Efficiency of Grain Production in 18F Micro-Autoradiography

著者	Yamada S., Kubota R., Kubota K., Ishiwata K., Ido T.
journal or publication title	CYRIC annual report
volume	1990
page range	153-155
year	1990
URL	http://hdl.handle.net/10097/49597

III.10. Efficiency of Grain Production in ^{18}F Micro-Autoradiography

Yamada S., Kubota R., Kubota K., Ishiwata K. and Ido T.**

*Department of Radiology and Nuclear Medicine, The Research Institute for Tuberculosis and Cancer, Tohoku University Cyclotron and Radioisotope Center, Tohoku University**

Introduction

Macro-autoradiography (macro-ARG) which reveals the distribution of tracer at tissue level has played an important role in the interpretation of clinical PET images[1]. To obtain a further information of tracer distribution at cellular level, we developed a micro-ARG method for ^{18}F in which a frozen section was directly mounted on a glass slide coated with nuclear emulsion[2]. The aim of this study is to measure the efficiency of grain production as influenced by the exposure time, and to decide the appropriate exposure time in the ^{18}F micro-ARG.

Materials and Methods

Micro-ARG experiment

Normal male C57BL/6 mouse weighing 20 gr was injected i.v. with 7.5 mCi (277.5 MBq) of 2-deoxy-2[^{18}F]fluoro-D-glucose (^{18}F-FDG), and killed 5 min later when the liver uptake was the highest[3]. As the homogeneous in vivo sample, the liver was quickly removed and frozen on a flat dry-ice. Under the safety light in a darkroom, the frozen liver block was sectioned on a cryostat (-20 °C). Each 5 µm-thick frozen section was directly mounted on a cooled glass slide coated with AR-10 stripping film (Kodak, U.K.), and exposed at -70 °C in an exposure box cooled by dry-ice for 1 to 10 hr with 1 hr interval. After the exposure, the autoradiograms were developed in Konidol-X (Konica, Japan), fixed in Fuji general purpose fixer (Fuji, Japan), washed in water and dried at 18.5 °C. The slides were counter-stained with Eosin.

Grain counting and radioactivity measurement

Grains on autoradiogram were counted using an 11.73 µm-grid micrometer under a light microscope (×1000). Counted grains per microgrid area were calibrated to those per 100 μm^2. Net grains / 100 μm^2 were calculated by subtracting the back-ground grains / 100 μm^2 from the total grains / 100 μm^2 Other 5 um-sections of the same sample were attached to thin polyethylene films, air-dried and punched circularly 6 mm in diameter. The ^{18}F radioactivity in the punched section was measured with a gamma counter. Cross calibration between the gamma counter and a well-type dose meter was performed for ^{18}F. Radioactivity per 100 μm^2 of the section was calculated and corrected for decay.

Efficiency of grain production

Efficiency of grain production can be defined by the number of grains produced for every one disintegration in the specimen. In ^{18}F, the number of disintegrations during exposure time of t, D(t), is mathematically expressed to be a time integral of ^{18}F radioactivity function of A(0)*exp(-ln2*t/T1/2) (A(0): radioactivity at starting time of exposure, T1/2: half life of 109.7 min), that is to say, to an A(0)*T1/2/ln2*[1-exp(-ln2*t/T1/2)]. When the counted grains at exposure time of t is G(t), G(t) is equal to K*D(t) (K: constant). The K indicates an efficiency of grain production at exposure time of t and the values of K were calculated by solving the above equation using experimental data of counted grains.

Results

The mean ^{18}F radioactivities of the 5-μm liver sections of the mouse injected 7.5 mCi of ^{18}F-FDG was 321 fCi/100 μm^2 at the starting time of exposure. The counted grains and the values of K as a function of exposure time are given in Table 1. The counted grains in the autoradiogram increased with the extension of exposure time until 6 hr, and then, decreased rapidly for next 1 hr followed by a gradual decrease. Back- ground grains were constant over the experimental exposure (0.66 ± 0.11/100 μm^2). The values of K were constant during the first 6 hr, rapidly decreased for next 1 hr followed by a gradual decrease.

Discussion

Our ^{18}F micro-ARG is a frozen section method to avoid the translocation of tracer during the sampling and ARG process. ^{18}F is a short-lived positron emitting radionuclide and its half-life is approximately 2 hr. The grain production is related to the number of emitted positrons, that is to say, the duration of exposure time and the radioactivity[4)]. If there is no latent image fading which reduces the developed grains, the value of K as an indicator of efficiency of grain production is constant and does not change with time. In this experiment, the grain production increased with time until 6 hr, however, rapidly decreased at 7 hr. The value of K at each exposure time was constant during the first 6 hr, however, rapidly decreased for the next 1 hr. These results indicate that the latent image fading occurred, at least, during 7 to 10 hr. In AR-10 stripping film, the efficiencies of grain production in ^{32}P (Emax= 1.7 MeV), ^{131}I (Emax= 0.82 MeV), ^{59}Fe (Emax= 0.46 MeV), ^{14}C (Emax= 0.15 MeV) and ^{3}H (Emax= 0.018 MeV) are 0.39, 0.9, 0.8, 0.9 and 0.43 grains/disintegration, respectively[5)], however, the efficiency in ^{18}F (Emax= 0.635 MeV) is not known. In this experiment,the average efficiency duringm the first 6 hr were 0.32± 0.02 grains/disintegration and was lower than those in ^{131}I and ^{59}Fe which maximum energies of emitted beta particles are close to that in ^{18}F. There are some factors affecting the efficiency, such as the temperature, oxygen tension and humidity[4]. In ^{18}F micro-ARG, the exposure at low temperature of -70 °C may be a main factor for the low efficiency. From views of the efficiency and the grain production, it can be concluded that 4 to 6 hr (twofold to threefold half life of ^{18}F) is preferable for the appropriate exposure time in the quantitative ^{18}F micro-ARG.

References

1) Sokoloff L., Reivich M., Kennedy C. et al., J. Neurochem. **28** (1977) 897.
2) Yamada S., Kubota R., Kubota K. et al., Neurosci. Lett. **120** (1990) 191.
3) Fukuda H., Matsuzawa T., Abe Y. et al., Eur. J. Nucl. Med. 7 (1982) 294.
4) Boren H.G., Wright E.C., Harris C.C. J. Histochem. Cytochem. **23** (1975) 901.
5) Pelc S.R. Theory of autoradiography. Autoradiography for biologists. (1972) 1. Academic Press. New York.

Table 1. Counted grains and K values.

	(321fCi/100um^2)		
Exposure time (hr)	Counted grains (unit:*1)	K value (unit:*2)	Back-ground grains (unit:*1)
1	12.1±2.3	0.34	0.6
2	16.9±6.4	0.28	0.7
3	22.8±7.9	0.30	0.6
4	28.6±4.8	0.32	0.8
5	32.5±9.7	0.34	0.8
6	33.2±4.9	0.33	0.7
7	28.3±3.8	0.27	0.6
8	26.2±9.9	0.24	0.6
9	23.5±4.1	0.22	0.6
10	21.9±1.9	0.20	0.6

*1: grains/100um^2, *2: grains/disintegration,
Values are mean±S.D or mean.