Rectal Dose–Volume Differences Using Proton Radiotherapy and a Rectal Balloon or Water Alone for the Treatment of Prostate Cancer

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Purpose
To describe dose–volume values with the use of water alone vs. a rectal balloon (RB) for the treatment of prostate cancer with proton therapy.

Materials and Methods
We analyzed 30 proton plans for 15 patients who underwent CT and MRI scans with an RB or water alone. Simulation was performed with a modified MRI endorectal coil and an RB with 100 mL of water or water alone. Doses of 78–82 gray equivalents were prescribed to the planning target volume. The two groups were compared for three structures: rectum, rectal wall (RW), and rectal wall 7 cm (RW7) at the level of the planning target volume.

Results
Rectum and RW volumes radiated to low, intermediate, and high doses were small: rectum V10, 33.7%; V50, 17.3%; and V70, 10.2%; RW V10, 32.4%; V50, 20.4%; and V70, 14.6%. The RB effectively increased the rectal volume for all cases (139.8 ± 44.9 mL vs. 217.7 ± 32.2 mL ($p < 0.001$). The RB also decreased the volume of the rectum radiated to doses V10–V65 ($p \leq 0.05$); RW for V10–V50; and RW7 for V10–V35. An absolute rectum V50 improvement >5% was seen for the RB in 5 of 15 cases, for a benefit of 9.2% ± 2.3% compared with 2.4% ± 1.3% for the remaining 10 cases ($p < 0.001$). Similar benefit was seen for the rectal wall. No benefit was seen for doses ≥70 gray equivalents for the rectum, RW, or RW7. No benefit of ≤1% was seen with an RB in 46% for the rectum V70 and in 40% for the rectal wall V70.

Conclusions
Rectum and rectal wall doses with proton radiation were low whether using water or an RB. Selected patients will have a small but significant advantage with an RB; however, water alone was well tolerated and will be an alternative for most patients.