Radiolanthanides as a tumor scanning agent

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The results of our series of basic systematic experiments using Yoshida sarcoma-bearing rat are summarized as following: Ga and In in the group III showed a very strong affinity to tumor and Sc also showed a slight affinity to Yoshida sarcoma, and furthermore, Hg and Bi in the period VI had a very strong affinity to tumor and Au also had a very strong affinity to tumor when used as a H^{198} $Aucl_4$ solution. Considering these facts carefully on the periodic table, it was quite natural to mark Tl, La and Lanthanides as a key element. ^{202}Tl citrate did not show any affinity to Yoshida sarcoma. Among 15 elements of lanthanides, 8 radioactive nuclides were available: ^{140}La, ^{141}Ce, ^{153}Sm, ^{160}Gd, ^{160}Tb, ^{170}Tm, ^{169}Yb and ^{177}Lu. All nuclides but ^{140}La (chloride) were used as citrate form. The amounts and specific activities administered to a rat were ^{140}La 3 μCi/La 40 μg, ^{141}Ce 2 μCi/Ce 7.2 μg, ^{153}Sm 3 μCi/Sm 36 μg, ^{153}Gd 2 μCi/Gd 0.006 μg, ^{160}Tb 2 μCi/Tb 5.4 μg, ^{170}Tm 33 μCi/Tm 3 μg, ^{169}Yb 2 μCi/Yb 11 μg and ^{177}Lu 30 μCi/Lu 3 μg, respectively. All radionuclides showed more or less affinity for the malignant tumor and the retention value in the tumor tissue of ^{170}Tm citrate was the highest, 1.34%/g, and was followed by ^{169}Yb citrate and ^{177}Lu citrate. Tumor-muscle and tumor-blood concentration ratio of ^{170}Tm citrate and ^{169}Yb citrate were very large and in this respect ^{170}Tm- and ^{169}Yb citrate were much more excellent than ^{67}Ga citrate. On the other hand, however, ^{170}Tm and ^{169}Yb had very strong affinity for bone which might be only one disadvantage of these nuclides inferior to ^{67}Ga. As a promising nuclide of clinical tumor scanning, ^{167}Tm, ^{169}Yb and ^{175}Yb (citrate form is preferable) are suggested from the viewpoints of physical properties of the nuclide.

^{169}Yb citrate was prepared and supplied for human use by Dainabot Radioisotope Laboratory, Ltd., Tokyo, Japan. Its specific activity ranged from 370 to 448 mCi/mg of Yb. Two to five hundred μCi of ^{169}Yb citrate was administered intravenously to each patient. Scintiphotos were obtained at intervals from one to five days following the administration. In our forty cases, no side-effect has been observed. The scintiphotos obtained were quite acceptable. The advantages and disadvantages of ^{169}Yb citrate tumor scintigraphy are as follows.

Advantages

1) Since ^{169}Yb has a relatively long shelf-life (physical half-life is 32 days), ^{169}Yb can be available any time when tumor scintigraphy is required.

2) ^{169}Yb is a reactor-produced nuclide and much cheaper than ^{67}Ga which is a cyclotron-produced nuclide.

3) The main peak of gamma rays of ^{169}Yb is 198 keV and suitable for scintigraphy.

4) Body back-ground is extremely small, especially three to five days after injection, and tumor image is obtained very clearly.

5) Distinct visualization of the skeleton is helpful in localizing the tumor to the anatomical landmark.

Disadvantages

1) Skeleton image might obscure the tumor image when superimposed.

2) Exposure to the patient is relatively high. Radiation dose is comparable to those of other agents, ^{203}Hg chlormerodrin or ^{75}Se-selenomethionine.