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Aim Exact anatomic localisation of elevated bone turnover is crucial in diagnosing patients with pain in the foot and ankle. Planar scintigraphies are often equivocal concerning anatomic correlation. Metachronous acquisition of SPECT and CT with secondary digital image fusion is tedious and often fails due to different patient positioning. The aim of this study was to assess the value of combined SPECT/CT using a hybrid scanner in these cases. **Patients and Methods** 64 patients (27m, 37f, age range 19 - 83) with substantial pain in the foot and ankle region were referred to the imaging protocol. Primary clinical assessment and triage was done by an experienced orthopedic surgeon with specialisation in foot and ankle diseases. 30 of these patients had undergone surgery before (11 arthrodeses, 12 prostheses, 4 osteosyntheses, 3 minor surgical procedures). Three-phase bone scanning including biplanar spot images in the late phase was performed after i.v. injection of 740 MBq ^{99m}Tc-DPD; in the late phase, SPECT/CT was additionally performed (thin-slice [1mm] spiral CT, 130 keV, 70 - 100 mAs). The exact anatomic localisation and number of lesions on both planar scintigraphies and SPECT/CT was read in consensus by experienced staff from nuclear medicine and radiology, and compared thereafter. Additionally, the referring surgeon was asked for treatment changes due to the information revealed by SPECT/CT. **Results** Only in 22% of patients all of their lesions were identified and correctly localised on biplanar scintigraphy. In 37% of the cases, only 50% or more of all lesions could be correctly assigned to their anatomic localisation. In 41% of the cases, less than 50% to none of the lesions were classified correctly. The additional information provided by hybrid SPECT/CT scanning influenced therapeutic procedures substantially in 25% of the cases (e.g. decision for surgery or conservative treatment, alteration of surgery planning). **Conclusion** SPECT/CT is an invaluable tool in patients with pain syndroms of the foot and ankle region. It facilitates an exact classification and anatomic localisation of DPD uptake, which is the prerequisite for adequate treatment planning and affects surgical decision-making in a substantial number of cases. Further studies to assess the impact on outcome are warranted.

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2nd ISRTRD – Plenary 2: Therapy

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Locoregional radionuclide therapy of brain tumours

Adrian Merlo (CH)

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Radiodine therapy of thyroid carcinoma in children

Markus Luster (DE)

293c

Enhancement of radionuclide therapy in bone metastases

M. Lam,

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Physics: Data Processing & Analysis 1

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Modelling and Correcting for Respiratory Motion in PET

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Aim: To model and correct for respiratory motion in PETMaterials and Methods: We have developed a complete simulation of the PET data acquisition and reconstruction process based on three software packages. NCAT was used to simulate the object activity and attenuation map, SimSET to model the scanner and data acquisition, and STIR to reconstruct the data using filtered back projection (FBP). Regular arrays of lesions of different sizes and contrast were incorporated into the NCAT Torso phantom, and SUVs were assigned to organs based on typical clinical FDG-PET studies. SimSET was used to simulate data acquisition and data was reconstructed using the FBP algorithm at 16 phases of the respiratory cycle. The simulated results were then used to assess the proposed motion correction technique. Rigid, affine and non-rigid registrations were performed on the images using voxel based similarity measures, to create a single summed motion corrected PET frame. The transformations were derived from (i) the PET images themselves and (ii) simulated CT images at the same respiratory phases.Results: Images reconstructed from the simulated data were subjectively very similar to those obtained clinically. Respiratory motion both blurs lesions and decreases the accuracy of quantification of PET images. These effects varied with lesion size and SUV. Lesion size is seen to increase and uptake values are seen to decrease in lesions undergoing motion. Smaller and lower contrast lesions show more differences between static, time average and motion corrected frames. Preliminary comparisons between corrected and static frames show that the CT corrected frame is closer to the static frame than the PET corrected one.Conclusions: A realistic complete simulation of the PET data acquisition and reconstruction process has been developed to assess the effect of respiratory motion and our proposed motion correction technique on PET data. For the small number of lesions of sizes described here, the differences in volume and SUV confirm that respiratory motion both blurs lesions and decreases the accuracy of the quantification of PET images. The simulation and assessment methods were used to evaluate motion correction methods used to correct simulated PET data. Results show that smaller and lower contrast lesions show more differences in volume and SUV between the corrected, static and time average frames. Future work will involve looking into ways to improve the motion correction scheme, and application of the technique to clinical data using respiratory gated PET and CT acquisition.

