctions in a nonarterial territory distribution (ischemic pattern). Familiarity with these 2 neuroimaging patterns of findings in the evaluation of MRI studies in adolescents with acutely altered mental status, may suggest the correct diagnosis and narrow the differential diagnosis.
Neuroradiology

Cerebral Diffusivity Changes in Fetuses with Chiari II Malformation

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Purpose: Chiari II malformation is a congenital abnormality characterized by a small posterior fossa with downward displacement of the hindbrain into the foramen magnum, almost exclusively associated with open spinal dysraphism. Diffusion-weighted imaging (DWI) can be used to quantitatively characterize brain injury and physiological maturation. We aim to evaluate DWI parameters of the infratentorial and supratentorial brain in fetuses with Chiari II malformation.

Material and methods: MRI and US studies of twenty-six fetuses with Chiari II malformation and fifteen controls were evaluated for presence/severity of hydrocephalus, myelomeningocele level, and ADC values of frontal, parietal and temporal lobes, pons and cerebellar hemispheres. Cerebral flow impedance parameters (resistance and pulsatile indexes, RI and PI, respectively) from concurrently preformed fetal US were also evaluated.

Results: Of the Chiari II group, 16 fetuses had hydrocephalus. There was increasing severity of lateral ventriculomegaly in the high compared to low spinal dysraphism subgroups. There were significant lower ADC values in the frontal (p=0.01) and temporal lobes (p=0.05) in Chiari II group compared with normal, regardless of presence or severity of hydrocephalus. No significant ADC differences identified in the cerebellum and pons. Fetuses with Chiari II showed significantly lower RI and PI values.

Conclusions: Abnormal ADC values indicate supratentorial microstructural changes in fetuses with Chiari II malformation, possibly secondary to altered CSF hydrodynamics related to CSF leakage through the open spinal dysraphism. Further investigation of the role of diffusion imaging metrics in evaluating abnormal brain development, parenchymal damage and efficacy of fetal surgery is needed.
Neuroradiology

**Contrast Extravasation on CTA in Acute Head Trauma**

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**Purpose:** In head trauma, neck/head CTA are indicated when there is concern for occult vascular injury. Prior studies showed that contrast extravasation (CE) on CTA might have prognostic and treatment implications, however data is scarce and opposing. In this study we sought to retrospectively characterize the implication of acute contrast extravasation on clinical outcome and care in a large patient’s cohort.

**Methods and Materials:** 244 cases were identified that matched the following search criteria: (a) acute trauma victims, (b) NCCT at presentation and early follow up CT up to 48 hrs, (c) CTA presentation (d) intracranial traumatic findings. CE was defined as intra-hematoma pooling of contrast, not within a blood vessel with density greater than 120 HU and of any shape or size. The reviewers were blinded to the patient’s outcome. The outcome was graded using Glasgow Coma Outcome Score (GCOS), based on the patient’s electronic record on discharge.

**Results:** 57 patients (23.3%) had CE on CTA upon hospital arrival. Hematoma types associated with CE were epidural hematoma, subdural hematoma and cortical contusion. On univariate analysis, patients with CE were significantly more likely to be intubated on arrival, had lower GCS on arrival, showed higher rates of hematoma growth, had active bleed intraoperatively, had longer hospitalization stay and had significantly higher rate of GCOS 1 (death). Patients without CE were significantly more likely to be treated conservatively and had higher rates of GCOS 5 (no or minimal neurologic injury). Per-hematoma type analysis showed that in patients with subdural hematoma and CE the prognostic effect of CE was retained and they were significantly more likely to have GCOS 1 (p=0.006). In patients with epidural hematoma and cortical contusion this association was not shown.

Multivariate analysis of outcome at discharge showed that the presence of any type of extravasation reduces the chance of a good outcome (p=0.02, OR=0.389, 95% CI=0.1760.862).

**Conclusion:** CE on CTA in acute head trauma setting is an important imaging finding that might have a prognostic significance. The prognostic effect is mostly apparent in patients with subdural hematoma.
Neuroradiology

CT Angiography (Early and Delayed Phase) Versus CT Perfusion for the Diagnosis and Treatment of Stroke

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Purpose: Stroke, the third leading cause of death and disability worldwide, remains a challenge for diagnosis and treatment. Stroke treatment focuses on three strategies – conservative treatment, thrombolytic treatment (IV rt-PA) or an endovascular procedure. Our purpose is to evaluate whether CTA (early and delayed phase imaging) provides information on cerebral damage equivalent to what is detected on CT perfusion (CTP) prior to endovascular treatment.

Materials and Methods: A retrospective review was done of 54 consecutive adult brain CT examinations (early and delayed phase CTA, CT perfusion) performed from January 3, 2015 – April 10, 2016 on patients admitted to the ER with acute stroke. All patients were candidates for thrombolytic treatment (arriving within 4.5 hours of symptom onset) or endovascular procedure (arriving within 6 hours) and NIHSS ≥ 4 or NIHSS 2 with concomitant major neurological deficit. Independent review was performed by a board certified neuroradiologist and invasive neuroradiologist. The raters blindly reviewed either the CTA images or CTP images of the selected patient at separate times. The ischemic areas were evaluated on axial imaging only according to ASPECT score.

