Comparison of hydrogel spacer and rectal immobilization on intra-fraction motion equivalence using image guidance prostate proton therapy.

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Purpose

Proton therapy treatment plans are sensitive to internal and external motion due to the specific calculation of range to the target volume. Because of this, localization and immobilization of the prostate is important. At our center, the standard of prostate immobilization is through the use of an endorectal balloon (ERB) placed into the rectum. SpaceOAR (Augmenix) is a hydrogel made of polyethylene glycol intended to reduce the high dose to the rectum by acting as a spacer between the rectum and the prostate during prostate radiotherapy. The hydrogel remains in place for about three months before it liquefies and naturally clears from the body. In this study we evaluate the efficacy of hydrogel acting as a prostate stabilizer and the efficiencies of its use.

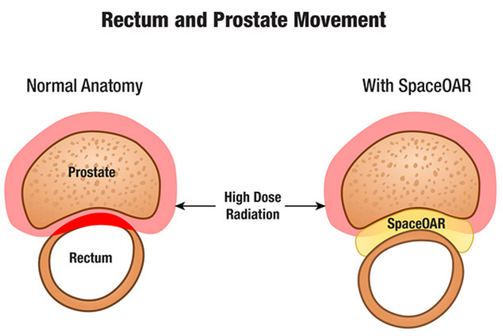


Figure 1: The SpaceOAR hydrogel is injectected through a small needle into the space between the prostate and rectum. On average, SpaceOAR hydrogel creates about 1.3cm of space between the two organs.
Used with permission from Augmenix, Inc.

Materials and Methods

Data was collected from 79 prostate cancer patients treated with proton therapy. All patients had 3 fiducial markers implanted perineally into the prostate, under endorectal sonographic guidance, to aid in target alignment for 2D kV portal imaging. 45 of the patients received 10cc SpaceOAR hydrogel as a rectal spacer, injected between the rectum and the prostate. 34 patients were simulated and treated daily with a 90cc endorectal balloon. Treatment plans were developed to deliver either 79.2CGE in 44 fractions or 38CGE in 5 fractions for low risk prostate cancer, 70CGE in 28 fractions for intermediate risk prostate cancer, and 50.4CGE in 28 fractions for high risk prostate cancer. Two orthogonal portal images were taken daily to match the fiducial markers within a 1mm margin. After treatment delivery, a second set of orthogonal portal images were taken. If the fiducial markers were displaced from the original position, a positional magnitude was calculated to determine intra-fractional fiducial motion, using offsets from three lateral (x-axis), anterior-posterior (z-axis), and craniocaudal (y-axis). An average magnitude was calculated for each patient and each immobilization device to compare intra-fractional movements of the target volume.

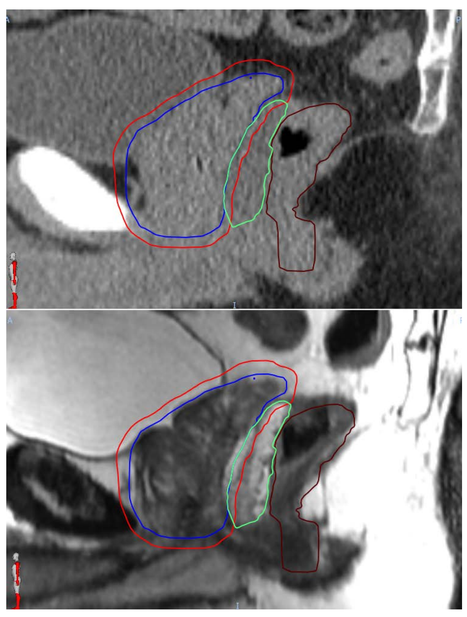
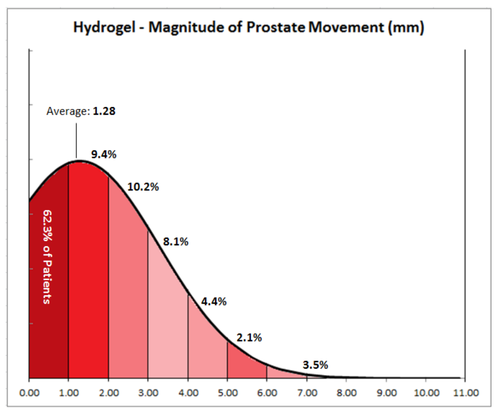
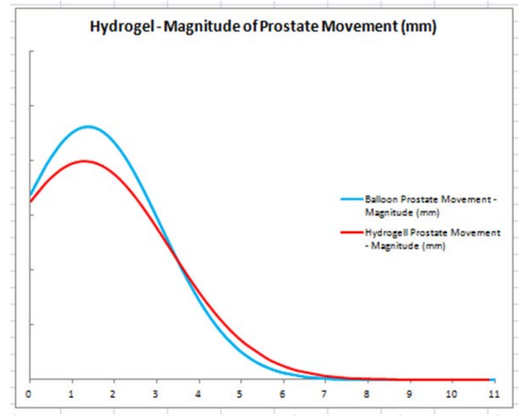


Figure 2: PTV (red), CTV (blue), hydrogel (green) and rectum (brown) of patient treated with hydrogel.



