

Dose-volume comparison of proton therapy and intensity-modulated radiotherapy for prostate cancer.

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Abstract:

PURPOSE: The contrast in dose distribution between proton radiotherapy (RT) and intensity-modulated RT (IMRT) is unclear, particularly in regard to critical structures such as the rectum and bladder.

METHODS AND MATERIALS: Between August and November 2006, the first 10 consecutive patients treated in our Phase II low-risk prostate proton protocol (University of Florida Proton Therapy Institute protocol 0001) were reviewed. The double-scatter proton beam plans used in treatment were analyzed for various dosimetric endpoints. For all plans, each beam dose distribution, angle, smearing, and aperture margin were optimized. IMRT plans were created for all patients and simultaneously analyzed. The IMRT plans were optimized through multiple volume objectives, beam weighting, and individual leaf movement. The patients were treated to 78 Gray-equivalents (GE) in 2-GE fractions with a biologically equivalent dose of 1.1.

RESULTS: All rectal and rectal wall volumes treated to 10-80 GE (percentage of volume receiving 10-80 GE [V(10)-V(80)]) were significantly lower with proton therapy ($p < 0.05$). The rectal V(50) was reduced from 31.3% +/- 4.1% with IMRT to 14.6% +/- 3.0% with proton therapy for a relative improvement of 53.4% and an absolute benefit of 16.7% ($p < 0.001$). The mean rectal dose decreased 59% with proton therapy ($p < 0.001$). For the bladder and bladder wall, proton therapy produced significantly smaller volumes treated to doses of 10-35 GE ($p < 0.05$) with a nonsignificant advantage demonstrated for the volume receiving ≤ 60 GE. The bladder V(30) was reduced with proton therapy for a relative improvement of 35.3% and an absolute benefit of 15.1% ($p = 0.02$). The mean bladder dose decreased 35% with proton therapy ($p = 0.002$).

CONCLUSION: Compared with IMRT, proton therapy reduced the dose to the dose-limiting normal structures while maintaining excellent planning target volume coverage.