Pilot Study of the dose sparing capability and inter-fraction repeatability of a shape optimized endorectal balloon for proton beam prostate cancer treatment

Xuanfeng Ding, Ph.D,[1] Colin Carpenter, PhD,[2] Hsinshun Wu, Ph.D.,[3] Lane Rosen, M.D.[3]

1. Beaumont Health System, Royal Oak, MI, 48304, 2. Siris Medical, Inc, 3. Willis-Knighton Cancer Center, Shreveport, LA 71103

Purpose: The treatment of prostate cancer with proton beam radiation requires precise positioning of the patient to deliver prescription dose to the target structure while sufficiently sparing critical structures. We evaluate the dose sparing capability and inter-faction repeatability throughout a patient's treatment course using a new endorectal balloon (Edge ERB, Ancer Medical, Hialeah, FL, **Figure 1**) intended to improve stabilization of the prostate.

Methods: In this study, a new ERB design is demonstrated on a proton prostate patient over a 9 week treatment course. This ERB incorporates a saddle shape to improve inter-fraction positioning repeatability and reduce inferior / superior prostate movement. During the 9 weeks' treatment course, the patient received 4 additional Re-CT simulations every two weeks to check the balloon position and dosimetric repeatability. The re-CTs were fused to the initial planning CT based on the position of 3 fiducial markers to simulate the day of treatment **(see Figure 2)**. We evaluated prostate shape, and distance from fiducial markers and anatomical landmarks to the balloon. We also measured dosimetric indices to the prostate and balloon. In the 4th re-CT, the balloon was found underinflated about 10cc fluids. However, with the IGRT aligned to the three fiducial markers, the target and OARs still received consistent dose compared to the initial plan

Results:

Dose repeatability to Prostate and critical structures (Figure 3) : The average dose of 99% prostate volume in the re-CT received 99.9%±0.16% of the initial planning dose (7924cGyE). The average dose of 2cc and 10 cc rectum received 99.59%±0.92%, 97.75% ±5.87%, of the initial planning dose (7981cGyE, 7673cGyE) respectively. The average dose of 10cc and 20 cc bladder received 99.54%±0.42%,96.87%±2.22% of the initial planning dose (7981cGyE, 7896cGyE) respectively. The average dose of 10cc and 20 cc ERB received 97.18%±3.16%,79.25%±18.88% of the initial planning dose (7960cGyE, 7306cGyE) respectively.

Distance from ERB center to the fiducial markers (Figure 4) : The distance to the superior marker was 2.7±0.2cm; middle marker, 3.5±0.1cm; inferior marker, 3.5±0.2cm.

Prostate shape (Figure 5): The prostate shape in the M/L direction was 5.2±0.05cm, and 5.5±0.3cm in the A/P direction.

Distance from internal landmarks (pubic symphasys) (Figure 6): The distance from the anterior prostate, anterior balloon, and posterior rectum to the pubic symphysis was 1.4±0.3cm, 5.9±0.3cm, and 9.9±0.3cm, respectively.

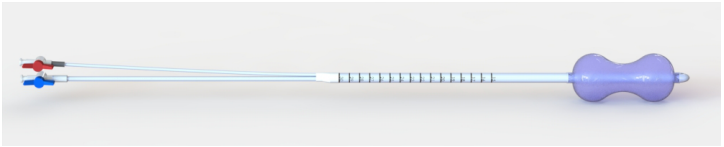

Figure 1 The Edge ERB (Ancer Medical, Hialeah, FL)

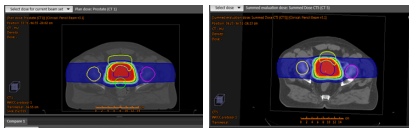

Figure 2: Dose comparison between initial CT and re-CT during treatment course.

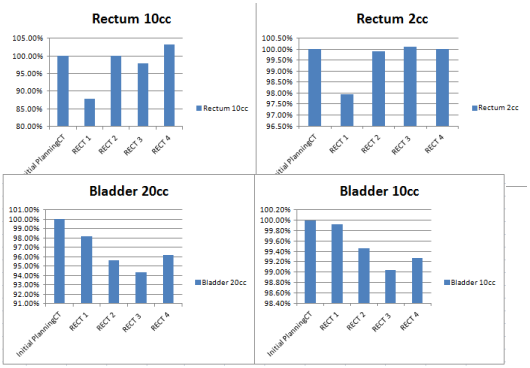

Figure 3. Dose repeatability from fused CT from initial CT to Re-CT # 1, 2, 3, 4.

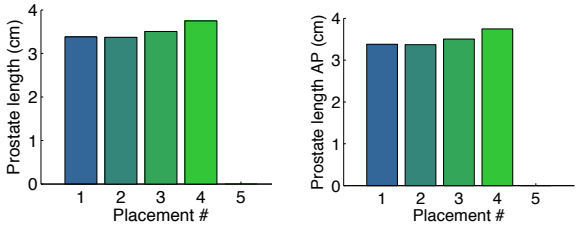

Figure 4. Repeatability in prostate shape was within 5mm (ML) and 3mm (AP).

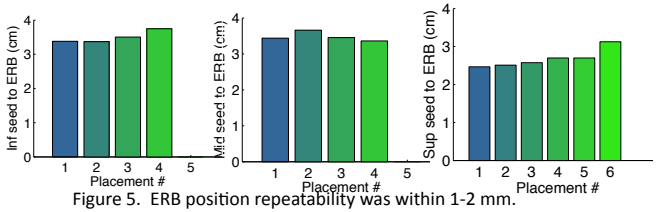

Figure 5. ERB position repeatability was within 1-2 mm.

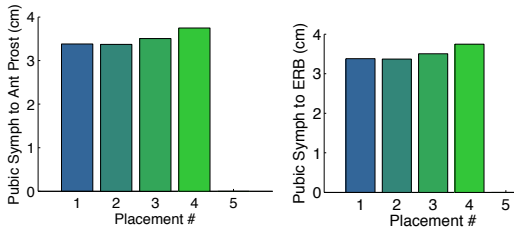

Figure 6. Prostate position repeatability was within 3mm.

Conclusions: This study shows that the ERB stabilizes the prostate gland and rectum during daily treatment and inter-fraction organs and balloon position is repeatable.

Xuanfeng Ding, Ph.D., DABR Email: xuanfengding@gmail.com