Results:

- The area measurements of the hypodensities (representing oligemia) on CTA early images were found to be non-equivalent to the penumbra areas seen on MTT/CBF images of the CTP.
- The area measurements of the hypodensities (representing oligemia) of the CTA delayed images were found to be equivalent to the core infarct areas seen on CBV images of the CTP.
- Conclusions: CTA should not be used independently for referring to endovascular treatment when CTP is available, and delayed CTA images show equivalence with CBV images on CTP.
Neuroradiology

Evaluation of White Matter Changes on T2 and T2 FLAIR Series on Fetal Brain MRI of Mothers with CMV Infection

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Purpose: CMV is part of TORCH and is the most common cause of congenital neurologic disability due to infection. The disease is expressed by nonspecific changes in the periventricular white matter and by other findings. In adults T2FLAIR series are more sensitive to white matter lesions than T2 series. This work is aimed at identifying early MRI changes in the white matter of fetuses with maternal CMV infection, and to investigate whether T2FLAIR will improve the detection of these changes.

Methods: It is a retrospective study of 207 women with established CMV infection examined at the Sheba Medical Center from 2013 to 2016. MRIs including T2 and T2 FLAIR series were performed in the third trimester without injection of contrast material. The imaging evaluation compared the findings on the T2 to the T2 FLAIR series. Some of the women underwent amniocentesis at different stages of pregnancy.

Results: T2 series showed nonspecific changes in the white matter, mainly in the temporal and frontal lobes in 24 of 160 fetuses. In none of the examinations the abnormal findings were seen on the T2 FLAIR series.

Conclusions: In contrast to adult MRI, T2 FLAIR was not useful in the evaluation of early changes in the white matter on fetal MRI. Therefore, omitting this series does not affect the diagnostic quality of the examination. The reason for this lack of sensitivity requires further study.
The Effects of Synthetic Cannabinoids on Brain Structure and Function: An MRI Study

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Purpose: The increasing use of synthetic cannabinoids ("designer drugs" like "Mr. NiceGuy" and "Mabsuton") is a cause for major public health concerns. THC, the active substance in cannabis, is a partial agonist to cannabinoid subtype 1 receptor (CB1R), whereas synthetic cannabinoids are full agonists. Synthetic cannabinoids are considered highly addictive and cause severe adverse effects. The purpose of our study was to assess whether chronic use of synthetic cannabinoids alters brain volume and whether chronic use of synthetic cannabinoids alters neuronal activity of working memory and executive functions.

Material & Methods: Thirty volunteers participated in the study: 15 synthetic cannabinoids chronic users were recruited from rehabilitation centers, and 15 healthy controls with no history of drug abuse were recruited from the community. All participants undertook a high resolution T1 MRI scan to assess brain volume and performed a functional MRI task of working-memory, the N-back task.

Results: Synthetic cannabinoids users showed significant diminished total gray matter volume compared to controls, as well as reduced gray matter volume in several cortical regions: right orbitofrontal cortex, right superior frontal gyrus, left fusiform gyrus, bilateral insula, right superior temporal gyrus, and right precuneus. Moreover, synthetic cannabinoids users showed diminished brain activations in the precuneus and bilateral parahippocampal gyri compared to controls while performing the working-memory N-back task. Synthetic cannabinoids users had also significantly longer reaction times and lower accuracy rates compared to controls.

Conclusion: To the best of our knowledge this is the first study showing overall reduced gray matter volume in addition to specific gray matter volume decrease in several brain regions associated with addiction and drug induced psychosis. Furthermore, impairment in the neural brain mechanisms responsible for executive functions was found in synthetic cannabinoids users. Our results of diminished activation during the N-back task in users compared to controls, implicates vulnerability of the working-memory network to the deleterious effects of synthetic cannabinoids. This may have major implications for our understanding of the long-term consequences of synthetic cannabinoids.
Altered White Matter Connectivity Following Treatment with MRgFUS Ablation of the Thalamus in Tremor Disorders

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Purpose: Magnetic resonance guided focused ultrasound (MRgFUS) for thermal ablation of ventral intermediate nucleus (VIM) of the thalamus is a new, noninvasive treatment of tremor disorders. This procedure has been proven as clinically safe and effective and has been shown to elicit changes in white matter (WM). Using diffusion tensor imaging (DTI) we studied white matter integrity of motor pathways before and following treatment with MRgFUS in patients with essential tremor (ET) or Parkinson’s disease (PD). We hypothesized that alterations in WM integrity will correlate with clinical outcome, thus serving as a biomarker that could be used to improve treatment success rates and patients selection.

Material & Methods: The study included 39 patients, 22 with a diagnosis of ET, and 17 with PD. DTI at 3.0T was performed before the ablation and a day, week, month, and a year following ablation. DTI data were processed, diffusivity parameters were calculated and fiber tractography measures were extracted using ExploreDTI. CRST and UPDRS scores were used to evaluate tremor improvement in ET and PD patients, respectively. FA changes were tested for correlation with clinical outcome.

