Improved detection rate and visualization of liver uptake foci in diagnostic ^{111}In-octreotide SPECT/CT investigations with a novel segmentation analysis

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Purpose: Detection of liver tumors will change the course of treatment of neuroendocrine tumours. In nuclear medicine ^{111}In-octreoscan is of high value for detection of neuroendocrine tumours. However, neuroendocrine tumours disseminated to the livers is often challenging to detect from ^{111}In-octreoscan SPECT images due to low uptake, high noise, poor resolution and low contrast. The aim of the present study was to develop a segmentation analysis method for increased diagnostic accuracy of neuroendocrine liver tumours.

Methods: For the SPECT reconstruction 120 projections are acquired with 3 degrees spacing around the patient injected with ^{111}In-octreoscan. The projections are reconstructed into a 128x128x128 voxel matrix using OSEM with CT based attenuation correction. The liver is segmented from the SPECT or CT using either an isosurface, region growing or a GPU accelerated level set algorithm. Manual editing finishes the segmentation of the liver. The segmented liver volume of interest, liver VOI, is thresholded at 125 equidistant threshold values between 0 and the maximum voxel value. At each threshold value a connected component labeling algorithm is used to calculate the number of uptake foci (NUF). The normalized NUF (nNUF) is then plotted against the threshold index (ThI), defined as $ThI=(c_{max}-c_{thr})/c_{max}$, where c_{max} is the maximal voxel value in the VOI, and c_{thr} is the voxel threshold value. The method is named nNUFTI - normalized Number of Uptake Foci vs ThI. The ThI at 0.25 nNUF was used for analysis of liver tumour involvement. SPECT images from 53 patients without tumour involvement (i.e SPECT negative) in the liver were analysed with nNUFTI. A three year follow up with MRI, SPECT, PET/CT and CT was used to separate the patients into two groups: the healthy group, with still no liver tumours, and the malignant group, shown to have developed tumours in the liver.

Results: 40 patients ended up in the healthy group and 13 in the malignant group. The ThI at 0.25 nNUF was significantly different between the groups ($p<0.01$). A probability function for the ThI values was constructed from the obtained data. This relationship might be a useful guide in the diagnostic decision making.

Conclusions: Our new developed method nNUFTI has been shown to perform well. More studies on the nNUFTI method are needed.