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# A Comparison of the Pre-plan, Intra-Operative Plan, and Post-Implant Dosimetry For a Prostate Implant Case Using Prefabricated Linear Polymer-Encapsulated Pd-103 (CivaString)

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**Purpose:** To investigate the reproducibility and limitations of Pd-103 prostate brachytherapy using fixed length linear sources (CivaString).

**Innovation/Impact:** A Preplan is required in order to prefabricate sources in various configurations (length and source/spacer distribution) for fixed length sources like CivaString. Ensuring reproducibility is a common difficulty for pre-planned LDR implants for prostate cancer. In this study, we investigate the reproducibility of pre-planning with CivaString by comparing geometric and dosimetric parameters between the pre-plan, intra-operative plan, and post-implant dosimetry. Our results show that the prostate volumes and axial cross-sectional areas are similar between the pre-planned and intraoperative plans, and that the seen intra-operatively accurately reflect the D90 measured in the post-implant dosimetry. From this data we conclude a combined pre-plan and intra-operative approach is beneficial in ensuring the variations in dose accurately reflect the variations in prostate volume on the day of the procedure.

**Material/Methods:** An LDR prostate brachytherapy case which was preplanned on MR images with prefabricated linear polymer-encapsulated Pd-103 sources (CivaString) was studied and compared with ultrasound based intra-operative planning and CT based post-implant dosimetry. We evaluated the following parameters among the three studies: prostate geometry (volume and cross sectional area), needle position and alignment deviations, and dosimetry parameters (D90).

**Results:** The prostate volumes and axial cross sectional areas at center of prostate were measured as 41.8, 39.3 and 36.8 cc, and 14.9, 14.3, and 11.3 respectively on pre-plan MR, inter-op US, and post-implant CT studies. The deviation of prostate volumes and axial cross sectional areas measured on pre-planning MR and intra-operative US were within 5%. 17 out of 19 pre-planned needles were positioned within 5mm (the template grid size). Figure 4 shows overlapping pre-planned needle positions with intra-op planning needle positions on the axial cut at the center of prostate. Needle P5 position was adjusted in the OR. All the other needles were placed within 5mm (grid size). Needles P2 and P3 were switched intra-operatively with P4 and P9 due to a deviation in longitudinal length measured during the procedure. Needle C3 was not implanted due to the proximity to the urethra (Fig.4). Most of the CivaString sources bent along the longitudinal direction with a maximum deviation of about 10 degrees. One needle location was adjusted intra-operatively and another needle was removed due to proximity to urethra. The needle pathways were not always parallel to the trans-rectal probe due to the flexibility of CivaString. The angle of deviation was up to 10 degrees. Two pairs of needles were exchanged to better fit the length of prostate at the time of implant. This resulted in a prostate D90 of 153.8 Gy (124%) and 131.4 Gy (106.7%) for intra-op and PID respectively.

Figure 1. MR based preplan in BrachyVision

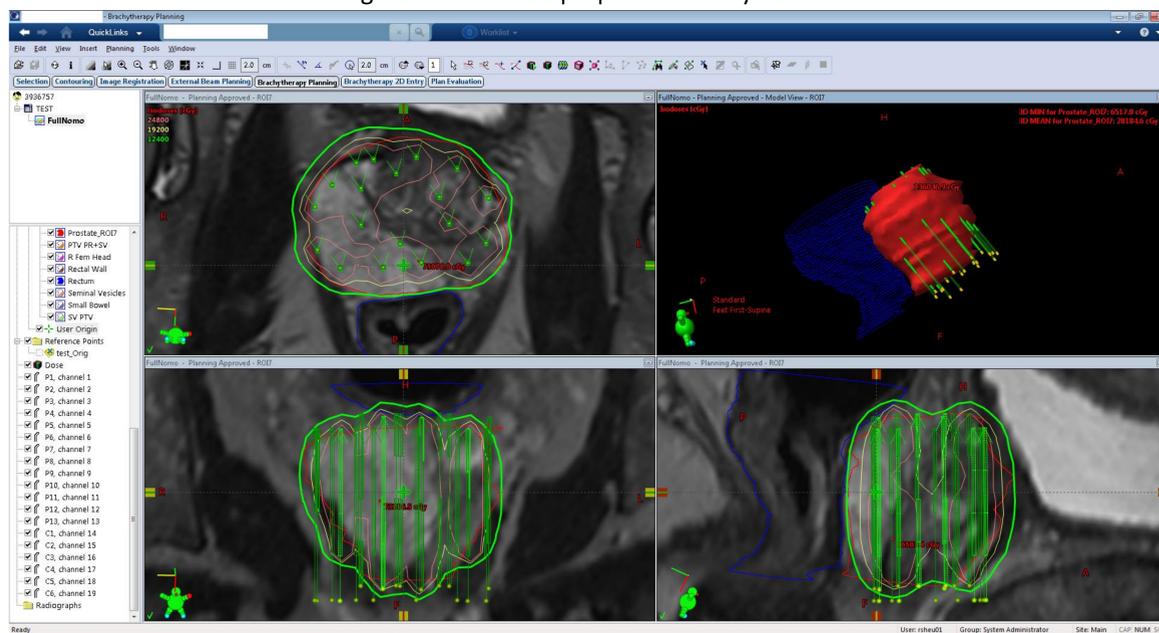


Figure 2. Sample of source description for ordering seeds

Implant Location	Seed Length (cm)	Activity (U/cm)	Quantity (Each)	Total Activity (U)	Total Length (cm)
Peripheral	2	3.2	2	12.8	4
Peripheral	3	3.2	9	86.4	27
Peripheral	4	3.2	2	25.6	8
Inner	2 cm seed + 1 cm spacer + 1 cm seed	3.2	2	19.2	8
Inner	1 cm seed + 1 cm spacer + 2 cm seed	3.2	4	38.4	16
Extra	3	3.2	2	19.2	6
Total:				201.6	69

