THREE DIMENTIONAL rCBF IMAGING USING OUR RCT SYSTEM AND CONTINUOUS INFUSION OF KRYPTON-81M

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It was reported recently by Fazio, F. et al that, under continuous intracarotid infusion of a solution of short half-life tracer, Kr-81m, regional brain activity reflect regional cerebral perfusion. Their procedure using γ camera, however, provides only rough information summed up over the brain tissue perfusion along the collimator axis. Since radionuclide computed tomography(RCT) offers an image of 3-dementional distribution of radioactive tracer, we carried out transaxial tomographic imaging using our RCT system with continuous intracarotid infusion of Kr-81m solution, in order to evaluate more accurate regional brain perfusion.

1. Theoretical consideration: Under continuous infusion of a Kr-81m solution with constant concentration, regional radioactivity (Nieq) at a region i at equilibrium of the gas in the brain tissue is given as follows,

$$Nieq = k \cdot fi \int_0^\infty \exp\left\{-\left(\mu + \frac{fi}{Vi \cdot \lambda i}\right)t\right\} dt$$

$$= k \cdot fi \Big/ \left(\mu + \frac{fi}{Vi \cdot \lambda i}\right) \quad \text{--------} \quad (1)$$

where fi, λi and Vi are blood flow, the blood-brain petition coefficient (1.09 for Krypton) and brain tissue volume at the corresponding region i respectively, k constant of counting efficiency, and μ the disintegration coefficient of the tracer (3.2 min^{-1} for Kr-81m). The equation (1) is just according with the equation introduced by Fazio, F. et al. This equation presents that the relation between regional radioactivity of the brain tissue is almost lineraly proportional to blood flow at the region for the general flow range from zero to 100 ml/100g/min.

2. Method: The Kr-81m solution was produced continuously by passing water or 5 % glucose solution through 10 mCi Kr-81m generator (Japan Mediphysics). The aquous Kr-81m solution was mixed by Y tube with equal volume of 1.8 % NaCl solution. ^{81m}Kr solution with constant concentration was infused continuously into the carotid artery in constant flow rate of 5 or 10 ml/min. Under the condition mentioned above, transaxial computed tomography of regional cerebral blood flow were obtained using our RCT system which was consisted of an Autofluoroscope Model 5600 (Baird Atomic) and an automatic rotating chair as reported previously by Kanno, I. et al. Thirteen slices of RCT Images of regional cerebral blood flow with 2 cm slice thickness by 1 cm interval could be obtained simultaneously by a 10 minutes scan. Total counts collected in the study were 100.000-200.000 count per one slice.

3. Results: Transaxial imaging of regional cerebral blood flow was carried out on 7 adult dogs and on a patient with cerebral infarction. On the experimental study using dogs, the brain tissue perfused by internal carotid artery could be distinguished clearly from the neighbouring tissues which were perfused by the external carotid artery. Increased cerebral blood flow due to hypercapnea (7% CO_2 inhalation) was also recognized clearly on the cross sectional images. In a dog with the accidentally occluded internal carotid artery, any increase of radioactivity in the diseased brain tissue was not able to be observed even under 7% CO_2 inhalation.

On the imaging of a patient with cerebral infarction at a month after onset, remarkable decrease of radioactivity was recognized in the infarcted brain tissue at the right frontal lobe. In this case, considerable decrease of radioactivity was also recognized at the lateral ventricle and periventricular white matter.

Although continuous infusion of Kr-81m and imaging by RCT system does not provide absolute value of regional cerebral blood flow at the present stage, the technique provides detailed and repeatable assessment of 3-demential regional perfusion. Especially, the procedure could describe the presence and the extension of ischemic area in cerebrovascular disease.