Study the Possibilities of the PET/CT Method with ^{18}F-FET in Nuclear Medicine

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In the paper, the authors presented the results of research for the production and synthesis of the radiopharmaceutical (RPC) 18F-fluoroethyltyrosine (^{18}F-FET). This RPC is new for Kazakhstan. Ease of production and synthesis of RPC - ^{18}F-FET, its high stability in the body, fast kinetics of accumulation in brain and tumor, its low accumulation in non-tumor tissue, provide a great opportunity for clinical use of the RPC - ^{18}F-FET for diagnosis of brain tumors.

The aim of this work is to study the production and synthesis of positron-emitting ultra-short-lived radionuclide ^{18}F in radioisotope diagnostics for its application in positron emission tomography of brain tumors.

Materials and methods: Preparation of [^{18}F]FET. [^{18}F]Fluoride is produced via the ^{18}O(p,n)^{18}F nuclear reaction by bombardment of a water target, enriched by ^{18}O for 98%, with an 11 MeV proton beam. [^{18}F]FET is prepared by a two-step reaction, which consists of ^{18}F-fluorination of ethylene glycol-1,2-ditosylate with subsequent ^{18}F-fluoroethylation of unprotected L-tyrosine. The solution is purified by reversed phase high-performance liquid chromatography (RP-HPLC) to isolate 18F-fluoroethyltosylate. Product is eluted with 0.9 ml of dimethylsulfoxide (DMSO) into a vessel containing 4 mg of di-potassium sodium salt of L-tyrosine (or D-tyrosine). The vessel is closed and heated at 90C for 10 min. After HPLC purification of the reaction mixture, the collected fraction is passed through a strong cation exchange cartridge. Once the cartridge is washed with 1 ml of water, [^{18}F]FET is eluted from the resin by 4 ml 0.15 mol/l phosphate-buffered saline (PBS; pH 7.4). Further, [^{18}F]FET is diluted with 2 ml of isotonic saline solution, and sterilizing filtration is carried out (Millex-GV 0.25 micron filter) into a sterile vial containing 1 mL 1 mol/l of sodium carbonate, which leads to a final solution composition.

Results: Depending on the concentration of tyrosine, the 18F-fluoroethylation resulted in saturation yields up to 75% $\pm$ 5% after 6-7 minutes. These results were observed using a 45 mmol/l solution of the di-sodium salt of tyrosine in 300 microliters of dimethyl sulfoxide.

Conclusions: The synthesis of L-[^{18}F]FET is simple, efficient and requires only commercially available chemicals and no complex equipment. The process of 18F-fluoroalkylation is often used and simple, starting with nucleophilic ^{18}F-fluoride. All the synthesis terminates in less than 1 hour with radiochemical yield of about 40% based on ^{18}F-fluoride. Compared with all the other amino acids, examined up to now, L-[^{18}F]FET shows the highest consumption by brain in last researches. Therefore, compared with ^{18}F-FDG PET/CT, PET/CT with ^{18}F-FET is a more sensitive method for the diagnosis of brain tumors.