Results: In both patient groups, a significant decrease in diffusivity parameters was seen in the sensory-motor subdivisions of the ablated thalamus at early follow-up scans. Complete or near complete recovery was demonstrated in the late follow-up scans (Figure 1A). A similar pattern of decline and recovery in diffusivity measures was seen among regions of interest of the dentato-red nucleus-cortical tract (Figure 1B). Fiber tractography of the whole tract demonstrated a consistent pattern (Figure 2). A statistically significant positive correlation (r=0.46,P<0.03) was found between the FA level in the motor thalamus a day following ablation and the clinical outcome (tremor improvement) in the ET group but not in the PD group (Figure 3A). A high FA level in the motor thalamus in the pre-ablation scan was associated (r=0.43,P<0.05) with unfavorable clinical outcome (Figure 3B).

Conclusion: Our results show that MRgFUS thalamotomy causes decline followed by recovery of WM diffusivity both within the thalamus and in distant motor areas. We found that FA values within the thalamus at baseline and a day post-ablation are correlated to the clinical outcome of ET patients but less so in the PD patients. Based on these results, we would like to propose that baseline FA values within the thalamus may predict treatment succes rates and may be used for better patient selection.
Figure 1: Changes in fractional anisotrophy within subdivisions of the thalamus (A) and between thalamus and cerebral peduncle (B) at all time points.
Figure 2: Longitudinal change in the tract between the Red nucleus and the Pre-motor cortex throughout the followup scans. Coronal view (A) and axial view at the level of the thalamus (B).

Figure 3: Correlation between tremor improvement and fractional anisotrophy before the ablation (A) and 1 day post ablation (B).
Oral

Neuroradiology

**Age and APOE Genotype Modify Tau PET Patterns in Alzheimer’s Disease**

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Figure 1: Effect of age on tau and amyloid tracer binding. Global cortical (A) and Braak ROIs (B) average SUVR
**Purpose:** Advanced age and APOE ε4 allele are the two strongest risk factors for sporadic Alzheimer’s disease (AD). ε4 genotype has been shown to predispose for amnestic/hippocampal driven AD pattern. Previous studies have linked earlier age of onset and ApoE ε4 genotype with increased deposition of amyloid β and hyperphosphorylation of tau proteins, the histopathological signature of AD. Here, we aimed to assess the effect of age and APOE ε4 genotype as potential modifiers of tau pathology using PET imaging with [18F]AV1451 for tau and [11C]PIB for amyloid pathology.

**Materials & Methods:** The cohort consisted of 75 clinically impaired, amyloid-PET positive patients (broad phenotypic range including patients with mild cognitive impairment (MCI) or AD dementia, amnestic, visual and language variants), age 47-83, mean 64±8.5yo,35 (47%) ε4 carriers. PET data were processed using Freesurfer 5.3 and SPM12 to compute Standardized Uptake Value Ratio (SUVR) images normalized to cerebellar gray matter (PIB) and inferior cerebellar gray matter (AV1451). Statistical analyses were performed assessing both age-related (while controlling for amyloid and ε4-status) and ε4-related (controlling for age and amyloid status) differences in global cortical uptake, in-vivo Braak ROIs (anatomically approximate of AD pathologic stages delineated by Braak&Braak,1991) uptake and conducting voxelwise analyses.

**Results:** In patients, age was negatively correlated with tau, but not amyloid, PET cortical binding. The effect was maximal at neocortical/Braak V-VI regions (r=-0.47), weak in limbic/Braak III/IV regions (r=-0.23) and absent at medial temporal lobe (MTL)/Braak I-II regions (r=0.006) (Figure 1). Voxelwise analysis confirmed a maximal effect in the frontal and parietal lobes. The difference remained unchanged when controlling for PIB-SUVR and was observed for all clinical phenotypes. The presence of ε4 allele was not associated with significant differences in global measures of AV1451 or PIB-SUVR nor in AV1451 uptake at Braak ROIs III-IV (p=0.95,Cohen’s d=0.01) and V-VI (p =0.57,Cohen’s d=0.15). A small increase in AV1451 binding was seen in ε4 carriers at Braak I-II ROI (p=0.02,Cohen’s d=0.61). Voxelwise analyses confirmed only a focal effect on AV1451-uptake in the anterior MTL bilaterally (Figure 2); that difference remained significant when controlling for PIB-SUVR.

**Conclusion:** Our result suggests that early onset AD is associated with greater tau neocortical burden, whereas ε4 positivity is associated with increased tau tracer binding in the MTL. These findings are in-line with the fact that ε4 genotype is known to predispose for amnestic AD pattern and suggest a possible link between genotype, tau-PET findings and cognitive phenotype.
Neuroradiology

Traumatic Brain Injury Severity Affects Brain Activation During an Executive Task

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Purpose: Traumatic brain injury (TBI) represents a significant public health concern as a leading cause of mortality and morbidity among young people in the industrialized world. TBI-related disabilities vary widely in type and duration and commonly result in reduced quality of life and prolonged social, medical and economic effects on society. Cognitive impairments are primary contributors to the disability of this population and include memory, speed of processing, attention and executive deficits, such as problem solving, abstract-reasoning, judgment and planning. Recently, there is a growing interest in the cognitive outcome of mild TBI, particularly in the absence of imaging evidence of brain pathology on CT scans of injury. Our research aimed to further investigate the injury severity effect on brain activation during an executive task.

