Single Photon Emission Computed Tomography and 3 Dimensional Quantitative Evaluation in Renal Scintigraphy

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Abstract The evaluation of cortical damage to the kidneys, especially in children, is currently performed by means of Tc99m-DMSA renal scan. The routine involves the acquisition of planar images and their qualitative and quantitative evaluation. Many recent studies have dealt with the possible advantage that single photon emission tomography (SPECT) could possess on qualitative criteria. This study attempts to quantitatively deal with the issue by the calculation of an index, through the digitised slices' data. The results exhibit a clear advantage of tomographic and 3D reconstructed images over the conventional planar ones.

1 Introduction

Tc-99m DMSA renal scan is the method of choice for the detection and follow-up of any possible cortical damage to the kidneys. The test is widely performed in children in order to check for any possible signs of pyelonephritis, as well as for any suspected dysplasia of the kidneys. The usual procedure involves intravenous injection of Tc99m-DMSA and acquisition of four planar images (ANT, POST, RPO, LPO) 6 hours post injection. The evaluation of the results is qualitative by the physician as well as quantitative in the form of two indices denoting relative and absolute renal function for the two kidneys.

As single photon emission computed tomography (SPECT) become more popular, a number of studies dealt with the possible extra information that could be gained by the use of SPECT in renal studies. The comparison between the conventional planar technique and the tomographic acquisition was based on qualitative criteria. The tomographic procedure involves 32 posterior planar views over an 180° arc as it has been argued that a 360° arc does not offer any extra information. On the contrary it contributes to the presence of artifacts as the distance of the camera head from the kidneys is varying and the anterior projections involve an increased amount of soft tissue between the collimator and the kidneys.

In the present study the comparison between the planar and the tomographic imaging is attempted on quantitative basis by the computer extraction of two types of indices.

2 Material-Method

The patient sample consists of 50 children from 4 to 10 year old were admitted for a renal Tc-99m DMSA scan on the suspicion of pyelonephritis. The usual procedure,

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described above, was followed and an extra tomographic study was acquired. It consisted of 32 planar views over a 180^0 arc (LLAT to RLAT). The tomographic study was reconstructed by typical parameters of filters (Hanning filter) and attenuation correction (0.12cm^{-1}). Three-dimensional reconstruction of the tomographic slices was obtained by a 25% threshold and a gradient factor of 15.

The typical procedure was followed by a tomographic reconstruction "by parts". That is, the images of kidneys were separated in three parts (upper, middle and lower), which were separately reconstructed for each kidney. A special program-routine was built to calculate the integrated number of counts over each reconstructed part, that is the number of counts **Integrated Over the Volume** of each part (IOV). This routine calculates the total number of counts over each "volume part" by integration of the transaxial slices corresponding parts. In order to avoid the background counts the routine was built so as to consider regions characterized by numbers of counts over a 20% threshold. This figure was extracted by measurements of the background to the kidney tissue ratio in a number of pathologic and normal images.

The result of this procedure was the calculation of three **Integrated Over Volume** (IOV) indices. These are the ratios of counts of upper to lower, upper to middle and lower to middle part. The corresponding count ratios were calculated from the posterior planar image.

3 Results

Indices were calculated from planar and tomographic (Integrated Over Volume [IOV] indices) images. Our Data concern 3 normal cases as well as pathologic cases (5 patients). In normal kidneys the results indicate a difference in the upper and lower kidney parts, the lower part is characterized by fewer counts than the upper one, a normal pattern that is not evident in the corresponding planar images. In pathologic cases the IOV concerning the kidney part where the focal defect is present is more representative than the corresponding planar index. This fact is clearer if the corresponding images are viewed.

4 Discussion

It has been demonstrated by many studies that SPECT imaging of the kidneys, by Tc99m-DMSA, can provide the physician with extra qualitative information on the anatomy of the kidneys, especially when children are concerned. This conclusion has been drawn by studies based on qualitative criteria. The calculation of the indices in the present study offers a quantitative comparison of the planar, tomographic and 3D reconstructed images.

To conclude, where Tc99m-DMSA renal scan is concerned, the tomographic acquisition and reconstruction and the 3D display clearly offers additional valuable information to the physician, especially in the cases of children. This procedure does not require any extra quantity of radiopharmaceutical to be injected to the patient, therefore the radiation burden is the same. The extra time required is in the order of 15 minutes, therefore not presenting any inconvenience for the patient.