World Academy of Science, Engineering and Technology
International Journal of Biomedical and Biological Engineering
Vol:9, No:07, 2015

Ytterbium Advantages for Brachytherapy

Authors : S. V. Akulinichev, S. A. Chaushansky, V. I. Derzhiev

Abstract : High dose rate (HDR) brachytherapy is a method of contact radiotherapy, when a single sealed source with an activity of about 10 Ci is temporarily inserted in the tumor area. The isotopes Ir-192 and (much less) Co-60 are used as active material for such sources. The other type of brachytherapy, the low dose rate (LDR) brachytherapy, implies the insertion of many permanent sources (up to 200) of lower activity. The pulse dose rate (PDR) brachytherapy can be considered as a modification of HDR brachytherapy, when the single source is repeatedly introduced in the tumor region in a pulse regime during several hours. The PDR source activity is of the order of one Ci and the isotope Ir-192 is currently used for these sources. The PDR brachytherapy is well recommended for the treatment of several tumors since, according to oncologists, it combines the medical benefits of both HDR and LDR types of brachytherapy. One of the main problems for the PDR brachytherapy progress is the shielding of the treatment area since the longer stay of patients in a shielded canyon is not enough comfortable for them. The use of Yb-169 as an active source material is the way to resolve the shielding problem for PDR, as well as for HRD brachytherapy. The isotope Yb-169 has the average photon emission energy of 93 KeV and the half-life of 32 days. Compared to iridium and cobalt, this isotope has a significantly lower emission energy and therefore requires a much lighter shielding. Moreover, the absorption cross section of different materials has a strong Z-dependence in that photon energy range. For example, the dose distributions of iridium and ytterbium have a quite similar behavior in the water or in the body. But the heavier material as lead absorbs the ytterbium radiation much stronger than the iridium or cobalt radiation. For example, only 2 mm of lead layer is enough to reduce the ytterbium radiation by a couple of orders of magnitude but is not enough to protect from iridium radiation. We have created an original facility to produce the start stable isotope Yb-168 using the laser technology AVLIS. This facility allows to raise the Yb-168 concentration up to 50 % and consumes much less of electrical power than the alternative electromagnetic enrichment facilities. We also developed, in cooperation with the Institute of high pressure physics of RAS, a new technology for manufacturing high-density ceramic cores of ytterbium oxide. Ceramics density reaches the limit of the theoretical values: 9.1 g/cm3 for the cubic phase of ytterbium oxide and 10 g/cm3 for the monoclinic phase. Source cores from this ceramics have high mechanical characteristics and a glassy surface. The use of ceramics allows to increase the source activity with fixed external dimensions of sources.

Keywords : brachytherapy, high, pulse dose rates, radionuclides for therapy, ytterbium sources
Conference Title : ICMPBE 2015 : International Conference on Medical Physics and Biomedical Engineering
Conference Location : Zurich, Switzerland
Conference Dates : July 29-30, 2015