Material & Methods: Forty-eight volunteers participated in the study: 14 mild TBI (GCS13) and 9 moderate-severe TBI (GCS13) patients were recruited. These included patients with CT scans post injury who were not hospitalized, patients from the Department of Neurosurgery, and the Head Trauma Rehabilitation Department at Sheba Medical Center, Tel-Hashomer. Twenty-five healthy controls matched by age and gender were recruited from the general population. All subjects undertook an MRI scan to assess anatomical abnormalities and performed an fMRI task of executive function. The task measures non-verbal abstract-reasoning and visual-spatial problem-solving abilities in a form similar to the Raven’s progressive matrices–R test (RPM-R), which is highly correlated with IQ scores.

Results: Our preliminary results show an injury severity effect on the brain activation of the abstract-reasoning task. Healthy controls exhibited activations mainly in a fronto-parietal network. Regions of activation included bilateral inferior and middle frontal gyrus, parahippocampal gyrus, precuneus, insula and cerebellum. Both TBI groups exhibited diminished activations compared to the controls. Mild TBI patients activated a similar network of regions, while moderate-severe patients exhibited activation in fewer regions compared to the controls (Figure 1).
Conclusion: Our preliminary results regarding the effect of the severity of injury on brain activations of abstract-reasoning, demonstrate a "dose response". We found a linear effect between injury severity and cognitive outcome, thus, the more severely injured individuals displayed a poorer cognitive performance. Our findings enable better understanding of brain recovery mechanisms and specifically establish the role of injury severity in executive-related brain activation post-TBI.
Injury Severity Modulates the Association between Structural Connectivity and Cognition in Traumatic Brain Injury: an MRI Study

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Purpose: Traumatic brain injury (TBI) is a major cause of death and disability worldwide. TBI is often characterized by white matter damage producing alterations in brain connectivity. These alterations are commonly suspected to disrupt the function of large-scale networks that support cognition. One analytic approach to examine these alterations is graph theory, which examines the brain from a network perspective. The present study aimed to examine whether injury severity modulates the association between white matter connectivity and cognition in TBI using a diffusion MRI based network analysis.

Materials & Methods: Graph theoretical network analysis was applied in order to assess differences in structural connectivity between TBI and healthy control subjects. We performed DTI scans of 22 patients with chronic TBI in different injury severities (mild and moderate-severe TBI) defined by Glasgow Coma Scale (GCS) score, and 22 healthy control subjects. White matter connections between 90 gray matter brain regions were defined using tractography. Weighted brain structural matrices were constructed for each subject, and network measures were calculated. An objective cognitive deficits score of non-verbal abstract reasoning in TBI patients was calculated by subtracting pre-injury (obtained in adolescence as part of the aptitude tests of the Israeli Defense Forces draft board) from post-injury performance on a Raven progressive matrices test (RPM-R). In order to assess the injury severity effect on network measures, we performed ANOVA between controls, mild TBI and moderate-severe TBI on cluster coefficients, strength, efficiency, betweenness centrality and characteristic path length. These network measurements were analyzed in both global and local levels. To examine the effect of injury severity on cognition, Pearson’s correlations were computed between network properties and deficit scores of the RPM-R task in TBI patients.

Results: Global analysis revealed differences between groups in strength, efficiency and cluster coefficient. Thus, when injury severity increases, graph measures decrease. Moreover, these measures differed between the 3 groups within particular hub regions, including the insula, frontal superior medial cortex, precuneus, frontal superior orbital cortex and caudate nucleus. Local analysis revealed a severity effect in strength, mainly in frontal and cingulum regions. Additionally, we found that reduced network efficiency in the left precuneus was associated with a greater deficit in nonverbal abstract reasoning performance.

Conclusion: Our findings support the notion that injury severity affects network measures of structural connectivity, in particular disconnection of network hubs, which in turn may contribute to cognitive impairments.
Lesion Conspicuity on Venous Phase Scan of the Head in CT Angio Studies Compared to Non-Contrast and Arterial Phase Scans

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**Purpose:** Routine CT Angio (CTA) scans of the head commonly include a non-contrast scan to rule out hemorrhage and an arterial phase scan for vessel delineation. Our purpose was to assess the contribution of the venous phase scan by evaluating the conspicuity of lesions found on tri-phasic CTA studies of patients with apparent neoplastic disease.

**Materials and Methods:** Retrospective review of reports of consecutive CTA scans of the head of patients with neurological signs, between September 2011 and April 2017, was performed. Reports containing neoplastic findings were selected for review. All scans were performed on 64 and 256 slice CT scanners (Philips, Netherlands). Pre-contrast, arterial and venous phase images were evaluated by a neuroradiologist for neoplastic disease. Lesions were graded on a 4 step scale of conspicuity (0-non-detectable, 1-barely detectable, 2-detectable, 3-easily detectable). Multiple detected lesions were grouped together if their conspicuity was identical.

