DOI: 10.1007/s00259-018-4148-3

EANM'18

Annual Congress of the European Association of Nuclear Medicine October 13 – 17, 2018 Düsseldorf, Germany

Abstracts

European Journal of Nuclear Medicine and Molecular Imaging (2018) 45 (Suppl 1): S1-S844
10.1007/s00259-018-4148-3

This supplement was not sponsored by outside commercial interests. It was funded entirely by the association's own resources.

BSREM images leading to higher GM CBF values and higher GM/WM contrasts. A beta value of 100 resulted in the highest GM/WM contrast and best image quality among the included beta values. Beta values higher than 100 are to be used for dynamic ^{15}O-water PET data if improved CBF image quality is required.

OP-289

Feasibility of Framework to Assess Noisy Data Inconsistency of SPECT Projection Data Prior to Tomographic Reconstruction

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Aims: We propose a framework to assess task dependent SPECT data quality prior to reconstruction, and allowing for decisions to improve or replace the data at the acquisition step. If the task dependent quality is insufficient a re-scan may be the best option, despite the possible correction and compensation methods within the reconstruction. The aim in this work is to test if an image based metric allows assessing noisy SPECT data inconsistency due to motion as compared to a visual observer. **Methods:** We used a computationally efficient center-of-light metric (CLM) on all the frames. In this feasibility work we computed one full FOV CLM and four quarter-FOV CLMs for each projection image. We then performed a local fluctuation analysis on these sets of CLMs, and mapped the local fluctuation quantity in mm to a numerical quality score (1-10), sensitive to both frame-to-frame motion and noise. We used 77 clinical data of different application with a total count median of 7.07Mc. 21 with and 56 without visible motion in the projection data, as well as count reduced the data to 50% and 10% of total counts by binomial subsampling. We performed ROC analysis at these different count levels comparing the CLM to truth established by human observers. **Results:** At 100% standard clinical count level for the respective application the CLM resulted in Area under the ROC curve (AUC) of 97.6% with a standard error (SE) of 0.0169 at P<0.0001, an Associated Criterion of AC>6, a sensitivity of 100% and specificity of 92.86%. At 50% the AUC=93.2%, SE=0.0287, AC>8, P<0.0001 with sensitivity of 90.48% and specificity of 85.71% and at 10% the AUC=54.5%, SE=0.0713, P=0.53, AC>7 with sensitivity of 100% and specificity of 8.93%, showing that now noise is excessive, destroying the ability to assess motion with the proposed CLM. A comparison between ROC curves shows no statistical significant difference between the 100% and 50% data, but significant at P<0.0001 when compared to the 10% data. **Conclusion:** We demonstrated the feasibility to assess and characterize quality issues of SPECT data prior to reconstruction using various center-of-light metrics at various noise levels, where at clinical (7 Mc total counts) and 50% reduced count levels the AUC is 98%, 93% respectively dropping to 53% for 10% count reduced data. This also allows establishing a lower noise floor at which subsequent intra reconstruction motion correction methods could fail as noise dominates.

OP-290

Use of the CT Scout View (Topogram) for Accurate Attenuation Correction of Planar Nuclear Medicine Studies

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Introduction: Planar quantitative studies (e.g. renograms) can benefit from the use of geometric mean to correct for organ depth. However geometric mean does not correct for attenuation due to total body thickness. With SPECT-CT systems becoming more common, we have examined the potential for the CT scout view (topogram) to provide an attenuation map for planar studies using the geometric mean. **Method:** We examined the relationship of the topogram pixel values with different depths of water (0-30cm) in a bespoke water tank. The topogram scans were fixed at 20mAs but the tube voltage was varied from 80kVp to 140kVp. A kidney sized phantom with known activity (nominal 100MBq Tc99m) was then imaged at different depths (0-15cm) in the water tank and with variable water levels (15-30cm) which relate to different body thicknesses. The attenuation corrected geometric mean counts were calculated using the derived total thickness from the topogram image and a linear attenuation coefficient of μ=0.12cm^{-1}. These values were then divided by the in-air sensitivity factor (cps/MBq) to give a derived activity (MBq). The derived activities of the phantom were compared to the actual activity for the different positions and water depths. **Results:** The relationship of the topogram pixel values with water depth was remarkably linear over the range 0-30cm. The uncertainty for the prediction of 'body thickness' was acceptable at ±4mm (95% CI). All derived measurements of phantom activity using the topogram and geometric mean technique were within ±5% of the actual activity for depths <20cm and within ±10% for depths 20-30cm. **Discussion:** We acknowledge that patients are composed of many different substances with varying attenuation coefficients (tissue, fat, blood, bone, etc.). However, the concept is not to use the CT topogram to quantify the different linear attenuation coefficients of these substances (as is the case for SPECT-CT attenuation correction) but rather estimate the equivalent thickness of water that these substances contribute on a pixel by pixel basis. **Conclusion:** The topogram gives a very quick and accurate method to determine total body thickness for attenuation correction of planar studies with minimal additional radiation dose (<0.1mSv). The corrected organ counts are then directly equivalent to the organ activity in MBq using the in-air sensitivity factor. This method may be a useful technique in quantifying absolute organ activity where SPECT-CT is not possible (e.g. dynamic studies).

