BNL--36937

BNL 36937

DE86 000317

CONF-8506187--2

THE DETERMINATION OF THE LUMPED CONSTANT AND THE KINETIC CONSTANTS FOR DEOXYGLUCOSE AND FLUORODEOXYGLUCOSE IN MAN

JH Greenberg, M Reivich, A Alavi, A Wolf, J Fowler, J Russell, C Arnett, RR MacGregor, CY Shiue, H Atkins, A Anard, B Dann (Cerebrovascular Research Center, University of Pennsylvania, Philadelphia, PA and Brookhaven National Laboratories, Upton, NY, USA)

Shortly after the introduction of the ^{14}C-2-deoxyglucose technique for the measurement of the local cerebral metabolic rate for glucose (LCMRgl) in laboratory animals (Sokoloff et al, 1977), this technique was extented to man using emission tomography (Reivich et al, 1979). Both ^{18}F-fluorodeoxyglucose (FDG) (Reivich et al, 1979; Phelps et al, 1979) and ^{11}C-deoxyglucose (DG) (Reivich et al, 1982) are in widespead use for the in vivo quantitative determination of LCMRgl in both physiologic and pathophysiological states in man. Quantification of LCMRgl, however, requires the knowledge of certain kinetic constants describing the transport of the glucose analogue in the cerebral tissue along with a constant, termed the lumped constant (LC), which describes the relationship between the uptake of the glucose analogue by the tissue to the uptake of glucose.

It has been previously shown (Sokoloff et al, 1977) that if a step change in arterial ^{18}F-FDG or ^{11}C-DG is produced, and if the arterial glucose concentration remains constant and the amount of dephosphorylation is negligible, then the value of the ratio of the extraction fractions of ^{18}F-FDG or ^{11}C-DG and glucose by the brain multiplied by the ratio of the arterial whole blood to plasma specific activity asymptotically approaches the value of the lumped constant. In a series of 15 normal male subjects, catheters were placed percutaneously into a radial artery and into the internal jugular bulb in order to obtain arterial and cerebral venous blood samples respectively. The glucose analogue was infused into a vein using an infusion schedule calculated to produce a step change in the arterial blood radionuclide concentration. Blood samples from both the arterial catheter and the cerebral venous catheter were drawn intermittently over the next 50 minutes, analyzed for glucose concentration and counted in a well counter for radioactivity. The infusion schedule was altered during a study if necessary in order to maintain a constant plasma ^{18}F or ^{11}C activity. The mean values (± SEM) of the lumped constants for FDG and DG are 0.52 ± 0.028 (n=9) and 0.56 ± 0.043 (n=6), respectively. These are the only reported values for the measurement of the lumped constant available.

If both the time course of the arterial plasma radionuclide concentration and the brain tissue radionuclide concentrations are known, it is possible to calculate the kinetic constants (k_1^*, k_2^*, k_3^*, k_4^*) of the glucose analogue (Sokoloff et al, 1977; Phelps et al, 1979). In a series of male subjects, arterial blood samples were obtained at frequent intervals immediately following the bolus administration of ^{18}F-FDG and then at less frequent intervals for up to 5 hours after the radionuclide administration. The tissue time course was obtained by making positron

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED