Mem. Fac. Eng., Osaka City Univ., Vol. 36,pp. 67−69.(1995)

A study of extraction of activation areas on PET images

by

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(Received September 30, 1995)

Synopsis

In this study, the new method is proposed which detects and extracts activation areas on PET (Positron Emission Tomography) images. A delegated method utilized t−statistical analysis, but not applied a sufficient conversion to densities on the images with noise derived from the precision of equipments. To improvement the conversion, the rate of density at each position to the average density on PET images is approximated for a linear function by using a least square root criterion of its varidation, which is proposed in this paper.

Keywords : Measurement Precision, t−statistical analysis, PET images, Image processing.

1. Introduction

It is important and useful means for studing the basic sickness of brain to obtain an activation area on images of PET. Because the quality of the PET images is not so fine, it is difficult to diagnose with the subtraction image between the activated and inactivated images. It is important to utilize the computerized methods to analysis the activation areas.

Several methods have been before studied for the purpose to obtain the activation areas on PET images[1−3]. These studies have mainly utilized t−statistical analysis for the density values. However, they have not made some methodological problems clear, and also the methodological estimation of the methods has not been performed positively. In this paper, delegated methods are surveyed and the new improved method is proposed.

2. Delegated Methods

The basic idea of delegated methods is to utilize t−statistical analysis because of the bad quality of PET images. The steps of its process are presented as follows:

(I −1) Select two images which are an activated image and an inactivated image.

(I −2) Indicate a brain area and calculate its density average on each image.

(I −3) Correct densities of images by linear shifting so that the average may become the value of 4000 which is the standard Cerebral value in clinical usage.

(I −4) Subtract the inactivated image from the activated image.

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PET images

(I−5) To obtain t−value, divide the subtracted value by the standard deviation (SD) at each pixel, which is calculated on a phantom study described after.

(I−6) Examine the obtained t−value with an appropriate significant value (p) to extract activation areas,.

Several methods utilized a smoothing method before the step (3).

The phantom study, which was performed to obtain the standard deviation at each pixel used at the step (I−5), is described as follows:

(II−1) Obtain the plural images, which present an uniformity phantom, and each of which shows a different average from the others.

(II−2) Indicate the phantom area and calculate its density average on each image.

(II−3) Fit the regression line to each position for the tuples of its density and average on the image, and calculate the standard deviation of densities on the basis of the regression line. The obtained standard deviation is utilized for the step (I−5) described above.

First, we must note that not the activation quantity but the activation rate is necessary for clinical usage. Second, the correction of the density of each pixel is performed along the linear function to the average, which was not confirmed on the delegated method. Consequently, the activated rate must be utilized on the analysis of PET studies, and the varidation according to the rate must be obtained.

3. Methods according to activation rate

The new extraction method is presented in this section, which avoids the two problems described in the former section. This method includes the same principal as regression analysis and t−statistical analysis. For the first problem to calculate the activation rate, the approximated linear function is constructed on the basis of the rate of dividing densities by the average. For the second problem of density correction, the density of each pixel is corrected along the obtainable approximated line. The steps of the process to obtain an approximate linear function by a phantom study are presented as follows:

(III−1) Obtain the plural images, which present an uniformity phantom and, each of which shows different average from the others.

(III−2) Delete the background on each image by thresholding and thrinking to obtain the central areas of the phantom.

(III−4) Smooth images by operating on them the Gaussian filter whose deviation is set to 3 pixels.

(III−5) Fit the regression line to each position for the tuples of the value obtained by dividing its density by the average on the image and the average on the image. And then convert the obtained line to the linear function of the density versus the average.

(III−6) Calculate the standard deviation of the rate of density on the basis of the converted regression line fit each position.

The converted regression line and the obtained standard deviation are utilized for extracting the activation area described after.

The steps of the process extracting the activation areas are described as following.

(IV−1) Select two images which are an activated imaged and an inactivated image.

(IV−2) Delete the background on each image by thresholding and thrinking to obtain the brain areas of the image. This step is same to the step (II−2) in the delegated method.

(IV−3) Smooth images by operating on them the Gaussian filter whose deviation is set to 3 pixels.

(IV−4) Correct densities of each pixels on images by shifting along the converted regression line to be normalized, that is, to make the average the value of 1.

(IV−5) Divide inactivated images by activated images.

(IV−6) To obtain t−value, divide the subtracted value by the standard deviation (SD) at each pixel, which is usually calculated on the phantom study.

(IV−7) Examine the obtained t−value with an appropriate significant value (p) to extract activation areas.

The steps (III−2), (III−3), (III−4), (IV−2), (IV−3) (IV−4) and (IV−5) are different from ones of the delegated method. The steps (III−2) and (IV−2) mean the computerized extraction of the phantom area and the brain area, respectively, to get more objective analysis. At the steps (III−3) and (IV−3), noises on images are reduced to make the extraction more adequate. The converted linear function at the step (III−4) is utilized to analyze the rate to the average value more significantly than to analyze quantity. The step (IV−4) is performed for that the activation areas are extracted at the basis of the accurate means. The step (IV−5) can give the activation rate.

4. Remarks

In this study, delegated methods to extract the activation areas on PET images is surveyed, some problems of them are pointerd out, and the new method is proposed to avoid the problems. By using this method, the accurate diagnosis will be performed more adequately in the clinical use.

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