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Abstract

A New Approach to Small Field Dosimetry in the Robotic Radiosurgery System with Home-Made Phantom

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Objectives: The effective atomic number of EBT film and BeO-OSL is ~6.98 and ~7.1, respectively. The effective atomic number of human tissue is ~ 7.4. It has been demonstrated in many studies that the closer effective atomic number to human tissue is needed to acquire more accurate dosimetric results. Although its effective atomic number is not same with the human tissue, there is a wide acceptance to use EBT film dosimetric system in the practice. BeO-OSL may be a better dosimeter choice in dosimetric systems due to its effective atomic number, but there are not enough phantom studies for BeO-OSL choice. We designed a special phantom and dosimetric system in order to use the OSL dosimeter. The aim of the study is two evaluate the uncertainty in CyberKnife system using 5, 7.5 and 10mm collimators with our homemade phantom and OSL dosimeter.

Methods: A head phantom was designed and printed in a 3-D printer. In the printing process, clear resin (60-90 HU) was chosen for the soft tissues, specially prepared CaSO42H2O mixture (800-2000 HU) was chosen for bone tissues and air spaces were left empty. Special holes were created in the phantom for inserting BeO-OSL dosimeters. After acquiring CT images of the phantom, we made treatment plans using Ray-Tracing algorithm for virtual targets contoured on CT images for 5, 7.5 and 10 mm collimators using Multiplan Treatment Planing Version 4.6. The irradiation dose was prescribed as 5 Gy and it was repeated for three times. Set-up errors in irradiation were kept under 0.5 mm for translational errors and under 0.5 mm for rotational errors to irradiation same condition. After acquiring X-Ray images for set-up process, the image guidance system turned off. Pdose OSL dosimeter reader was used to measure the irradiation dose.

Results: Mean planned dose obtained from treatment planning system for 5, 7.5 and 10mm

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collimator was 587 cGy, 578 cGy, 583cGy, respectively and it was measured with BeO-OSL 530.5 cGy, 548 cGy, 551cGy respectively.

Conclusions: Uncertainty was increased with increasing collimator size in 5, 7.5 and 10 mm collimators. The uncertainty for the 5mm, 7.5mm and 10 mm cones was 9.62%, 5.19% and 5.48% respectively. These results were consistent with literature. The uncertainty in the small collimators in the CyberKnife system was demonstrated with a home-made phantom that was customized to the OSL dosimetry system.