Calculation of Dose Distribution near an Innovative Concentric Balloon Catheter for Endovascular Brachytherapy

One of the possible intravascular irradiation techniques is to use a radioactive solution filled catheters. This method has the advantage of accurate source position and a uniform dose to the vessel wall. However it has a potential problem of chemical and radiological toxicity of the radioactive liquid due to the risk of balloon rupture. In order to minimize the risk of the toxicity in case of balloon rupture, an innovate concentric balloon catheter was designed to increase the dose per volume of radioactive solution with inner balloon and the outer balloon filled with saline and radioactive solution, respectively. The dose rate versus the radial distance from the center of the radioactive-filled balloon was calculated by numerical integration for P-32, Re-188, and Y-90 with various inner and outer radii. The results showed that for a balloon with outer radius of 1.5 mm, there is no advantage of double balloon. For a balloon with outer radius of 3.0 mm and the inner radius of 2mm, the dose rate reduction is 30% whereas the volume reduction is as big as 45% at the point of 0.5mm away from the outer surface (prescription point). The optimal inner radius is 1.5mm since by further increasing the inner radius the reduction of the dose rate is at the same pace as the reduction of the volume. A similar calculation was done for balloon with outer radius of 5mm. The results showed that in this case 3mm inner radius is the optimal radius.