E. Radiopharmaceuticals

The Production of Aqueous Solution of ^{18}F for Injection for the Bone Scanning

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^{99m}Tc-labelled compounds have been widely used for bone scanning. On the other hand, $Na^{18}F$ began to be used again for the diagnosis of bone with development of positron camera.

The $^{16}O(\alpha, pn)^{18}F$ and $^{16}O(^3He, p)^{18}F$ reactions in a distilled water are very useful for the production of ^{18}F aqueos solution.

With these reactions, ^7Be, ^{11}C and ^{48}V are produced as by-products. H_2O_2 is also produced in the solution by the radiolysis of water. Therefore it is necessary to purify the irradiated water and to obtain a pyrogen-free solution of $Na^{18}F$ without by-products for clinical diagnosis. ^{18}F was produced by the $^{16}O(\alpha, pn)^{18}$ Freaction by bombarding distilled water with 60 MeV α particles.

A glass vessel was designed specially for monitoring the target water level and attached on the top of the target box without the Pt-Pd reforming catalyst. The irradiated solutions were introduced into the distillation vessel through a teflon tube by the pressure of a He gas. H_2O_2 and $^{11}CO_2$ generated in the solution buring the irradiation were removed out by heating.

^{18}F was distilled from the solution, after the addition of H_3PO_4 (0.5 m*l*). A small amount of water (1–2 m*l*) was introduced into the distillation vessel and distilled again.

Pure ^{18}F solution without impurities was obtained at the yield of 90% by these procedures. A calculated quantity of 9% NaCl (pyrogen-free solution) was added into the solution to make it isotonic.

All the final solutions produced by this method could pass the pyrogen test (limulus test and rabbit test).

For example 151 mCi of ^{18}F could be obtained in the final solution at 15 μA and at the irradiation time of 88 min.

These ^{18}F solutions have been used for bone scanning at the NIRS-hospital.

Synthesis of 21-fluoroprogesterone-^{18}F and Its Distribution in Mice

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In our studies on development of assay of the target tissue in vivo by using the specific binding of γ-radio nuclide labeled hormone with receptor protein, we have labeled 21-fluoroprogesterone with ^{18}F.

For this purpose, the labeled hormone is required to have high specific activity. 21-Fluoroprogesterone was synthesized in 1956 by the reaction of 21-iodo derivative with AgF, but this method would be unadaptable because high specific activity might not be expected. Therefore, we prepared 21-fluoroprogesterone-^{18}F from 21-hydroxypregn-4-enc-3, 20-dione methanesulfonate, $K^{18}F$ and crown-ether (18-Crown-6). The following is general method: $K^{18}F$-quarz sand was labeled with high specific activity by dry up of ^{18}F-water, about 10μ mol of carrier KF and quarz sand in a platinum crucible. The $K^{18}F$, crown-ether and methanesulfonate in acetone or chloroform were refluxed for 1 hour. After column chromatography of the reaction mixture, 21-fluoroprogesterone-^{18}F was obtained in an overall radiochemical yield about 7% of $K^{18}K$-quarz sand with specific activity of about 10 mCi/mg at the end of preparation.

This labeling system is regarded to be suitable for ^{18}F-monfluorination of active methyl group and high specific activity labeling approximately with carrier-free ^{18}F by reducing of carrier KF.

The distribution of 21-fluoroprogesterone-^{18}F was studied in female mice at 0.5, 1, 2 and 3 hours after intravenous injection of 1 μg/head. The blood showed the highest concentration and uptake in bone increased gradually. The target organ, uterus contained lower concentration, 0.35% dose/gm at 3 hrs. These results were regarded that the receptor site was fulled with natural progesterone and that defluorination took place in vivo.

^{81m}Kr-Generator for Medical use: The Effect of Humidity on ^{81m}Kr Effusion Efficiency in Gaseous Delivery

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In the lung inhalation study using medical ^{81m}Kr-generator (Nihon Medi-Physics Co., Ltd.), marked depression of ^{81m}Kr effusion efficiency was observed when dry, unhumidified air was used as the effusion gas, and quick recovery of the efficiency was noted with the use of humidified air.

In order to evaluate the effect quantitatively, the equilibrium ^{81m}Kr activity concentration in the effluent was measured as a function of time using an experimental apparatus in which the effusion air can be selected instantaneously from both dry and humidified line under constant pressure and flow rate. The depression of the effusion efficiency was exponential vs. time and it could be expressed in the following equation:

$$\text{dry}\,(\bar{A}_2)t = \frac{31.98}{\alpha} \times e^{(-0.100-0.122\alpha)t} \qquad (0.5 \leqq \alpha \leqq 2.5)$$

where dry $(\bar{A}_2)t$ is the ^{81m}Kr activity concentration (mCi/l) in the effluent from a generator (^{81}Rb: 10mCi) at t min after the start of the effusion with dry air, and α is the flow rate (l/min) of the dry air. Once the effusion gas was switched to the humidified air, the recovery of the efficiency was completed within 3 min at the flow rate of 0.5–2.5 l/min.

The ion exchange (Dowex 50wx8 100–200 mesh) contains about 45 weight % water at humidified state. Dry air graduary removes a portion of this inner water (free water), and hence the contraction of the resin sphere would be caused. This contraction reduces the effective surface area, i.e. the surface that contacts with outer atmosphere, and depresses the diffusion of ^{81m}Kr which generated from ^{81}Rb on the resin surface.

On the other hand, the surface of the resin maintains its original shape under a humidified atmosphere and ^{81m}Kr diffuses well into the effusion gas.

In summary, the humidification of the effusion gas is showed to be necessary from the two viewpoints: the protection of the subject's throat and the prevention of the effusion effiiency depression.

A Chemically Characterized ^{99m}Tc-PG Preparation for Cholescintigraphy: a Kit Method

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^{99m}Tc-Pyridoxilidene glutamate introduced by Baker et al. is an interesting technetium labeled cholescintigraphic agent but its cumbersome method of preparation and the lack of reproducible singular compound severely limits its use in the clincial field.