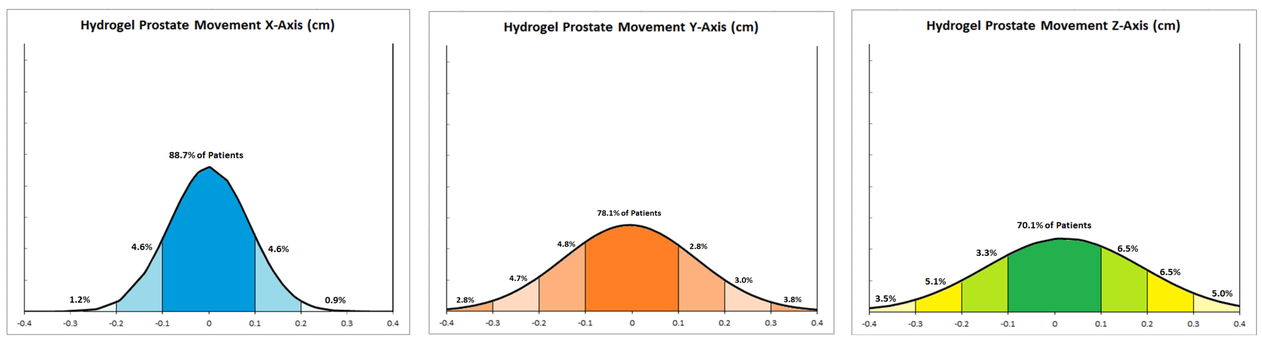
Graph 1: Mean magnitude (in mm) of prostate movement in patients treated with hydrogel.



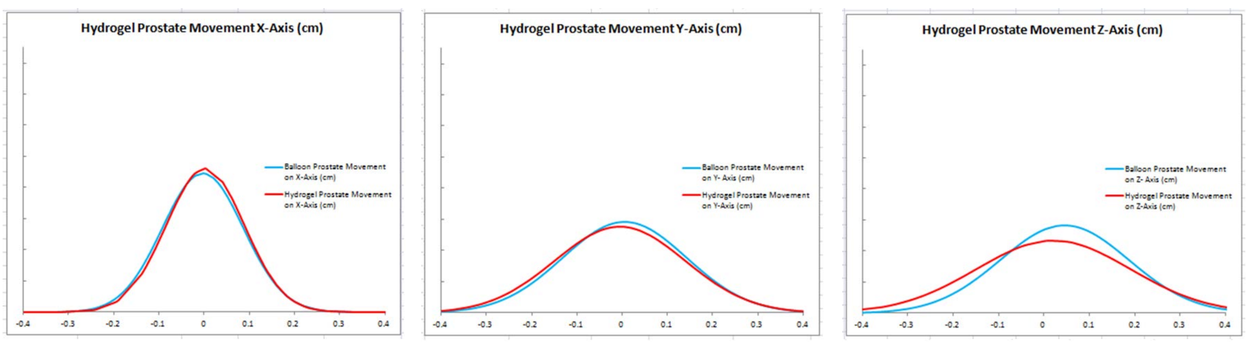
Graph 2: Overlay of mean magnitude (in mm) of hydrogel and ERB patients.

Results

2020 images gained during 1010 fractions were analyzed: 487 fractions in the hydrogel group and 523 fractions in the 90cc ERB group. The mean magnitude (in mm) for the hydrogel group was 1.28 (SD=0.95). The mean magnitude for the 90cc ERB group was 1.1 (SD=0.55). An ANOVA was performed to test the difference in the mean magnitude between the two groups, and this yielded statistically insignificant results (p= 0.344).



Graphs 3-6: Mean directional shifts in the x-axis (lateral), y-axis (craniocaudal), and z-axis (anterior-posterior) for patients treated with hydrogel.



Graphs 7-9: Overlay of mean directional shifts of hydrogel and ERB patients in the x-axis (lateral), y-axis (craniocaudal), and z-axis (anterior-posterior).

Conclusion

Based on our study, hydrogel can be used as a prostate stabilizer for proton therapy. Hydrogel proved to be just as effective as endorectal balloons to reduce intra-fraction motion. The additional benefit of hydrogel is that it is a onetime injection prior to treatment. This saves time for therapists by eliminating daily endorectal balloon preparation as well as the cost of having a balloon for each fraction. Additionally, patient comfort is improved by eliminating the use of a balloon. These efficiencies in conjunction to its actual use of reducing rectal dose show hydrogel as a good choice for prostate immobilization for proton therapy.