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Optimal dose of injection in activation study with O-15 water and PET

Norihiro SADATO,* Yoshiharu YONEKURA,** Yasuhiro MAGATA,* Sadahiko NISHIZAWA,* Koichi ISHIZU,* Hidehiko OKAZAWA,* Tatsuro TSUCHIDA,* Fumiko TANAKA,* Nagara TAMAKI,* Satoshi SASAYAMA,* Hiroshi SHIBASAKI** and Junji KONISHI*

*Departments of *Nuclear Medicine and **Brain Pathophysiology, Kyoto University Faculty of Medicine*

In activation studies with the bolus method for O-15 water and PET, the radiotracer concentration may reach the limits of the system in terms of dead time correction and accidental coincidence. To obtain the optimal injection dose of O-15 water, we performed a normal volunteer study to evaluate the relationship between the injected dose and the radioactivity concentration in the brain and a phantom study to evaluate the performance of the PET scanner (PCT3600W) under high count rate conditions and the effect of averaging on the signal to noise ratio for the PET images.

A linear relationship was noted between the injected dose (normalized for each body weight: x) and the mean radiotracer concentration in the brain measured by PET (y) ($y = 2.52 + 30.1\,x$, $n = 64$, $r = 0.87$, $p < 0.001$). The percent error in the measurement of radioactivity with PET was within $\pm 5\%$ in the 100 to 2000 nCi/m*l* (3.7–74 KBq/m*l*) range. Below 100 nCi/m*l* (3.7 KBq/m*l*), the percent error increased due to the rapid increase in noise in the reconstructed images. Over 1000 nCi/m*l* (37 KBq/m*l*), on the other hand, the noise was almost unchanged.

With our PET scanner, the optimal range of the radiotracer concentration in the brain is below 1000 nCi/m*l* (37 KBq/m*l*), corresponding to an injection dose of 33 mCi (1.22 GBq)/60 kg body weight. With the same total dose, the increment of number of repeated measurements for averaging provided the better signal to noise ratio. In designing a paradigm for an activation PET study, the injection dose and the number of repeated measurements for averaging should be considered.

Key words: PET activation study, O-15 water, optimum dose, signal to noise ratio