Evaluation of a treatment planning system used for BNCT at the Kansai BNCT medical center

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Introduction

The Kansai BNCT medical center located in Osaka prefecture, Japan, has opened in June 2018. At present, a phase II clinical trial of grade 2 and 3 meningioma has begun, and the center is aiming to provide BNCT medical care in the year 2020. The center is fitted with a cyclotron-based epithermal neutron source (C-BENS), providing high flux of epithermal neutrons to treat tumours located several centimeters below the surface of the skin. The treatment planning system (TPS) used during the clinical trial was the Simulation Environment for Radiotherapy Applications (SERA) version 1CO. SERA was developed by Idaho National Engineering and Environmental Laboratory (INEEL) in collaboration with Montana State University [1]. Evaluation of a TPS is crucial to understand the limitations of the system to allow a better understanding on the treatment outcome. This study aims to evaluate SERA TPS by comparing the results against measured data.

Material and Methods

The experimental setup during the beam data commissioning phase of C-BENS was replicated using SERA and the central axis depth profile and off-axis profile of the thermal neutron flux inside a water phantom was simulated. The results were compared against measured data, which was obtained using gold foil activation method. The field sizes compared were 10, 12, 15 and 25 cm diameter circular fields.

Results

The central axis depth profile was found to be in good agreement with measured data, difference less than 2%, with the exception near the surface and buildup region. The off-axis profile was also found to be in good agreement, up to a depth of approximately 5 cm. At a depth greater than 5 cm, a difference between 5-10% was observed.

Conclusion

The SERA simulation showed a good agreement with measured values (difference of less than 2%), with the exception near the buildup region (i.e. up to 2 cm depth) and at depths greater than 5 cm. From a clinical perspective, the surface dose (i.e. dose delivered to the skin region) is extremely important and an accurate determination is desirable. Given the calculation voxel size used in SERA is a 10 mm cube, the uncertainty in the flux and dose simulation around the buildup region is

high. A more robust Monte Carlo system, such as Particle and Heavy Ion Transport code System (PHITS), will be used to evaluate the thermal neutron flux and dose distribution at these regions.

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References

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