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Implementation of Simultaneous Integrated Boost Radiotherapy in GRID Spatially Fractionated Radiotherapy

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Abstract

Purpose: This study focused on the clinical implementation of simultaneous integrated boost (SIB) planning technique for GRID Spatially Fractionated Radiotherapy (SFRT). Methods: The GRID SFRT SIB plan was generated using 10Gy for the bulky target (PTV: 248 cc) and a boosted dose of 15Gy for the high-risk target (PTV_boost: 26cc). The Truebeam STX linac with HD-MLC (multileaf collimator) and brass GRID block from *dotDecimal* were used to generate conformal peak-valley doses inside the targets, respectively. The plan was generated with Eclipse v15.6 (2mm calculation resolution). It had two GRID beams "Fld_PTV" of 13x12 cm2 and "Fld_PTV_boost" of 6x5 cm2 with MLC to shape the dose conformal to PTV and PTV_boost. The dose was prescribed at dmax of a standard GRID beam (i.e., 100cm SSD and 10x10cm2). The output factors of GRID beams (the central hole) were verified with ion chamber and solid water using clinical plan set up at dmax. Two-dimensional dosimetric QA was performed with ArcCheck. Results: The overall peak-valley dose ratio (PVDR) for PTV_boost was 4.7. The PVDR of Fld_PTV and Fld_PTV_boost were 4.5 and 4.8, respectively. D10/D90 of PTV and PTV_boost were 5.4 and 4.9, respectively. Difference in output factor between measurement and treatment planning system (TPS) calculation was within 3%. The gamma passing rate was 91% (3% and 3mm). Conclusions: This study demonstrated the feasibility of target dose escalation using SIB technique for GRID SFRT plans.

Introduction

The traditional GRID SFRT used a physical brass GRID collimator with holes of 1-1.5 cm in diameter (Fig. 1A). In addition, the MLC leaves can be used to achieve the dose conformity. By implementing the "field-in-field" planning technique in GRID SFRT planning, customized dose can be prescribed to boosted area or multiple targets.

Methods and Materials

As shown in Fig. 1B, the GRID SFRT SIB plan was generated using 10Gy for the bulky target (PTV: 248 cc in red) and a boosted dose of 5Gy (a total of 15Gy) for the high-risk target (PTV_boost: 26cc in pink). It had two GRID beams "Fld_PTV" of 13x12 cm² and "Fld_PTV_boost" of 6x5 cm² with multileaf collimator (MLC) to shape the dose gradients that were conformal to PTV and PTV_boost (Fig. 1C-D). The gantry angle was adjusted according to the target geometry (Fig.2).

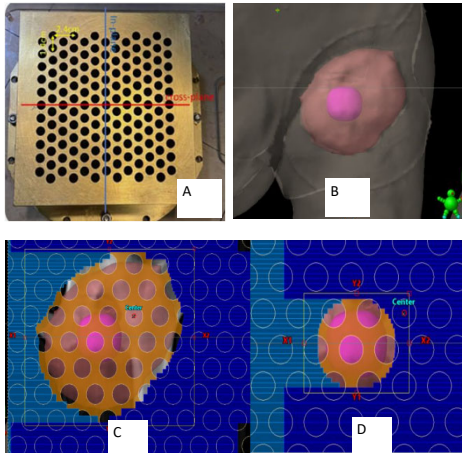

Figure 1. (A) Illustration of the physical brass GRID collimator; (B) Target (brown) with a boosted area (pink); (C)-(D): two separate beams using MLC for beam shaping.

Results

Figure 3 demonstrated the 10Gy to PTV (Brown), boosted 5Gy to PTV_boost (Green), and overall 15Gy (blue) to the "PTV_boost". Parameters for the GRID SFRT plans were demonstrated in Table 1.

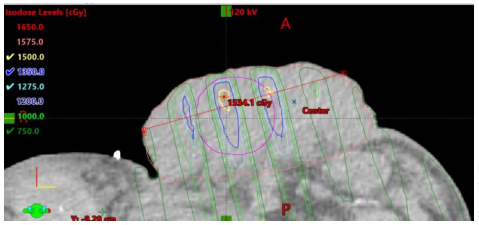

Figure 2. Gantry angle was determined based on the patient's anatomy

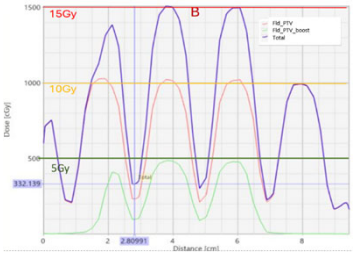

Figure 3. Dose profiles of "Fld_PTV" (brown), "Fld_PTV_boost" (green), and overall dose to the "Fld_PTV_boost" (blue).

Table 1. Peak-valley dose ratio (PVDR) and D10/D90 ratio for "PTV" and "PTV_boost"

	PVDR	D10/D90
PTV	4.7	5.4
PTV_boost	4.8	4.9

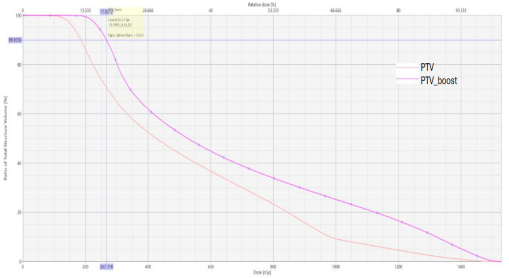

Figure 4. DVH curves for "PTV" (brown) and "PTV_boost" (pink)

Conclusions

The planning technique explored in this study can be used for GRID SFRT with escalated dose. In addition, this technique can also be used for multiple targets with different prescription doses.

Contact

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