**Results:** 14 patients were identified with neoplastic disease and 23 separate lesions were evaluated. On the non-contrast and arterial phase scans 48% of lesions (n=11) were non-detectable. 30% (n=7) and 35% (n=8) were barely detectable, respectively. Only 17% (n=4) were detectable on both scans and 4% (n=1) were easily detected on the non-contrast scan. On the venous phase scans 74% (n=17) of the lesions were easily detected and 26% (n=6) were detected. None of the lesions were barely detectable or undetectable on the venous phase.

**Conclusion:** In a small number of cases, adding a venous phase scan of the head, during routine CTA scans in patients with neurological signs, greatly increases conspicuity of neoplastic lesions, compared to the non-contrast and arterial phase scans.
Neuroradiology

**Improved Visualization of Thrombus in the Carotid Arteries by Spectral Analysis of Mono-energetic Images Derived from Spectral Detector CT – A Phantom Model**

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**Purpose:** Spectral Detector CT (SDCT) generates virtual mono-energetic (ME) images at different photon energies (keV). The purpose of this study is to evaluate accurate detection of very small blood clots by spectral analysis of mean Hounsfield Unit (HU) as a function of the energy of the ME images.

**Material and Methods:** Phantoms were constructed using clotted swine blood, placed in 8mm tubes (n=6). Heparinized blood containing 0.5, 1.0 and 2.0 mg/ml iodine (Iomeron 350 mg/ml) was added to the tubes. Control tubes (n=6) were filled with blood with the same iodine concentrations, without clot. The tubes were located in a water phantom, which was scanned with a 64-slice Dual-layer detector CT, at 120 kV, 250 mAs. In addition, an anthropomorphic phantom containing Iodine solutions of various known concentrations (2-20 mg/ml) was scanned. Mono-energetic images at 40, 50, 65, 80 and 200 keV were generated for both phantoms. Software was developed to calculate the relationship between Hounsfield Units (HU) of pixels containing iodine solutions in the ME images at 65 keV and 200 keV. This relationship created a spectral map that uniquely characterized the material in the pixel, independent of its concentration. For any given image of the clots, the software generated an iodine image by searching and identifying pixels, which fit into the spectral map equation of iodine and displayed them in different color.

**Results:** Clot detection was significantly better in the iodine images, generated by the spectral map of the ME images, when compared to the conventional images. The non-clot containing tubes demonstrated a homogeneous map on the iodine images. The number of clots and their size could be easily determined in the iodine images. In the images with the lowest iodine concentration, clot visualization was slightly reduced but was much better than the conventional images.

**Conclusion:** Iodine images based on spectral maps generated by ME images improved clot visualization in a phantom model, compared to conventional CT images. The results imply that spectral detector CT with the aid of iodine images permit contrast dose reduction while increasing reader confidence of clot detection.
Introduction: Accurate numbering of vertebral levels may not just help with clinical assessment, but also may prevent unnecessary errors and aid in clinical management, especially at times of palliative injections for pain or spine surgery. Nowadays, the C1 level vertebral count is considered the most reliable method with no reported variability in the cervical level morphology, however, there are significant variations in the thoracic and lumbar levels. As a result, having studies where just the lower spine is imaged, may cause confusion and inaccurate numbering. In our study, we independently evaluated the origin of psoas major muscle in CT studies where the whole spine is imaged, to assess whether the superior origin of the psoas major muscle may be a reliable method in vertebral levels enumeration.

Patients and Methods: We retrospectively selected 200 consecutive patients who underwent total body CT in the ER as a part of trauma protocol, between the period of November 2016 and April 2017 in Rambam Hospital. Patients that fulfilled the following criteria were included: (1) Above 10 years of age, (2) All spinal levels were included, (3) No major vertebral injury, (4) No major spinal deformity. A single neuroradiology fellow numbered the vertebra and recorded the level of psoas muscle insertion on a PACS work-station.

Results: Over all 312 CT studies were reviewed, from them 112 studies were excluded from the study according to the exclusion criteria. From the final 200 studies that were included, 147 (73.5%) of the patients were males and 53 (26.5%) were females. We found that in 182 patients (91%) there was correct numbering of vertebra using the psoas major muscle according to C1 count as the reference, and in the remaining 18 (9%) there was no match. 14 (%78.7) of the patients with the incorrect numbering were males, and 4 (22.3%) were females. There were no statistical significant differences between the two genders (P0.05, according to Z-score calculation between two population portions).

Conclusions: Although C1 count is considered nowadays the most reliable method, we found that counting vertebra with the aid of the psoas major muscle may considered a reliable method, especially in cases when there are no studies of the entire spine available.
Correlation of ASPECT Scoring Using Non-Contrast CT Images of the Head and Virtual-Non-Contrast Images Derived from Post Contrast CT Images

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Purpose: Non-contrast images of the head are used for evaluating stroke severity in the acute setting, using the Alberta Stroke Program Early CT Score (ASPECTS). Our purpose was to assess the correlation between the ASPECT score using non-contrast images and Virtual Non-Contrast (VNC) images of the brain, acquired on a dual layer spectral CT scanner.

