provision center for PROTON THERAPY

Rationale and Technique for Dose Escalation Around Prostate Fiducial Markers to Compensate for Dose Shadowing Using Pencil Beam Scanning Proton Therapy

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Purpose

In the treatment of prostate cancer, high-density fiducials are commonly utilized to visualize and align the prostate during image guided radiation therapy. Studies have shown that, in proton therapy, these high-density fiducials can cause dose shadowing. The purpose of this abstract is to explain the rationale used for dose escalation using proton therapy around prostate fiducials and demonstrate a technique with pencil beam scanning.

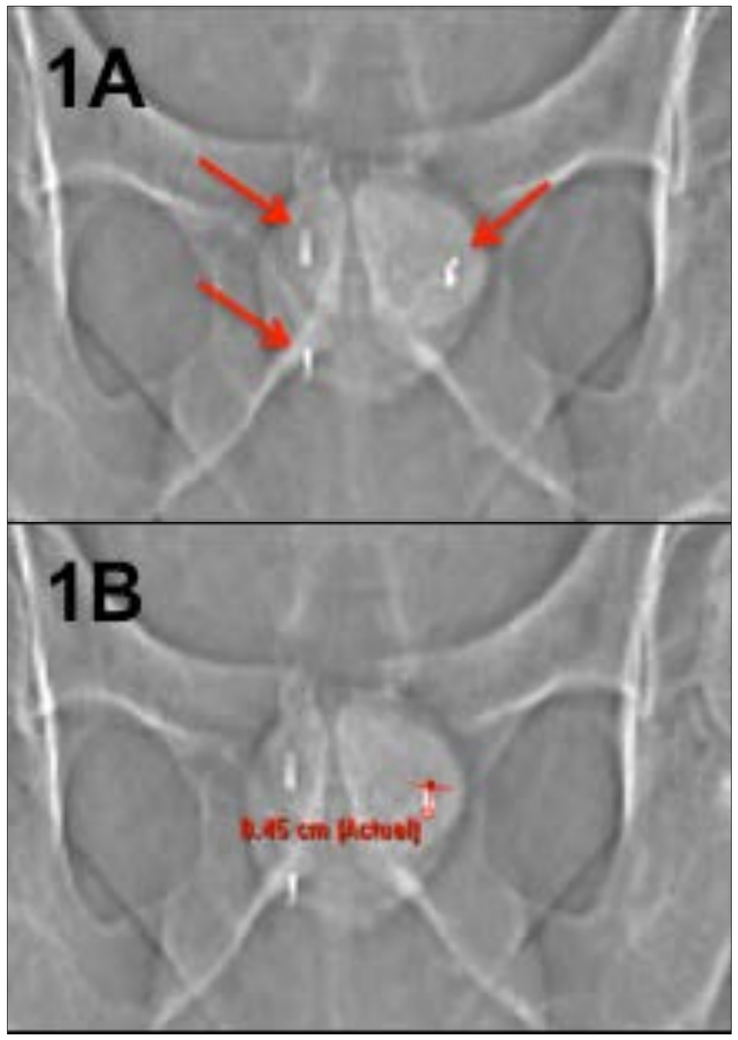
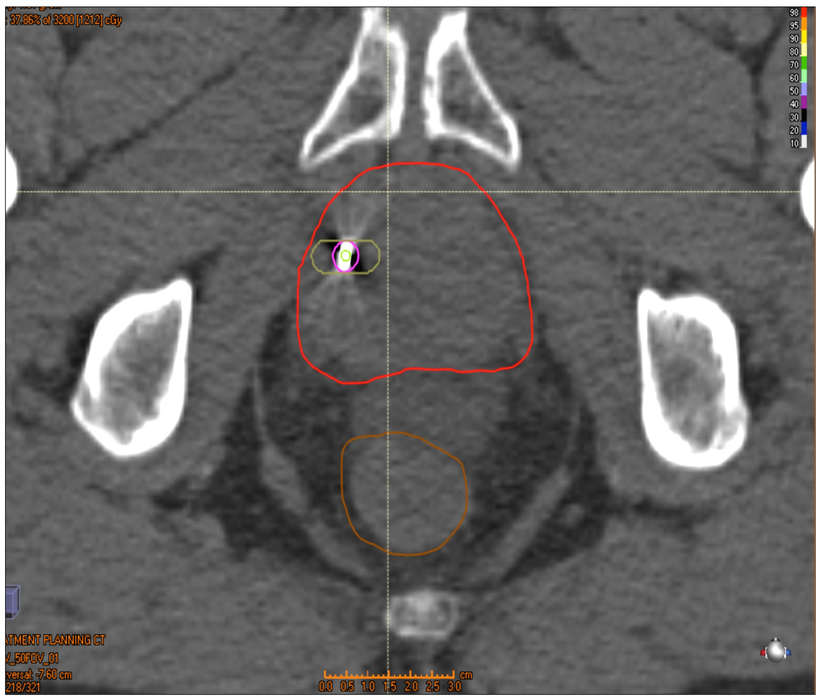


Figure 1A. AP scout view from CT simulator showing Gold Anchor Fiducials and measurement of fiducial (figure 1B.)

