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Potential for Dose-escalation in the Post-prostatectomy Setting with Intensity-modulated Radiation Therapy: A Dosimetric Study Using EORTC Consensus Guidelines for Target Volume Contours

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Purpose

Radiation therapy (RT) is delivered after radical prostatectomy (RP) for prostate cancer (PC). Although intensity modulated radiation therapy (IMRT) has become standard in definitive RT for PC, dosimetric data in support of post-RP IMRT are limited. This study was designed to quantify benefits of IMRT versus 3D conformal RT (3DCRT) with respect to dose sparing of rectum and bladder and target volume coverage. Motivated by the desire to deliver higher radiation doses and to quantify the dosimetric impact of IMRT, we retrospectively analyzed images in order to: 1) identify a preferred IMRT beam arrangement; 2) evaluate the dosimetric advantages of IMRT compared to 3DCRT; and 3) assess the variation of dosimetric parameters during the RT course using conebeam CT (CBCT) images.

Methods

Twenty patients who received post-RP RT at our institution were identified. All patients were treated with 4-field 3DCRT plans (68.4 Gy to a minimum of 95% coverage). A single observer delineated all volumes to comply with EORTC consensus guidelines. The CTV was expanded 7 mm, except 5 mm posteriorly, to create the planning target volume (PTV). To identify optimal IMRT beam arrangements, 10 patients were planned with both 5- and 9-field, coplanar IMRT plans. Then, 9-field IMRT plans (72.0 Gy) were completed for the remaining patients. Differences of DVH values between IMRT and 3DCRT plans were evaluated using 2-tailed paired t-tests. CBCT data was used to evaluate rectal volume and dose throughout treatment.

Results

The 9-field IMRT plans (vs. 3DCRT) improved mean bladder dose values (31.23 Gy vs 34.89 Gy, $p=0.003$) and V65Gy (15.4% vs 21.4%, $p=0.06$). Additionally, 9-field IMRT reduced rectal endpoints: mean (31.58Gy vs 36.14 Gy, $p=6.8E-07$), V75% (24.4% vs 31.0%, $p=0.0005$), and V65Gy (10.5% vs 20.0%, $p=1.08E-8$). Advantages of IMRT were at the cost of small increases in maximum dose delivered to the bladder

(73.3 Gy vs 71.3 Gy, $p=0.0004$) and the rectum (72.8Gy vs 71.1 Gy, $p=0.001$) compared to 3DCRT. The 9-field and 5-field IMRT plans had comparable PTV coverage. The 9-field IMRT produced minimal improvements in mean rectal doses, but had lower maximum dose to 1 cc volume (71.58 Gy vs 73.18 Gy, $p=0.003$). CBCT images ($n=132$) were analyzed for 8 patients; rectum mean dose and V65 were also improved by IMRT on these scans. IMRT allowed dose escalation to 72.0 Gy while maintaining similar bladder and rectum mean doses, V65, and V40 compared to 3DCRT to 68.4 Gy.

Conclusion

IMRT improves dosimetric parameters for the rectum and bladder, which may reduce toxicity and allow dose-escalation after radical prostatectomy. Future studies should determine whether these dosimetric improvements translate into improved clinical outcomes for PC patients.