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Dosimetric commissioning of range shifter bed for superficial region treatment in spot scanning proton therapy

○Ota Seiichi[1, 2], Kajikawa Tomohiro[2], Kijima Kenta[1], Okita Tetsuya[1], Takaya Hisashi[1], Mikawa Saki[1], Ogata Toshiyuki[2], Aibe Norihiro[2]

Department of medical technology, Kyoto prefectural university of medicine[1], Department of radiology, Kyoto prefectural university of medicine[2]

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Purpose: Range shifter (RS) was utilized for delivering effective dose to superficial tumors in proton therapy. Several types of gantry-mounted RS were available currently. However, when dorsal beam arrangement is required in some cases such as central nervous system, the use of the gantry-mounted RS might be difficult due to interference with treatment couch. We had developed a RS bed that allow to attach immobilization devices such as vacuum cushion and mask. Aim of this study was to evaluate dosimetric accuracy in use of the RS bed for treatment of shallow tumors in spot scanning proton therapy.

Materials and Method: Single beam to water phantom perpendicularly was designed with a treatment planning system (TPS). Isocenter was placed at 50 mm below water surface and a target volume set as 80 x 80 mm in lateral and 80 mm from water surface to target distal side. Dose was calculated in different air gaps (AG) between RS and water surface that ranged from 0 to 100 mm. Dose was measured with ion chamber at several depths (3-70 mm) in several AGs (10 to 100 mm) and compared with TPS dose. Gamma pass rate (2%, 2 mm) was also evaluated at combination of 3 depth (9, 20 and 50 mm) and several AGs (0-100 mm) with 2D array detector.

Result: Over 3% dose difference to TPS dose were found at depth 3 mm with AG 70 and 100 mm. The %dose difference was -3.2 and -4.4%, respectively. In other points, %dose difference was within 3%. Mean gamma pass rate at depth 9 mm with AG 20, 30, 50, 70 and 100 mm were 90.4 ± 3.6%, 94.9 ± 2.0%, 98.8 ± 1.4%, 96.2 ± 0.6 and 86.6 ± 6.5%, respectively. Gamma pass rate at depth 20 and 50 mm in any AGs were acceptable.

Conclusion: Dosimetric accuracy in use of the RS bed was evaluated within AG 100 mm. In AG 100 mm, gamma pass rate at depth 9 mm was below 90%. We should keep AG between RS and surface as possible as close. In case of just below skin surface treatment, it might be better to keep AG within 70 mm in aspect of point dose difference.