The integration of Astatine-211 as potential radiotheranostics in personalized cancer treatment

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Astatine-211 (At-211) belongs to the group of alpha radioisotopes used for targeted radiotherapy (TAT). The advantages of astatine-211 over other alpha emitters are its higher linear energy transfer - LET (~100 keV/µm) and short-range tissue penetration range (max 100 µm). Moreover, its primary advantage lies in the emission of only a single alpha particle per decay until the formation of stable Pb-207, without formation of radioactive daughters. The last few years it is alpha medicinal radioisotopes with major interest for personalized therapy in cancer patients.

Appropriate molecules that can be labeled with astatine-211 include monoclonal antibodies, proteins, Fab'-fragments, peptides and astatine-211 without a vector molecule. These diverse groups of labeled molecules with astatine-211 could be used for treating prostate cancer, lung cancer, leukemias, multiple myeloma, thyroid gland cancer, ovarian cancer and another micro metastasis (1).

Astatine-211 is the heaviest element in the halogen group that also exhibits metallic properties, adding complexity to the study of its the characteristics. It possesses somehow similar characteristics to iodine. This similarity is particularly useful for researching chemical behavior, as astatine-211 is one of the rearrest elements on the earth with limited access. Astatine can exist in several oxidation states depending on the pH conditions (- I, 0, + I, + III, + V, and + VII). The most clearly established is oxidation state -1. Astatine-211 is produced in a cyclotron by irradiating bismuth-209 and is mostly purified from the target by dry distillation. There are several appropriate labeling procedures such as: aromatic nucleophilic substitution with halogen exchange, dediazonation, direct electrophilic aromatic substitution, demetallation and usage of boron clusters (2). Firstly, the two step labeling procedure of monoclonal antibodies using N-succinimidyl 3-[211At]astatobenzoate (SAB) as prosthetic group, was well established. For a much faster labeling procedure, which is very important due to the 7.2 h half-life of the isotope, and higher labeling yield, there is a single step labeling procedure with boron moiety as prosthetic group (3).

Recently, the research focus is to improve the therapeutic effect of astatine-211 and to involve the benefits from this radioisotope to prepare formulation with other isotopes such as gallium-68, so they will have radiotheranostic effect (4, 5). In that case, both radioisotopes use the same precursor, peptides. This approach with multiradionuclides could contribute to the radiotheranostic formation of astatine-211.

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