Materials and Methods: Retrospective assessment of CT scans of the head, between January 2017 and February 2017, was performed. Scans were included if they were indicated for symptoms of acute stroke, within the therapeutic window for thrombolytic or endovascular treatment. Scans were performed on an iQon dual layer 64 slice CT (Phillips, Netherlands). CT Angio protocol for acute stroke patients in our institution includes a tri-phasic scan. Images for evaluation were obtained from the non-contrast scan and from VNC images which were reconstructed from the spectral data of the venous phase scan. The scoring was performed independently by two radiologists using the ASPECTS method, on an axial image at the basal ganglia level and at the supra-ventricular level. Scores were compared and subjected to statistical analysis.

Results: 11 CT scans were included in the study. One scan was excluded due to poor VNC image quality. ASPECT scores ranged between 9-10 for reader 1 and between 8-10 for reader 2. There was poor inter-rater agreement for the scores of the non-contrast scans ($r^2=0.13$), however this was slightly higher for the VNC images ($r^2=0.26$). Additionally, there was poor correlation between the scoring of the non-contrast images and the VNC images for both readers independently ($r^2=0.05$ and $r^2=0.003$ for reader 1 and 2, respectively).

Conclusion: Stroke scoring using VNC images does not correlate with scoring of conventional non-contrast images and thus is not a suitable replacement as the modality for ASPECT scoring in the setting of acute stroke.
Rational: Brain tumor malignancy correlates with tumor neovascularity. This neovascularity manifests increased cerebral blood volume (CBV) and increased vessel permeability (VP). These can be assessed by two essentially different dynamic contrast MRI sequences; T2* for CBV and T1 for VP, which require separate acquisitions and bolus injections. We developed a single bolus acquisition method to assess both parameters - DPASS.

Purpose: To compare the VP to the CBV of tumors as assessed by DPASS.

Methods: From March 2015 to June 2017 154 patients underwent 414 DPASS examinations. The effect of size, anatomic location and treatment on relative VP (rVP) and CBV (rCBV) were assessed visually.

Results: It was difficult to assess rCBV but not rVP in gray matter, pial regions, or regions of high susceptibility. rVP had higher spatial resolution. Some discrepancies between rCBV and rVP were due biologic differences as evidenced by change in time or due to treatment. rVP was more sensitive to motion.

Conclusion: DPASS is feasible without sophisticated software or sequences. It extends the clinical range of tumor neovascularity evaluation by simultaneously assessing the complementary rCBV and rVP values.
Purpose: One of the issues on health system’s agenda concerns actions required in response to complications discovered retrospectively in legitimate medical treatments. Technological developments, progress in genetic research and lawsuits upon required notifications all impose a need to consider a model for these scenarios. The research focuses on such a case: irradiation treatments received routinely in Israel until 1960 for Ringworm of the scalp, later discovered to increase the risk of tumors. A national survey was conducted among Israeli physicians upon levels of knowledge of the Ringworm affair and the Israeli law compensating victims. The study focuses on role of physicians in the Israeli health system as mediators transferring important messages from regulatory authorities to the public, based on stronger ethical commitment in the physician-patient relationship and court rulings.

Material & Methods: An Internet survey was distributed among 6,395 physicians in specialties who potentially may treat patients irradiated for ringworm, including 470 radiologists. Knowledge score was calculated for each respondent according to six key knowledge questions. Data was analyzed using SAS® 9.4 program.

Results: Findings were analyzed for 779 respondents who completed the questionnaire, 14.15% of Israeli registered physicians in relevant specialties, including 55 radiologists. Among radiologists, data indicates 65.5% failed to know about the ringworm case and the compensation program, highest rate in all specialties examined. Moreover, 78.2% were not aware of the national center established for compensating scalp ringworm irradiation victims. Respondents lack knowledge on dangerous levels of exposure to radiation (94.7%), including 87.3% of the radiologists. Examining physicians’ information sources on the ringworm case in Israel shows most physicians gather their knowledge from medical schools (36.8%), scientific papers (23.1%), and even their patients (22.9%), and much less from their employers and supervisors, meaning the Ministry of Health (15.2%) and Health Maintenance Organizations (HMOs) (4.6%).

Conclusion: Most radiologists failed to know about the ringworm affair and the compensation program their patients could benefit from. Most radiologists are not aware of dangerous levels of radiation. The state and HMOs could contribute to expand knowledge by informing physicians in general and radiologists in particular, as significant agents in the medical field towards patients and the public.
Objectives: Umbilical venous catheter (UVC) insertion is a common procedure in neonatal intensive care units. It is used as central line access for infusion of fluids, medication, TPN etc. and for central venous pressure monitoring. Complications are rare and include vascular injury, liver injury (laceration, hematoma, necrosis, abscess) and portal vein thrombosis. Most of the parenchymal liver complications are related to misplacement of the catheter.

The aim of our study is to describe the clinical and radiologic characteristics of UVC related complications in the liver.