OP-291

Joint dual photopeak Lu-177 SPECT image reconstruction with a stacked system model

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Aim: Although Lu-177 has two relatively low intensity gamma-rays, 112.9-keV (6.2%) and 208.4-keV (10.4%), typically only the 208-keV photopeak is used in SPECT imaging. However, including both photopeaks can be beneficial especially in low count-rate situations such as imaging at later time points for

dosimetry following Lu-177 therapies or potentially pre-therapy diagnostic imaging. We propose/evaluate a joint image reconstruction (JIR) method for Lu-177 where a single source distribution is reconstructed from projections acquired from both windows within a unified framework. **Methods**: The JIR approach estimates a single image by concatenating the datasets from the two windows and stacking the corresponding system models that each include the known gamma-ray emission yield, camera detection efficiency, attenuation map and 3D-collimator detector response at each photopeak energy. Because the JIR system model includes gamma-ray yields, the lower-count window is automatically given appropriately lower weight in the Poisson model. To evaluate JIR, we used the following Lu-177 phantom studies with multiple dual energy-window acquisitions/realizations on a Symbia SPECT/CT with medium-energy collimators: 1) measurement with six 'hot' spheres (2,4,8,16,30 and 113 mL) in a 'warm' background, 2) measurement with 'hot' spheres in the 'warm' liver of a torso-phantom at low (typical for pre-therapy) and high count-levels, and 3) XCAT simulations of liver lesions with count-levels typical for patient imaging at 1 and 7 days after Lu-177 DOTATATE. We reconstructed images with single-photopeak (SIR-113, SIR-208) and joint dual photopeaks (JIR) methods, including triple-energy-window scatter, using 50 iterations of in-house EM algorithm. We evaluated each reconstruction with image-ensemble-noise (IEN: variability across multiple acquisitions), contrast-recovery (CR), contrast-recovery-to-noise-ratio (CRNR) and point source calibration-based activity-recovery (AR). **Results**: Visual comparison showed similar quality in both SIR-208 and JIR, while SIR-113 generated noisier image. Quantitatively, JIR improved noise significantly in all studies while keeping AR and CR at similar level, thereby improving CRNR. In sphere phantom measurements, compared to SIR-208, JIR improved IEN by 19.0% and CRNR of each sphere by 20.1-23.2%. In liver-torso phantom measurement, JIR improved IEN by 15.9% (20.9% at lower count-level) and CRNR by 16.7-17.5% (17.3-21.5% at lower count-level). In XCAT simulation, JIR improved IEN by 20.8% (20.9% at lower count-level) and CRNR by 25.4-25.8% (24.9-25.5% at lower count-level). The improvements over SIR-113 were substantially higher. **Conclusion**: In clinically realistic evaluations, joint reconstruction, where the Poisson nature of the multi-window acquisitions is modeled appropriately, significantly improved contrast-recovery-to-noise-ratio compared to single photopeak reconstruction of either photopeak.

OP-292

Evaluation of the accuracy and consistency of a quantitative SPECT reconstruction method for 99mTc Liver MAA images

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Purpose: With the increasing use and diversity of dosimetry applications based on SPECT images, there is a growing need for accurate and consistent quantification of these images. A notable example is the use of 99mTc-MAA scanning for 90Y SIRT pre-planning. In the current work, the accuracy and consistency of 99mTc quantification using an OSEM-based SPECT reconstruction tool (SPECTRA Quant™*, MIM Software Inc.) is reported. **Methods:** Five SPECT images of a multi-compartment liver phantom were acquired over a period of 5 hours after injection of 223MBq of 99mTc. The phantom contains a liver compartment with 3 lesion compartments in which known activity concentrations were injected. At each imaging timepoint, primary and lower scatter energy windows were acquired. A CT image of the phantom was acquired for attenuation correction and to define regions, including a large background region in the liver to evaluate the accuracy of a large structure minimally affected by partial volume effect.The first timepoint projections were decay corrected to the injection time before a reconstruction step (8 subsets, 16 iterations), including CT-based attenuation correction, dual energy window (DEW) scatter correction, and resolution recovery. The quantitative conversion factor was defined in counts/second/MBq from the known injected activity and the number of recorded counts within the whole phantom, and was applied to convert the image into units of Bq/ml. Reconstruction of subsequent timepoints followed this same protocol while using the quantitative conversion factor from the first timepoint. **Results:** The average errors between known injected activities and measured activities over each timepoint were: whole phantom, 0.3%; background region, 1.2%; 25mm-diameter sphere, -36.2%; 32mm-diameter sphere, -25.0%; and 48mm x 32mm ovoid, -15.9%. The coefficients of variation (COVs) were: whole phantom, 0.24%; background region, 0.81%; 25mm-diameter sphere, 0.52%; 32mm-diameter sphere, 0.65%; and 48mm x 32mm ovoid, 0.16%. **Discussion:** The quantitative accuracy was very high (<2% error) in larger regions not influenced by partial volume effects, such as the background region, while being lower (15.9-36.2% error) in smaller regions as expected due to the influence of partial volume effects. The algorithm was found to have a high degree of consistency with a COV<1% across the 5 timepoints. The accuracy and consistency of the MIM SPECTRA Quant tool shows promise for use in 90Y treatment planning. *May not be available in all countries. Contact MIM Software for details.

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Pitfalls & Artefacts 4 - Interactive Clinical Cases: Neuroimaging / Physics: Amyloid Imaging

OP-293

Effects of Acquisition and Reconstruction Settings on Image Interpretation and Quantification

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OP-294

Equivocal and Borderline Amyloid PET Scans - Pitfalls and Challenges of Visual Analysis

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