Periphery	Seed Length (cm)	Inner Loading	Seed Length
P1	3	C1	2 cm seed + 1 cm spacer + 1 cm seed
P2	2	C2	2 cm seed + 1 cm spacer + 1 cm seed
P3	2	C3	1 cm seed + 1 cm spacer + 2 cm seed
P4	3	C4	1 cm seed + 1 cm spacer + 2 cm seed
P5	3	C5	1 cm seed + 1 cm spacer + 2 cm seed
P6	3	C6	1 cm seed + 1 cm spacer + 2 cm seed
P7	3		
P8	3		
P9	3		
P10	3		
P11	3		
P12	4		
P13	4		
Loading sequence: Start from bottom right, then in clockwise direction.			
Extra Seed Length (cm)			
X1	3		
X2	3		

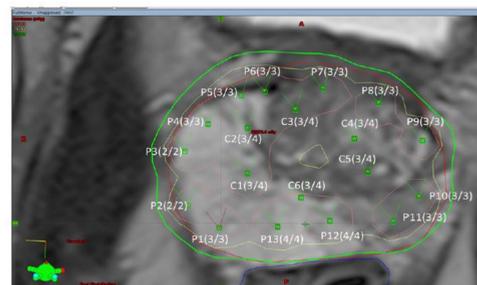


Table 1. Geometric and dosimetric parameters for three plans

	Prostate Vol (cc)	Modality	Planned Needles	Activity (U)	Prostate D90
Preplan	41.80	MR	19	182.4 U	161.9 Gy
Intra-op	39.26	US	18	172.8 U	153.8 Gy
PID	36.75	CT	-	172.8 U	131.4 Gy

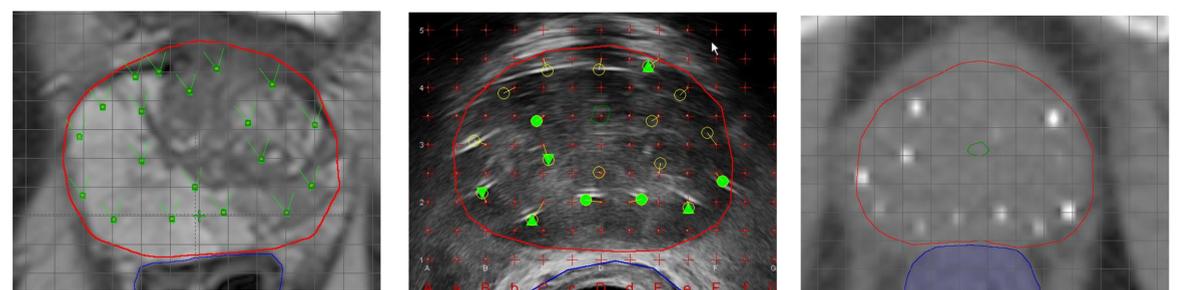


Fig.3. Axial cut at center of prostate for three different modalities

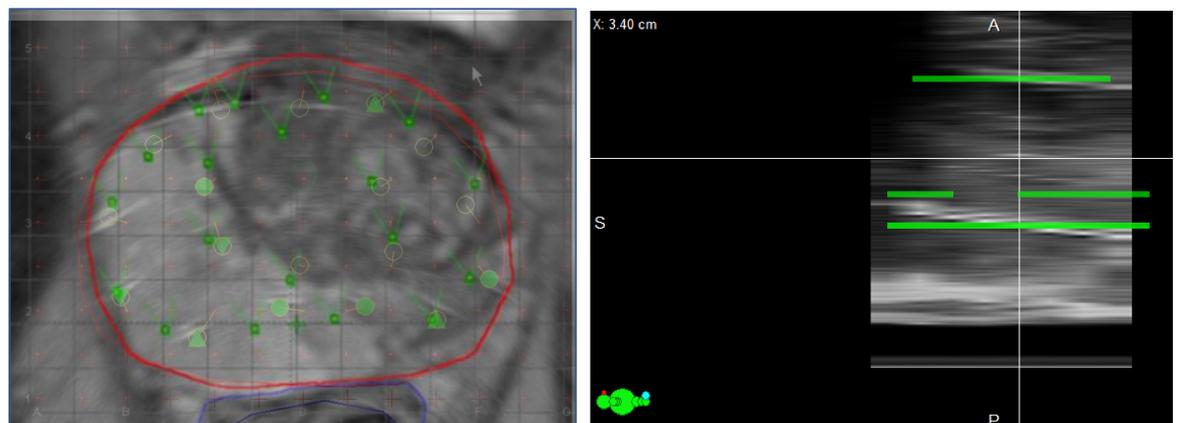


Fig.4. Pre-plan and Intra-op planning needle position overlay

Fig.5. Sagittal view in Intra-op ultrasound

**Conclusion:** Preplanning is a necessary part of implants performed with prefabricated linear polymer sources. However, as is often the case, there were real-time deviations from the pre-plan. Intra-operative planning provides the ability conform to anatomy at the time of implant. Therefore, we propose to develop a systematic way to order extra strings of different length to provide the flexibility to perform intra-operative planning with fixed length strands.