

Organ positional differences between planning US and implant procedure in two-step LDR brachytherapy

Orla A Houlihan^{1,2}, Sergio Esteve³, Owen McLaughlin^{1,3}, Geraldine Workman³, Monica Byrne³, Kevin M Prise¹, Alan R Hounsell³, Darren M Mitchell², Suneil Jain^{1,2}

1. Patrick G. Johnston Centre for Cancer Research, Queen's University Belfast, Belfast, Northern Ireland
2. Department of Clinical Oncology, Northern Ireland Cancer Centre, Belfast City Hospital, Belfast, Northern Ireland
3. Department of Radiotherapy Medical Physics, Northern Ireland Cancer Centre, Belfast City Hospital, Belfast, Northern Ireland

Purpose

To quantify dosimetric differences for the prostate, urethra and rectum between the planning transrectal ultrasound (TRUS) and the implant procedure in two-step LDR brachytherapy.

Methods

For 30 patients undergoing two-step LDR prostate brachytherapy, the prostate, urethra & rectum were delineated on the planning TRUS, performed 3-4 weeks prior to the implant procedure and compared to a TRUS performed immediately prior to the implant.

Institutional dose constraints were: prostate V150% <60% & V200% <20%, urethra D5% <150% & D30% <130%, rectum D1cc <100% & D0.1cc < 138%. Target coverage for prostate was D90% >121% & V100% >99.5%.

As the dose to the percentage volume parameter is sensitive to the volume size contoured, the absolute urethral volumes (in cm³) corresponding to 5% and 30% were initially extracted from the planning TRUS DVH. These absolute volumes were then interpolated on the DVH for the pre-implant TRUS.

This method was independent of urethral volume size contoured and therefore allowed direct comparison of these parameters. Positional differences of the urethra were also compared between planning and pre-implant TRUS.

Results

Relative to the planning TRUS, the median urethra D5% on the pre-implant TRUS was greater by 1% and median urethra D30% was greater by 3%. The median rectum D1cc was lower by 1% and D0.1cc by 4%. Median prostate dosimetric parameters were also lower on the pre-implant TRUS versus the planning TRUS (Table 1).

The number of cases exceeding dose constraints for urethra D5% increased from one on the original planning US to ten on the pre-implant TRUS, for urethra D30% increased from three on the planning TRUS to fifteen on the pre-implant TRUS and for rectum D1cc increased from zero on the planning TRUS to two on the pre-implant TRUS. The urethral doses on the clinical plans were all within tolerance.

Two-tailed t-test on the mean curvatures demonstrated a significant difference ($p < 0.01$) in the urethral path between the planning and pre-implant TRUS (Fig. 1). 21/30 patients' urethras (70%) were more curved on the planning TRUS compared to the pre-implant TRUS.

Conclusions

Median relative differences between the pre-implant TRUS and the planning TRUS were low at $\leq 5\%$ which is reassuring for centres performing two-step LDR prostate brachytherapy.

The increased number of cases exceeding dose constraints for the urethra on the pre-implant US may be a result of positional differences caused by the relaxation of the urethra due to spinal anaesthetic used during the implant procedure and should be considered intra-operatively by the brachytherapy clinician.

Table 1. Median (IQR) dosimetric parameters for prostate, rectum and urethra on the planning TRUS and pre-implant TRUS.

		Prostate			Rectum			Urethra	
		V200% (%)	V150% (%)	V100% (%)	D90% (%)	D1cc (%)	D0.1cc (%)	D5%	D30%
Median dose (IQR)	Planning TRUS	19 (18-20)	57 (56-58)	99.6 (99.5-99.8)	124 (123-125)	88 (85-91)	114 (107-117)	206 (202-210)	186 (183-188)
	Pre-implant TRUS	18 (17-19)	54 (52-56)	99 (97-99)	121 (119-123)	84 (80-92)	110 (96-118)	210 (202-220)	189 (183-191)
Median % dose difference		-5 (-8 to -3)	-4 (-7 to -2)	-1 (-2 to -1)	-2 (-6 to -1)	-1 (-6 to 4)	-4 (-10 to 5)	1 (0-3)	3 (0-6)
Number of plans not within dose constraints	Planning TRUS	8	0	3	0	0	0	1	3
	Pre-implant TRUS	4	0	28	13	2	0	10	15

Urethral Path with Curve Approximation

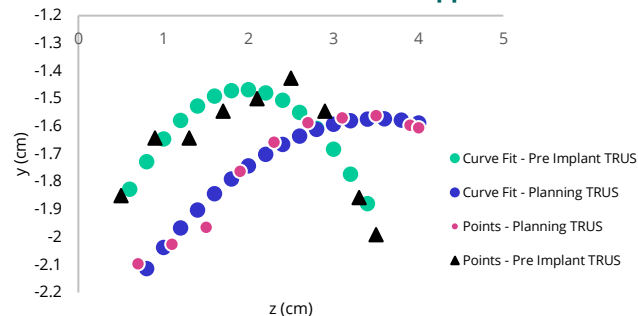


Fig.1. Urethral path on planning and pre-implant TRUS with curve approximation for sample patient.