Early Tolerance and Treatment Compliance to Linac-Based Prostate SBRT Using Real-Time Electromagnetic Tracking

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Objectives

To investigate treatment compliance and early gastrointestinal (GI) and genitourinary (GU) side effects in patients with organ-confined prostate cancer following dose-intensified linac-based Stereotactic Body Radiation Therapy (SBRT), coupled with an electromagnetic (EM) tracking device for real-time intra-fraction organ motion.

Methods

Thirteen consecutive patients with unfavorable prostate cancer were treated with dose escalated prostate SBRT in 4 or 5 consecutive fractions, to a total dose of 38 Gy or 40 Gy, respectively, in association with ADT as per standard of care. A volumetric modulated arc therapy (VMAT) was delivered on linac platform with two 6FFF or 10FFF arcs optimized to have the 95% isodose covering at least 95% of the PTV (2 mm isotropic expansion of the CTV). The EM tracking device consisted of an integrated Foley catheter with a transmitter in a dedicated lumen [RayPilot HypoCath], which was placed before the first treatment fraction and removed at treatment completion. After the daily CBCT, the system monitored the transmitter position, and the beam delivery was interrupted whenever the displacement exceeded 2 mm. Organ motion mitigation was obtained by a rectal micro-enema and a 100 cc bladder filling. The incidence treatment related genitourinary (GU) and gastrointestinal (GI) toxicity (CTCAE_v5), patient QoL and PSA outcomes were computed from the start of treatment to the last follow-up date.

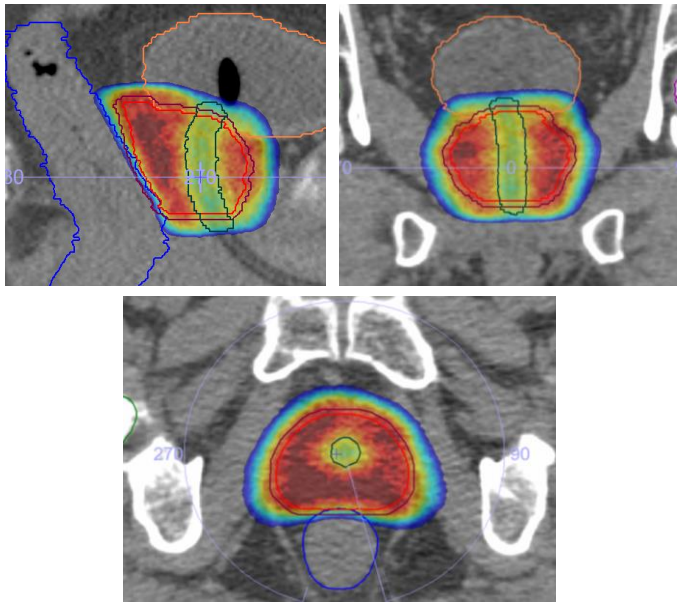

Figure 1. Dose distributions of treatments plans

Results

Median age was 77 years (range 63-81). Intermediate and high-risk prostate cancer accounted for 69.2% and 30.8% respectively. Median PTV volume was 76.2 cc (range 48.9-128.5). Average total treatment time lasted 10.2 minutes (range 5.5-22.7), 6.7 minutes (range 2.7-17.8) for setup, and 3.5 minutes (range 2.5-7.3) for beam delivery. In 45% of the monitored fractions, a new CBCT was mandated. The prostate was found within 1 mm from its initial position in 78% of the beam-on time, between 1 and 2 mm in 20%, and exceeded 2 mm only in 2%. All patients completed the treatment in the expected time and their compliance to the procedure was excellent. No clinically significant acute Grade 2 or higher GI (rectal) and GU toxicity was observed during treatment and at 3-months. The median IPSS increased from 8 at baseline to 12 one-month after treatment and settled to 6 at 3 months. EPIC-26 scores in the urinary domain decreased from a median baseline of 86 pre-treatment to 79 at one-month and returned to baseline at a later timepoint (median score of 85 at 3 months). EPIC-26 scores in the bowel domains did not show significant changes within 3 months following radiotherapy. Median pre-treatment PSA level was 9,78 ng/ml (range 4,99-25) and dropped to 0,25 ng/ml (range <0,008-3,86) at 3-months.

Conclusions

Linac-based SBRT with VMAT-FFF technique coupled with daily image guidance including real-time EM tracking allowed dose-escalated treatment with negligible early side effects. The procedure was implemented rapidly and resulted well tolerated and less invasive than the surgically implanted transmitter. The use of FFF VMAT beams shortened the treatment time and significantly contributed to reduce the intra-fractional motion. These findings need to be confirmed on a larger scale and a longer follow-up.