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Qualitative Changes in Bone Scans Using Filters Fbp, Osem, Butterworth

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Key words: Filter, FBP, OSEM, butterworth

Abstract: Filter selection is one of the most important parts of data processing in spectral imaging and is also one of the most important and effective factors in image reconstruction. The purpose of this study is to determine which of the technical factors that have a significant impact on the quality of spectral images is the filtering of raw images that, if selected correctly and accurately, significantly increases the accuracy of image recognition. On the other hand, image reconstruction algorithms play a significant role in noise distribution. Computational algorithms based on the concept of error propagation and statistical algorithms based on the concept of statistical uncertainties, each in turn, will affect the final image noise.In other words, each image reconstruction algorithm behaves differently in a synogram event, which will cause a different effect of each algorithm on the image noise. Algorithms are one of the most common methods of analytical and statistical image reconstruction, respectively. In this study, three filters, OS-EM, butterworth and FBP were examined to determine the quality of the captured images.50 static bone scan images were examined by FBP, OSEM and butterworth software filters. The images were provided to the nuclear medicine specialist to determine the quality, contrast and quality acceptance. The best quality or excellent number 2 was given the average quality number 1 and the poor quality number 0, and finally the obtained images were compare. The results showed; In terms of image quality measured with FBP filter, 68% of the images were of excellent quality and 32% of the images were of medium quality. In terms of image quality measured with OSEM filter, 40% had excellent quality images, 56% had medium quality images and 4% had poor quality images. In terms of image quality measured with butterworth filter, 10% of the images were of excellent quality, 54% of the images were of medium quality and 36% of the images were of poor quality. Chi-square test was used to determine the difference in the quality of the measured images. The results showed that there was no significant difference between the three filters in terms of image quality ($p = 0.63$). At the end of this study, the results showed; There was no difference in image quality between the filters compared, however, the FBP filter had the best image quality compared to the other two filters. Of course, there is a debatable point here, according to the study area, the type of complication, the choice of filter and its parameter are different, so an optimal filter is not possible and depends on the type of disease.

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INTRODUCTION

Single photon emission computed tomography (SPECT) of the bone is the second most frequently performed SPECT examination in routine nuclear medicine practice, with cardiac SPECT being the most frequent. Compared with planar scintigraphy, SPECT increases image contrast and improves lesion detection and localization[1-3]. Studies have documented the unique diagnostic information provided by SPECT, particularly for avascular necrosis of the femoral head, in patients with back pain, for the differential diagnosis between malignant and benign spinal lesions, in the detection of metastatic cancer in the spine, for the diagnosis of temporomandibular joint internal derangement, and for the evaluation of acute and chronic knee pain. Although less rigorously documented, SPECT is being increasingly used in all types of situations that demand more precise anatomic localization of abnormal tracer uptake. The effectiveness of bone SPECT increases with the selection of the proper collimation, which allows one to acquire adequate counts and minimize the patient-to-detector distance. Low-energy, ultrahigh-resolution or high-resolution collimator is preferred over all-purpose collimators. Multi head gamma cameras can increase the counts obtained or shorten acquisition time, making SPECT acquisitions more practical in busy departments and also increasing image quality compared with single head cameras. Iterative reconstruction, with the use of ordered subsets estimation maximization, provides better quality images than classical filtered back projection algorithms[4-5]. Images and information obtained in various disciplines and scientific fields are usually associated with noise and other disturbances related to various sources, and nuclear medicine images are no exception to this rule. Poisson noise is mounted on these images and causes image degradation, therefore, to increase the quality of the images, it is necessary to reduce the effect of these contaminants[6].The basic method for relative noise reduction is to increase the signal-to-noise ratio in images by increasing the amount of radiation and radioisotope prescribed or by increasing the shooting time. There is a limit on the amount of prescription Radiopharmaceuticals due to protection issues. It also limits the patient's ability to move, the length of the imaging time. Therefore, there is always significant noise in nuclear medicine images and the use of filters to reduce noise in many cases is inevitable[7]. Many types of filters are designed and used to reduce data noise. But in general, their success rate largely depends on the relative amplitude of noise and signal. If they are close in noise and signal amplitude, noise removal is associated with reduced spatial resolution and image contrast. Spatial resolution filters, such as Metz and Wiener filters, can reduce spatial resolution and contrast to some extent by increasing some frequencies. In practice, however, it is very difficult to pinpoint the frequency to be amplified, and if misled, it can lead to confusion and misinterpretation of results[8]. Over the past three decades, much research has been done to improve noise reduction methods in nuclear medicine, and various filters have been used. But the problem of filtering nuclear medicine images has not yet been fully resolved, and research remains open and there is still a demand for new methods. One of the recently considered methods of noise reduction is the use of wavelet transformer, which has been proven to be able to reduce some types of noise, and many researches are underway to find its applications in various branches of science. The mathematical basis of wavelet analysis dates back to the work of Joseph Fourier in the 19th century. In 1909, Alfred Hare formulated the first theory of what we now call a wavelet. The theoretical concept of the wavelet as it exists today was first articulated by John Morlett, and then Meyer followed it, advancing the theory. Stephen Maltster wrote the main wavelet algorithm in 1988. It was after this time that wavelet research became a global endeavor, and Dabychs, Kuifman, and Wickerhauser did valuable research in this area. The speed is growing[9]. Because in medical imaging practice, depth information is not available where the radiation occurs, and in addition, activities resulting from separate parts may overlap on the detector screen, the image resolution may be low. Therefore, it is impossible to determine the distribution of activity with just one imaging, because an unlimited number of distributions can have the same visual function. Its difficulty is like finding two numbers just by knowing the sum of them. However, the overlap observed in the images depends on the relative position of the detector and the internal parts of the body. Therefore, more information about the relative position can be obtained by taking more images from a large number of viewing angles around the object. The primary goal in single-photon computed tomography, or "spectrum", is to obtain the most accurate possible image of the gamma-ray emission distribution in any part of the body using images obtained by rotating a gamma camera at several angles of view. The basic principle of nuclear medicine imaging is that the labeled gamma-emitting drug is injected into a living organism and an external device (gamma camera) detects the resulting radioactivity from one or more viewing angles. Many different algorithms are used for spectra including FBP, conjugate gradient (CG), maximum likelihood maximum (MLEM) and maximum posterior maximum maximization (MAPEM). This study aims to investigate qualitative changes. Bone scan was performed using FBP, OSEM, butter worth filters[10-12].