Material and Methods: A retrospective review of cases of neonates with parenchymal liver changes associated with the presence of UVC between 02/2014-08/2017. Demographics, clinical and radiologic data were collected.

Results: Overall 10 cases were reviewed (7 males). Average age at diagnosis was 16.8±23 days (range 1-77 days). Average time between the documented misplacement of the catheter and the first ultrasound 8.6±8.5 days.

Three patients were symptomatic (sepsis and abdominal distention) at the time of the ultrasound. In 7 cases, liver lesions were an incidental finding in an ultrasound done for another purpose. Average age at diagnosis in the symptomatic patients was 9±7 days (range 1-77 days) vs. 20.1±27.1 days (range 2-16 days) in the asymptomatic patients.

Sonographic findings included: hypoechoic lesion with hyperechoic rim (2 patients), single hyperechoic lesion (4 patients) and multiple hyper-echoic lesions (5 patients). Lesions volume range was 0.05-52.8cc (Average 10.4±16.6, 18±30.2cc in symptomatic patients and 6.6±4.7cc in asymptomatic patients).

Parenchymal heterogeneity and left portal vein thrombosis were seen in one patient. CT and MRI were done in 2 cases, with similar findings of a single liver lesion containing fat and calcifications (mimicking teratoma). Both patients were asymptomatic.

Treatment: the UVC was removed in all cases. Symptomatic patients were treated with antibiotics. Asymptomatic patients had routine sonographic follow-up without any additional treatment.

Conclusions: Misplacement of UVC can cause several types of liver injuries. In our study, most of the parenchymal injuries were asymptomatic and were found incidentally. No specific imaging features could distinguish between symptomatic or asymptomatic patients. Treatment should be based on clinical assessment. If asymptomatic, no treatment is required and ultrasound surveillance can be used to ensure lesion regression.
Pediatric Imaging

Indian Ink Artifact as a Tool for Assessment of Transmural Involvement of the Terminal Ileum in Children with Crohn’s Disease

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Objectives: Transmural involvement in Crohn’s disease (CD) might precede fistula formation which may warrant a change in medical management. Indian ink artifact (also known as black boundary artifact) shows a signal drop-out in voxels that contain water and fat. Thus, this artifact appears as a smooth black line on the outer border of normal bowel walls. Inflammatory changes in the bowel wall or the mesentery may cause this smooth line to become blurred or irregular. We aimed to assess the change in appearance of the Indian ink artifact in the True Fast Imaging with Steady-State Free Precession (TrueFISP) sequence and to correlate it with other inflammatory markers.

Material and Methods: This ancillary study utilized 41 MRE’s of 31 children (average age 12.5 ±2.88, 21 (51%) males) with CD performed as part of the larger prospective ImageKids study in which children with CD, underwent MRE and ileocolonoscopy as part of clinical care. Inclusion criteria for this study were: 1. Disease limited to the terminal ileum 2. The MRE included TrueFISP sequences. The TrueFISP sequences were reviewed and evaluated for the distortion of the Indian ink artifact. Findings were compared with the endoscopic score (Simple Endoscopic Score for Crohn’s Disease (SES-CD)), CRP and calprotectin levels.

Results: Nine of the 41 examinations (22%) had marked irregularity of the Indian ink artifact, 20 (48.8%) had mild irregularity, and 12 (29.2%) had normal appearance. All constructs of disease severity showed a significant gradient across the three groups: mean segment length was 16.3±12.4 cm vs. 13±8.7 cm vs. 3.2±3.2 cm, respectively (p=0.001; Kruskal Wallis test). Edema of the mesentery was noted in 9 examinations (100%), vs. 13 (61%) vs. 3 (25%), respectively (p=0.002; Fisher’s exact test). Enhancement of the mesentery was noted in 9 examinations (100%), vs. 12 (57%) vs. 2 (16%), respectively (p=0.0001). Median CRP values were 8.8 (IQR 6.95-25.6) vs. 4.1 (1.0-16.7) vs. 0.2 (0.2-0.5); respectively (p=0.0001). Finally, median fecal calprotectin levels were 813 (IQR 487-1728) vs. 327 (81-892), vs. 57 (10-77), respectively (p=0.004).

Conclusion: In our study, distortion of the Indian ink artifact was associated with both radiologic and laboratory markers of inflammation. Further studies are required to validate our findings and their utility in follow-up during treatment and differentiating inflammation from fibrosis.
Introduction: The introduction of Dual Source Single Energy CT (DSCT) scanners few years ago was an opportunity for development of lower dose protocols. We built a low-dose chest protocol using this novel technique to evaluate lung fields in children. Patients referred by pediatric pulmonologists for CT evaluation either for Cystic Fibrosis (CF) or Bronchiolitis Obliterans (BO) were scanned using this low-dose protocol. Balla score for CF was used to assess the diagnostic power of the images. We present the Rambam pediatric radiology experience with this low-dose protocol, along with its impact on clinical care of patients in the pediatric pulmonology unit.

