Medically Important Radionuclides Obtained by Alpha Particle Irradiation

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Some radionuclides used in nuclear medicine have unique properties. These include the α-emitter 211Ac and the β- emitter 61Cu used in therapy, and the PET radionuclide 43Sc used in PET diagnostics. Unfortunately, they can be effectively produced only on α particle-accelerating cyclotrons in α,n, and α,p reactions. 211At seems to be the most promising candidate for targeted α- radiotherapy because its 7.2 h half-life assures sufficient time for its transportation, synthetic chemistry, multistep labeling, quality control, and clinical application without the problems caused by the relatively long-lived daughters emitting the α-particle. Recently, significant interest in 44Sc (T1/2= 3.87 h) as a tracer for PET imaging has been observed. Unfortunately, the co-emission by 44Sc of high-energy γ rays (Eγ = 1157 keV, 99%) causes a dangerous increase in the radiation dose to the patients and clinical staff. Also, the co-production of longer-lived 44mSc (T1/2 = 58.6 h) increases the radiation dose for patients. However, it is possible to produce another radionuclide of scandium, 43Sc which has properties similar to 44Sc but is characterized by much lower energy of the concurrent gamma emissions. One of the most promising ways of production of 43Sc are 40Ca(α, p)43Sc and 40Ca(α, n)43Ti → 43Sc nuclear reactions on natural calcium carbonate running simultaneously during the bombardment of targets made of natural calcium carbonate.

Unfortunately, only few cyclotrons in the world are currently able to accelerate α-beams with adequate for 211At production energy and intensity consequently, the availability of 211At and 43Sc is limited to a few nuclear medical centers. In Europe, 211At was produced only in France and Denmark. We believe that the use of the p-11B fusion to produce a flux of alpha particles as proposed in the PROBONO project can solve the problem with the availability of these radionuclides and radically change the availability of radiopharmaceuticals, especially for targeted alpha therapy.

The lecture will present the latest achievements in diagnostics and radionuclide therapy. Next, the methods of obtaining medical radionuclides and the production of radiopharmaceuticals will be presented, with particular emphasis on the radiopharmaceuticals based on 43Sc, 211At, and 61Cu radionuclides.