Methods

- 3 Gold Anchor 0.4x10mm fiducials are implanted into the prostate at 3 strategic positions. Fiducials are implanted at least 1cm away from the prostate capsule/rectal interface.
- Gold Anchors are optimally implanted if they are in a straight line, perpendicular to the incident proton treatment beam.
- The fiducial placement is evaluated on the AP and lateral CT scout views, and linear measurements are taken of each fiducial in the superior to inferior directions (figure 1).
- If the measured fiducial is less than 6mm in length, it is considered to be in a semi crumpled/folded position and dose escalation in the direction of the proton beam is warranted to mitigate a potential cold dose shadow (figure 2).
- During the optimization process, this expanded volume around the fiducial is prescribed 5% higher dose than the prescription, generating an escalated dose around the fiducial (figure 3).



Axial slice showing contours: Prostate (red), 5mm dose escalation contour (brown), setup contour (pink), and threshold fiducial (green)

Results

Using the described technique, we are able to generate treatment plans that meet all of the clinical goals for the target and organs at risk. We are able to compensate for dose shadowing around the fiducial by escalating the dose around the fiducial that is implanted in a crumpled/folded position. Because the fiducials are implanted at least 1cm from the prostate/ rectal interface, the subsequent escalated dose does not add additional rectal dose compared to not escalating the dose around the fiducials.

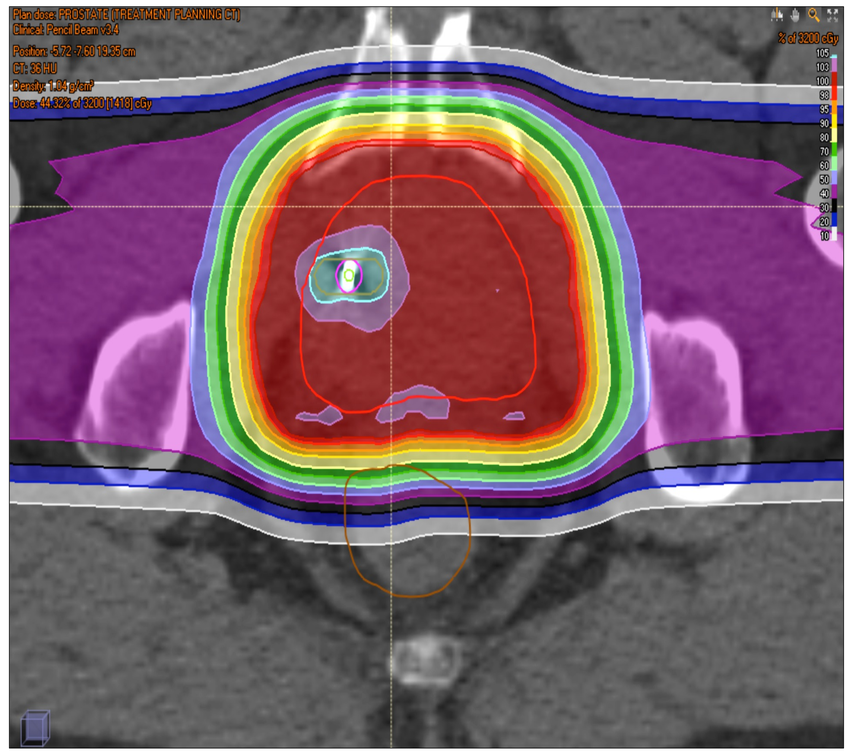


Figure 3. Resulting optimized dose distribution demonstrating dose escalation of ~105% around fiducial.

Conclusions

For prostate gland treatments utilizing high-density fiducials implanted in a crumpled/folded position, pencil beam scanning proton therapy gives us the opportunity to optimize treatment plans and compensate for potential dose shadowing by escalating the dose to a focal point around the fiducial. In principle, a similar technique could be used in other areas of the body, if there is concern of dose shadowing.