Purpose: To assess the reduction in radiation doses using low-dose chest DSCT protocol for CF and BO pediatric patients, and to assess the diagnostic feasibility using Balla score.

Methods: Chest CT scans of either CF (n=46) or BO (n=25) in pediatric patients aged 0-20 years performed at our institute using the DSCT from September 2013-July 2017 were collected. Radiation effective dose was calculated using dose length product (DLP) and age related factor. Two pediatric radiologists calculated Balla score for all scans in agreement. The ability to calculate the score was used as a threshold for image quality.

Results: The median effective dose in all chest CT scans was 0.49 mSv demonstrating at least 84% reduction compared to typical effective dose of pediatric chest CT scan according to the Israeli Ministry of Health. Median DLP in the 0-5-year age group demonstrated 95% reduction compared to the DLP reported for this age group by the National Radiological Protection Board in the UK. A similar 95% and 94% reduction was noted in the 5-10, and 10-15 year age groups respectively. Moreover, CT dose index (CTDI$_{vol}$) demonstrated 96%, 96%, and 91% reduction in the 0-5, 5-10, 10-15-year-old age groups respectively compared to CTDI$_{vol}$ reported for the corresponding age group in the aforementioned British study.

Conclusion: CT is an extremely important diagnostic tool, yet carries a toll of radiation risk burden. Our study revealed that a low dose chest protocol using DSCT led to significant reduction in effective dose and other radiation parameters (DLP and CTDI$_{vol}$) compared to the Israeli Ministry of Health recommendations and worldwide literature using traditional CT scanning techniques. The low-dose yet diagnostic study changed the clinical practice in pediatric pulmonology unit and improved patient care.
Pediatri Imaging

**Added Value of Bowel Sonography in Pediatric Acute Abdominal Pain – The Rambam Experience**

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**Purpose:** Acute abdominal pain is a common complaint in the pediatric emergency department. Sonography is often the first diagnostic study performed. Our routine study includes the abdominal solid organs as well as the appendix. Adding a sonographic evaluation of the cecum and terminal ileum may reveal additional pathologies, mainly acute infectious colitis-ileitis or inflammatory bowel disease. Early diagnosis improves patient care and reduces the need for additional diagnostic studies in the acute setting.

**Materials and Methods:** We retrospectively reviewed sonographic examinations of children who presented to our tertiary care center at Ruth Children’s Hospital Rambam, with acute abdominal pain, between February 2017 and June 2017. We included all children 8-18 years of age with abdominal pain, and excluded patients with known Inflammatory Bowel Disease (IBD). Two pediatric radiologists reviewed all studies. For each examination, the appearance of the cecum and terminal ileum, was documented and evaluated for presence of colitis or enteritis.

**Results:** Over all there were 722 abdominal sonographic studies done in the acute setting. We excluded 401 studies due to known IBD or lack of demonstration of the bowel. Among the 321 studies included in the cohort, 65 patients were sonographically diagnosed with acute appendicitis (20.2%), 26 patients (8.0%) with acute colitis/enteritis, and 2 patients (0.6%) were diagnosed with IBD. Findings were correlated with clinical and pathological data, yielding a positive predictive value of 78.6% for colitis-enteritis patients and of 98.2% for appendicitis.

**Conclusion:** Evaluation of the cecum and ileum for signs of inflammation as a part of the workup of acute abdominal pain may have an important diagnostic value. Findings may prompt further investigations, such as gastroenterological evaluation, laboratory tests or colonoscopy, leading to early detection of inflammatory bowel disease and optimal patient care.
Early Recurrent Ileo-Colic in Intussusception, Incidence and Characteristics.  
Ten Years Experience in a Single Hospital

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Background: Incidence of early recurrent intussusception (ERI) was previously reported at 10%. Today’s common practice is to admit the patient for 24 hours after the reduction for follow-up due to high probability of an early recurrence.

Purpose: To evaluate an incidence of early recurrent intussusception and its possible predictive factors.

Patients and methods: Hospital registry was searched for all the cases of ileo-colic intussusception for the last 10 years. Clinical records, laboratory results and imaging findings of each patient were evaluated. Statistical analysis was performed between the groups of children with and without ERI for such parameters as age, gender, clinical signs, laboratory data and sonographic characteristics of the lesion, as well as comparison between the groups for the seasonal distribution.

Results: Total 245 cases of intussusception in 208 children, 89 girls and 156 boys were included, ages 2 to 77 months, mean age 12.7 months, median 9.75 months, all underwent successful air enema reduction. Only 6 cases (2.9%) of ERI were observed, in an interval of 7 to 26 hours, mean 17.6 hours. Statistically significant difference of age was observed between the groups of children with and without ERI for such parameters as age, gender, clinical signs, laboratory data and sonographic characteristics of the lesion, as well as comparison between the groups for the seasonal distribution. 83% of the cases of early recurrence happened in the January to March period (p=0.001). No statistically significant difference was noted for other parameters.

Conclusion: In our series an incidence of an ERI was significantly lower compared to previous reports, and probably does not justify routine admission of all the children after intussusception reduction for 24 hours. Admission should be reserved for older children, in winter months, or according to clinical indications.