Functional Imaging of Regional Cerebral Blood Flow Based on Height/Area Method

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The purpose of this presentation is to investigate following computer processing techniques in brain functional imaging of regional cerebral blood flow (rCBF10) based on Height/Area method (stochastic analysis) using ^{133}Xe. That is,

1. Time interval (integration duration)
2. Smoothing method
3. Matrix size
4. Statistical error

The joint camera-computer system used in this study consists of the GCA-202 gamma camera and the DAP-5000N computer system. Following intra-arterial injection of 3–5 mCi of ^{133}Xe, 5 second frames of data in 64×64 matrix form were acquired for a period of 14.5 minutes utilizing the computer system.

Automatic computation of rCBF10 (eq. 1) and its relative standard deviation (RSD, eq. 2) was done for each element of the matrix.

$$\mathrm{rCBF}\ 10 = \frac{100 \cdot \lambda \cdot (H_0 - H_{10})}{\sum_{i=0}^{10\mathrm{min}} H_i} \quad (\mathrm{ml/100g/min}) \qquad \cdots\cdots\cdots (1)$$

$$\mathrm{RSD} = \frac{1}{\sqrt{f}} \cdot \sqrt{\frac{H_0 - H_{10}}{(H_0 - H_{10})^2} - \frac{\sum_{i=0}^{10\mathrm{min}} H_i}{(\sum_{i=0}^{10\mathrm{min}} H_i)^2}} \times 100\ (\%) \qquad \cdots\cdots\cdots (2)$$

Where Hi is height at time i, H_0 initial height, H_{10} height at 10 minutes, λ blood-tissue patition coefficient and f filter factor ($f=(\sum W_i)^2/\sum(W_i)^2$ W: weight).

In view of spatial resolution and statistical error, the optimum conditions for rCBF10 functional imaging were concluded as follows,

1. Time interval — 5. seconds
2. Smoothing method — $f=10.2$ or 15.1
3. Matrix size — 64×64 matrix form
4. Statistical error — mean RSD=5–8%

It is considered that brain functional imaging is of special value for the assessment of regional cerebral blood flow and that it will be useful for daily clinical studies, since this procedure requires only a few minutes with the computer system.

Computed Differential Diagnosis of Abnormal Brain Scan at Real Time

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Using 310 true positive brain scans, a computer system (TOSBAC 40C) for the differential diagnosis of brain lesions has been evaluated at real time. Eighty-six parameters were extracred from brain scan findings without relationship to neurological signs and the likelihood method was adopted as an example of mathematical logic. Brain scan findings are marked on card with dark pencil according to the parameters. The mark cards are read by card reader, and computer starts calculation using the data of internal sumples (236 cases), and computer diagnosis and scan findings are typed on report paper within two minutes for each patient.

Overall accuracy rate of the computer diagnosis by the maximum likelihood method was 67.6% in external sumple (74 cases). The computer gave satisfactory results for diseases such as infarct, subdural hematoma, meningioma and acoustic neurinoma.