Single fraction HDR brachytherapy in low-risk prostate cancer

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toxicities. Longer follow-up is needed to confirm these early results.

EP-2264 Single fraction HDR brachytherapy in low-risk prostate cancer: a search for the best dose level

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Purpose or Objective

Single fraction ultrasound-based high-dose-rate brachytherapy (HDR-BT) as monotherapy for low-risk prostate cancer (PCa) compared to multiple fractions, will improve patient comfort and treatment accuracy and save time, costs and human resources. Moreover, it is also expected to decrease toxicity rates with similar clinical outcome. However, there is no clear evidence which dose level will result in the best outcome. Therefore, we performed a planning study to investigate the best dose level of single fraction HDR-BT.

Material and Methods

Ultrasound-based plans of 26 consecutive patients with low-risk PCa (n=19 treated with 4 fractions of 9.5 Gy; n=4 with 1 fraction of 19.0 Gy and n=3 with 1 fraction of 13.0 Gy; treated between October 2016 and August 2017) were used to generate new treatment plans for three fractionation schemes, using the existing needle geometry: 1 x 19.0 Gy, 1 x 19.5 Gy and 1 x 20.0 Gy. All plans were optimized according to the following objectives:

Prostate: V100% ≥ 95% and D90% ≥ 100% PD (Prescribed Dose)

Bladder: D1cc < 16.0 Gy and D2cc < 15.5 Gy

Rectum D1cc < 15.5 Gy and D2cc < 14.5 Gy

Urethra D0.1cc < 21.0 Gy and D10% < 20.5 Gy and V120% in 0 cc

The coverage of the prostate was maximized considering the dose constraints for the organs at risk.

The V100%(%), D90%(Gy) and V22.8Gy(%) (120% of 19.0 Gy) were used to evaluate the 78 treatment plans.**Results**

The mean prostate V100% for the 19.0, 19.5 and 20.0 Gy schemes was 95.0%, 94.3% and 91.5% respectively with 69.2%, 50.0% and 7.7% of the plans meeting the objective of V100% ≥ 95%.

The urethra D10% was the limiting factor for meeting the V100% objective in respectively 73%, 50% and 50% of the plans.

The D90% increased for the 19.5 Gy plans compared to the 19.0 Gy dose schedule with a mean of 0.3 Gy with 96.2% of these plans meeting the objective D90% ≥ 100%PD.

The D90% decreased in the 20.0 Gy plans by a mean of 0.2 Gy compared to plans with a prescribed dose of 19.5 Gy.

The V22.8Gy increased for the 19.5 Gy plans by a mean of 3.2% compared to 19.0 Gy plans and dropped for the 20.0 Gy plans by a mean of 1.3% compared to the 19.5 Gy plans (see table 1 for ranges and figure 1).

		Fractionation schemes		
		1 x 19.0 Gy Mean (range)	1 x 19.5 Gy Mean (range)	1 x 20.0 Gy Mean (range)
Dose objectives	V100% (%)	95.0 (91.3-97.8)	94.3 (89.9-97.2)	91.5 (84.1-95.8)
	D90% (Gy)	20.0 (19.2-20.8)	20.4 (19.5-21.0)	20.2 (18.8-21.1)
	V22.8Gy (%)	67.1 (55.9 82.4)	70.3 (60.6 83.1)	69.0 (59.0 84.1)
	D90%(xGy)-D90%(19.0Gy) (Gy)		0.3 (0.06-0.7)	0.2 (-0.5-0.7)
	D90%(20.0Gy)-D90%(19.5Gy) (Gy)			-0.2 (-0.8-0.3)
	V22.8(xGy)-V22.8(19.0Gy) (%)		3.2 (0.7-7.9)	1.8 (-0.3-6.0)
	V22.8(20.0Gy)-V22.8(19.5Gy) (%)			1.3 (-4.1-1.0)

Table1 **Dosimetric Results of three fractionation schemes**

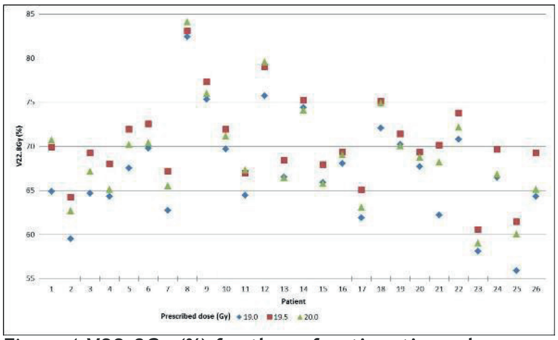

Figure 1 **V22.8Gy (%) for three fractionation schemes**

Conclusion

With both a higher mean D90% and a higher mean V22.8Gy in the 19.5 Gy plans compared to the other two dose levels, in this planning study, the 19.5 Gy seems to be the dose level we should focus on. However, the absolute dose differences are limited and the question remains whether or not these dose differences are clinically relevant.

Further increase in the number of plans meeting the V100% objective is necessary and can most likely be done by a slight improvement of the needle configuration.

EP-2265 Edema adapted treatment plan in LDR prostate brachytherapy: beyond common inverse treatment planning

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Purpose or Objective

Edema evolution following seeds' implantation is not considered during low-dose-rate (LDR) prostate brachytherapy inverse planning. Commonly, planning is performed after inserting the peripheral needles, when edema has occurred. Hence, the selected plan can result in increased toxicity due to seeds' migration during edema resorption after implantation. In this work, we propose a strategy to adapt intraoperative inverse planning based on edema resorption effects. A previously developed edema biomechanical model was introduced in an in-house inverse planning system. A dose-volume-histogram (DVH) based optimization algorithm combined with Monte Carlo dosimetry was used for implant optimization.

Material and Methods

To account for edema, a biomechanical model based on the biphasic theory was previously developed. Edema formation is simulated by a linear pressure increase in prostate's fluid compartment. Resorption is exclusively driven from the prostate's elastic response in a time-span of 30 days. The model is solved with the Finite Elements Method on a tetrahedral mesh of the patient's transrectal ultrasound (TRUS) image. In a simulation scenario with 63 kPa fluid pressure and 50 kPa prostate Young Modulus, edema magnitude is at 40% during the operation and 3% after 30 days. A plan is generated for intraoperative prostate volume (40% edema) and postoperative dosimetry at day 30 is performed assuming linear seeds' migration due to edema resorption. To account for edema resorption during planning, a volume resampling algorithm is used to deform the intraoperative TRUS image and apply edema-related seeds' migration to the candidate implantation sites selected during the intra-operative planning. MC dose kernels are calculated for each migrated candidate site. Dose evaluation during implant optimization is performed minimizing the variation of DVH metrics from the AAPM TG-137