Quantitative Measurement of Renal Function Using Ga-68-EDTA

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YAMASHITA, M., INABA, T., KAWASE, Y., HORII, H., WAKITA, K., FUJI, R. and NAKAHASHI, H. Quantitative Measurement of Renal Function Using Ga-68-EDTA. Tohoku J. exp. Med., 1988, 155 (2), 207-208 — We studied renal function using a positron emission tomography with C15O gas and 68Ga-EDTA in 6 normal subjects (male, 21-77 years old). The blood volume (ml/100 g (kidney)) was 19.2±1.8 for the one 21 years old subject and 11.8±2.0 for the rest (65-77 years old). The glomerular filtration rate (ml/min/100 g (kidney)) was 57.8±1.1 for the 21 years old subject and 30.4±2.8 for the rest. ———— kidney; glomerular filtration rate; gallium-68-ethylenediaminetetraacetic acid; positron emission tomography

We investigated 68Ga-EDTA, to test its clinical applicability.

METHODS

An ionic 68Ge-68Ga generator (New England Nuclear Co., Boston, MA, USA) was used with 2 ml of 1N HCl to eluate the 68Ga. The eluate (added about 2 mg of EDTA-2 Na) was neutralized with 1 N NaOH and made isotonic (1.5-8 mCi/20 ml). The solution passed a heavy metal test, a tin contamination test, a radioisotope purity test and a paper chromatography test (Yamashita et al. 1985, 1986a, b). It also passed bacteria culture and endotoxin tests. In a radiochemical test (HPLC), a single radioactivity peak was revealed in the urine obtained 1hr after the intravenous injection and no side effects were noticed for at least 3 days. A positron emission tomography (PET) system using a whole body collimator (SET-120W, Shimazu Co., Kyoto) and a cyclotron with gas purifying system (BC-1710, Japan Steel Works, Muroran) were used. These systems are located at Nishijin Hospital.

Six normal subjects (one 21 years old male and 5 males (65-77, 71±4.4 years old)) were studied. The scan position for each subject was determined using an ultra-sound apparatus. About 10-20 mCi of C15O gas was administrated by a single inhalation method and 1-5 mCi of 68Ga-EDTA was administrated by intravenous injection (supine position). Arterial blood samples were obtained from the upper arm and counted by a gamma-scintillation counter. Emission data were collected simultaneously for 3 slices (≈1.5 cm width/slice) by initial twelve 5 sec scans followed by eight 30 sec scans. Regions of interest (ROI) were placed on the aorta and the parenchymal portion of the kidney and the time activity curves (TAC) were then obtained. The TAC of the aorta was corrected for the counter data using

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An accumulation model was used for $^{68}$Ga-EDTA. The tracer is introduced into the vessel by blood flow, filtrated at the glomerular portion by glomerular filtration rate (GFR), accumulated in the tubular portion and excreted in the urine. This model is reliable in the early portion of the TAC as the tracer is transported to the pelvi-calyceal system and escapes from the ROI.

The renal TAC includes both the accumulation and blood circulation processes, where the blood volume cannot be negligible. It is necessary to estimate and exclude the blood activity from the measured data and obtain a real accumulation curve. We obtained a transfer function (blood transit process in the kidney) from the CO data using deconvolution calculations using the TAC of the aorta as an input function and the renal TAC as an output function. Then a convolution calculation was performed using this transfer function (CO study) and an input function (TAC of the aorta obtained from the EDTA study), and resultantly an output function (estimated TAC for the blood activity in the EDTA study) was obtained. Thus the blood activity was subtracted from the measured renal activity.

The least square method was employed to obtain the optimal subtraction weight factor which would produce the best straight correlation between the integrated artery activity multiplied by a constant (ideal accumulation process by GFR) and the subtracted renal activity.

**RESULTS**

Thirty slice data for 6 subjects were available but the rest, 6 slice data, was unavailable as the kidneys were partially out of the slice. The blood volume was $19.2\pm1.8$ ml/100 g (kidney) for the one subject (21 years old) and $11.8\pm2.0$ ml for the rest (65-77 years old). The GFR value was $57.8\pm1.1$ ml and $30.4\pm2.8$ ml/min/100 g (kidney) for the 21 years old male and the rest, respectively.

**DISCUSSION**

The blood volume and GFR values obtained from the young subject were comparable to those listed in Folkow and Neil’s (1971) physiology textbook and those from the elderly subjects were comparable to those published by Guyton (1986). Until the present report no articles have mentioned the clinical application of $^{68}$Ga-EDTA in renal studies. From the present results obtained with $^{68}$Ga-EDTA, it can be said that PET studies are quite viable for the quantitative measurement of GFR.

**References**