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An iterative image reconstruction algorithm for 4D PET/CT incorporating respiratory motion correction

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Objectives: Current state of the art solutions accounting for respiratory motion in PET/CT use an external detector system for respiratory synchronisation of acquisitions. Despite such a synchronisation the reconstruction of individual frames using part of the available data leads to poor quality images and have subsequently limited the utilisation of such techniques in clinical practice. The objectives of this work were to (i). develop a reconstruction algorithm combining all of the available respiratory synchronised data, and (ii). evaluate this algorithm using simulated and clinical datasets. **Materials and Methods:** Our group has previously proposed respiratory motion correction solutions based on the application of an elastic transformation during image reconstruction of respiratory gated list mode data (Lamare F et al 2005, EJNMMI, 32(S1) S33). The drawback of this approach has been long execution times. In this work we present an algorithm that integrates the spatial deformation approach into the classical MLEM reconstruction framework. The deformation is incorporated in the reconstruction process by applying the transformations directly on the system matrix during the forward-projection and backprojection steps. The operation is repeated for each of the iterations. The elastic deformations applied on the system matrix are calculated for each of the respiratory gated frames using the algorithm previously described (Ledesma M et al, IEEE TMI, 2005, 24(9), 1113) and validated for use with 4D PET/CT images (Visvikis D et al JNM, 2006, in press). Different implementations evaluated the need to account during the reconstruction process for deformed voxel shapes as a result of considering elastic transformations. The algorithm has been tested using simulated 4D PET/CT datasets produced by using the NCAT anthropomorphic phantom including lesions (7 to 22mm) in the lung fields. Clinical validation of the algorithm was subsequently performed on a 4D PET/CT patient list mode dataset acquired using a GE DST PET/CT scanner. **Results:** Taking into consideration during the reconstruction voxel shape deformations using continuous b-spline interpolations eliminated artefacts present around the diaphragm where the maximum of respiratory motion displacement is occurring. Simulated and clinical respiratory corrected reconstructed images demonstrated an improved contrast in comparison to respiratory average or individual respiratory synchronised frames. In addition, the NCAT lesion location accuracy was significantly improved irrespective of their location in the lung field. **Conclusion:** An iterative reconstruction algorithm incorporating respiratory motion compensation without increasing the overall time of reconstruction was developed and validated using simulated and clinical 4D PET/CT datasets.

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Effects of motion and background in PET quantification

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The aim of this study was to evaluate in experimental conditions the influence of the motion and the surrounding activity on the measured maximal radioactive concentrations.Materials and Methods: Six spheres of 0.5/1.0/2.0/4.0/8.0/16.0mL were filled with the same solution of FDG (real volumes determined by weighing). They were in a box filled of water. The biggest sphere (16mL) was always static but after a first acquisition with an Advance-PET camera (GEMS), the 5 others moved with a periodic motion of vertical translation (amplitude of 18 or 26mm, period of 7s.) without then with background activity (BG: 1/6.5). Four acquisitions were performed (emission: 5 min, transmission: 3 min). ROIs were drawn around the spheres to determine maximal (Cm) and mean concentrations. Because the partial volume effect could be estimate with the first acquisition, the data could be corrected of this effect. The mean concentrations were summed then multiplied by the ROI volume (number of voxels x voxel volume) to determine the Measured total Activity (MA) of the spheres. The calculated values were divided by the reference values (Cm of the 16mL sphere: Cr and Real Activity: RA).Results:

Volume (mL)	Diam. (mm)	Cm/Cr without motion	Cm/Cr motion 26 mm	Cm/Cr motion 18 mm	Cm/Cr motion 18 mm + BG	MA/RA without motion	MA/RA motion 26 mm	MA/RA motion 18 mm
16.0	31.27	98.7 %	98.8 %	101.6 %	100.9 %	99.1 %	101.0%	99.9 %
8.0	24.82	98.4 %	75.6 %	91.7 %	93.0 %	102.2%	102.4%	101.4%
4.0	19.79	94.8 %	55.2 %	73.8 %	74.8 %	97.7 %	98.1 %	98.6 %
2.0	15.43	87.1 %	45.0 %	67.7 %	69.5 %	94.5 %	95.0 %	100.2%
1.0	12.43	77.5 %	39.6 %	48.0 %	66.6 %	99.0 %	101.2%	95.5 %
0.5	9.89	53.4 %	40.3 %	51.6 %	71.3 %	101.0%	113.8%	108.4%

Conclusions: The underestimation of Cm increases with the motion amplitude and the decrease of the sphere size then becomes stable. When the motion is larger than sphere diameter, background activity is take account in the measurement of Cm (lower underestimation). Moreover, because the motion increases the apparent size of the activity, the global activity is unchanged.