MATERIAL AND METHODS

In this study, 50 static bone scan images were processed by FBP, OSEM and butterworth software filters. The images were provided to the nuclear medicine

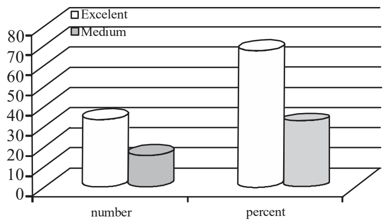

Fig.1: Frequency chart of images taken with FBP filter

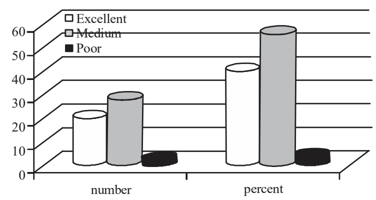

Fig.2: Frequency determination chart of images taken with OSEM filter

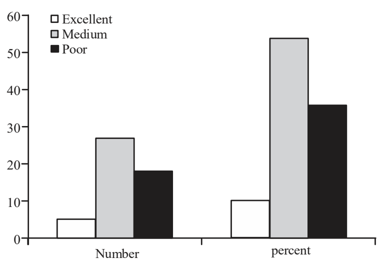

Fig.3: Frequency chart to determine the quality of images taken with the butterworth filter

specialist to determine the quality, contrast and quality acceptance. The best quality or excellent quality number 2 was given the average quality number 1 and the poor quality number 0. Comparing the effect of 3 filters on the quality of images is the aim of this study. The nuclear medicine specialist looks for abnormal changes in bone metabolism in the scans performed. In the obtained photos, darker areas are seen as "hot spots" and logically lighter areas are seen as "cold spots", which differ depending on the accumulation or non-accumulation of radioactive materials in one area. Also, due to the high sensitivity of bone scans to abnormal changes in bone metabolism, this test can be helpful in accurately identifying the cause of problems. Analysis and interpretation of nuclear medicine flat images plays a very important role in diagnosis. These images usually have relatively low contrast, high noise and small dimensions at the site of injury. Damage detection in these images depends on their quality and sharpness. It seems that the removal of noise frequency components using two-amplitude algorithms can be useful in reducing noise. Bone scan images for the process are selected with the studied filters. Static images are selected for the study. Then digital filters are placed on the images and the qualities are checked. Images are recorded on each of the filters. The images are analyzed by xeleris software.

RESULTS AND DISCUSSION

The choice of filter is one of the most important parts of data processing in spectra photography and is also one of the most important and effective factors in image reconstruction. Trying to reduce scattered rays and improve image quality is of great importance. The advantage of image simulation is complete control of each noise. Therefore, the present study was conducted to investigate and compare three filters FBP, OSEM, Butterworth. For this purpose, 50 static bone scan images were examined by FBP, OSEM and Butterworth software filters. The results showed; In terms of image quality measured with FBP filter, 68% of the images were of excellent quality and 32% of the images were of medium quality. In terms of image quality measured with OSEM filter, 40% had excellent quality images, 56% had medium quality images and 4% had poor quality images. In terms of image quality measured with Butterworth filter, 10% of the images were of excellent quality, 54% of the images were of medium quality and 36% of the images were of poor quality. Chi-square test was used to determine the difference in the quality of the measured images. The results showed that there was no significant difference between the three filters in terms of image quality. (P = 0.63).

Finding : Quality of images taken with FBP filter In terms of image quality measured with FBP filter, 68% of the images were of excellent quality and 32% of the images were of medium quality. Frequency chart of images taken with FBP filter In terms of image quality measured with OSEM filter, 40% had excellent quality images, 56% had medium quality images and 4% had poor quality images. Frequency determination chart of images taken with OSEM filter In terms of image quality measured with butterworth filter, 10% had excellent quality images, 54% had medium quality images and 36% had poor quality images. Frequency chart to determine the quality of images taken with the butterworth filter

CONCLUSION

The results of this study showed; There was no difference in image quality between the filters compared, however, the FBP filter had the best image quality compared to the other two filters. Of course, there is a debatable point here, according to the study area, the type of complication, the choice of filter and its parameter are different, so an optimal filter is not possible and depends on the type of disease.

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