

Background and Purpose

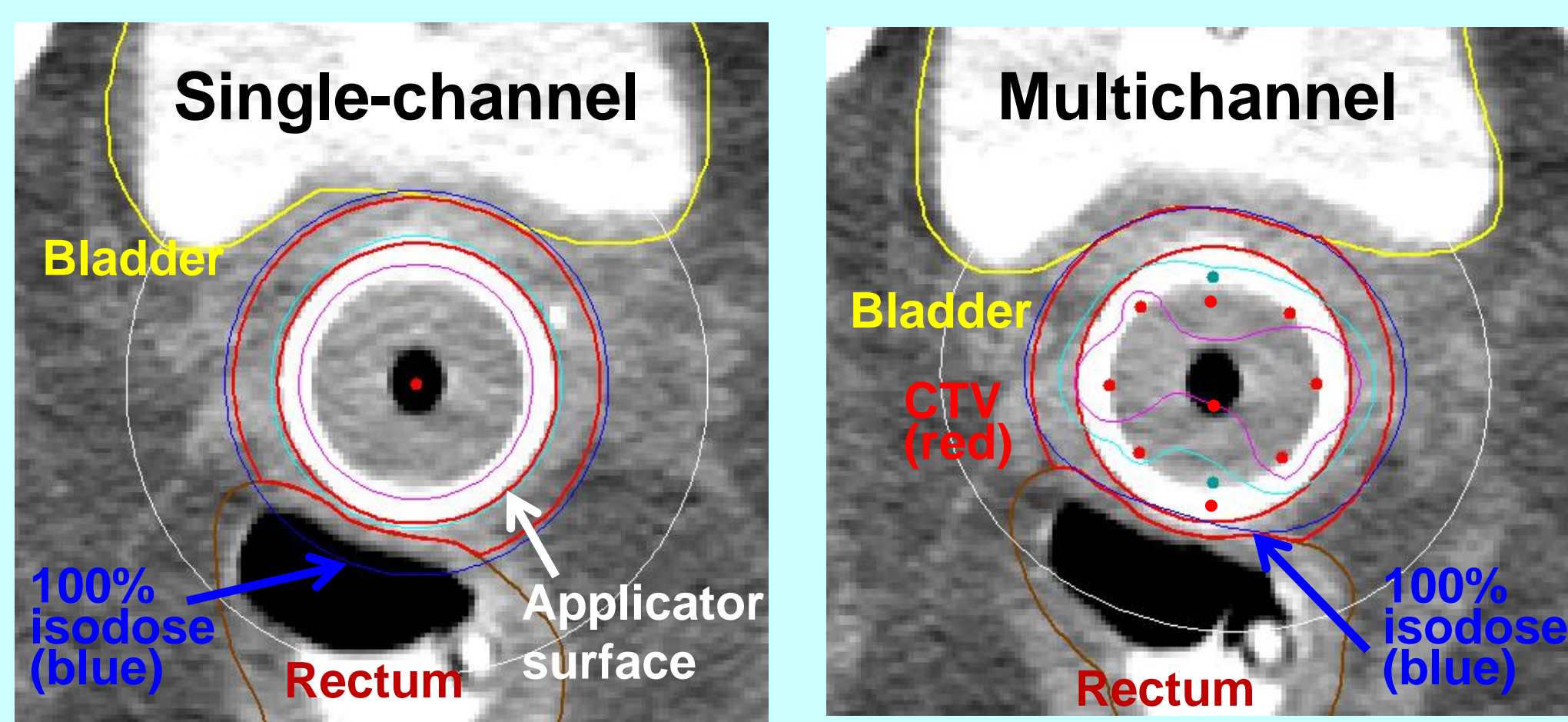


Fig. 1. single-channel vs. multichannel applicator dosimetry. CTV (red) covered by isodose lines 100% (blue), 150% (cyan), and 200% (magenta).

Background:

Single-channel vaginal cylinder applicators [1] are most commonly used to treat early stage endometrial cancers but have limitations in sculpting dose away from organs at risk (OARs) (see above Fig. 1). Multichannel applicators [2-3] can reduce dose to OARs while optimizing target coverage. The Capri is a new 13 channel applicator. It is not known how to best utilize this device.

Purpose:

A dosimetry study was performed to determine the pros and cons of utilizing various channel combinations on target coverage and dose to OARs for vaginal cuff brachytherapy.

Materials and Methods

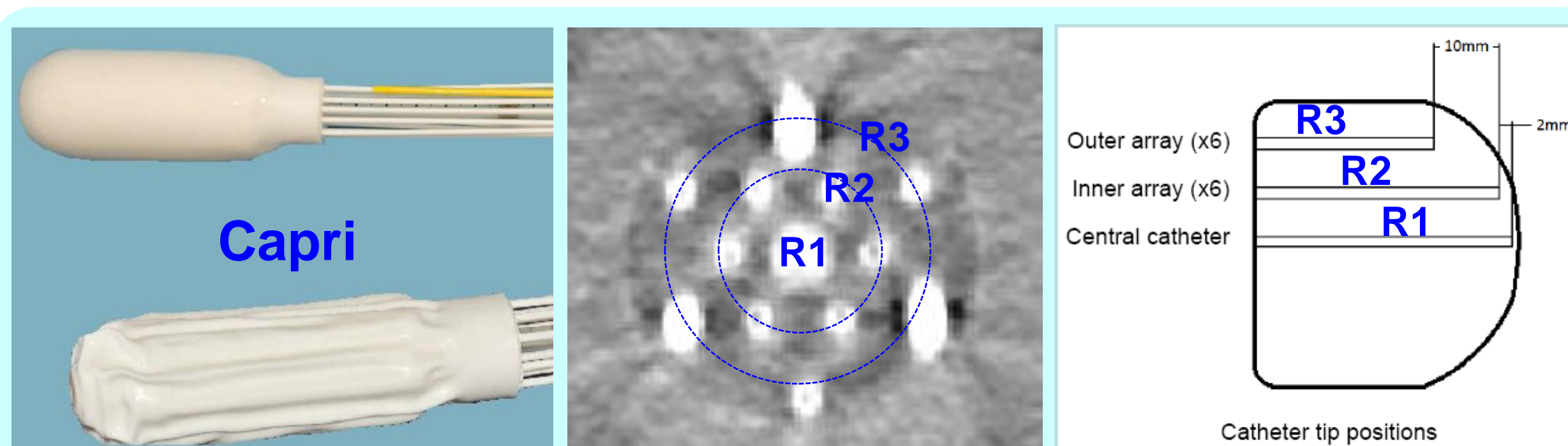


Fig. 2. The Capri applicator consists of a single central catheter (R1), an inner array of six catheters (R2), and an outer array of six catheters (R3).

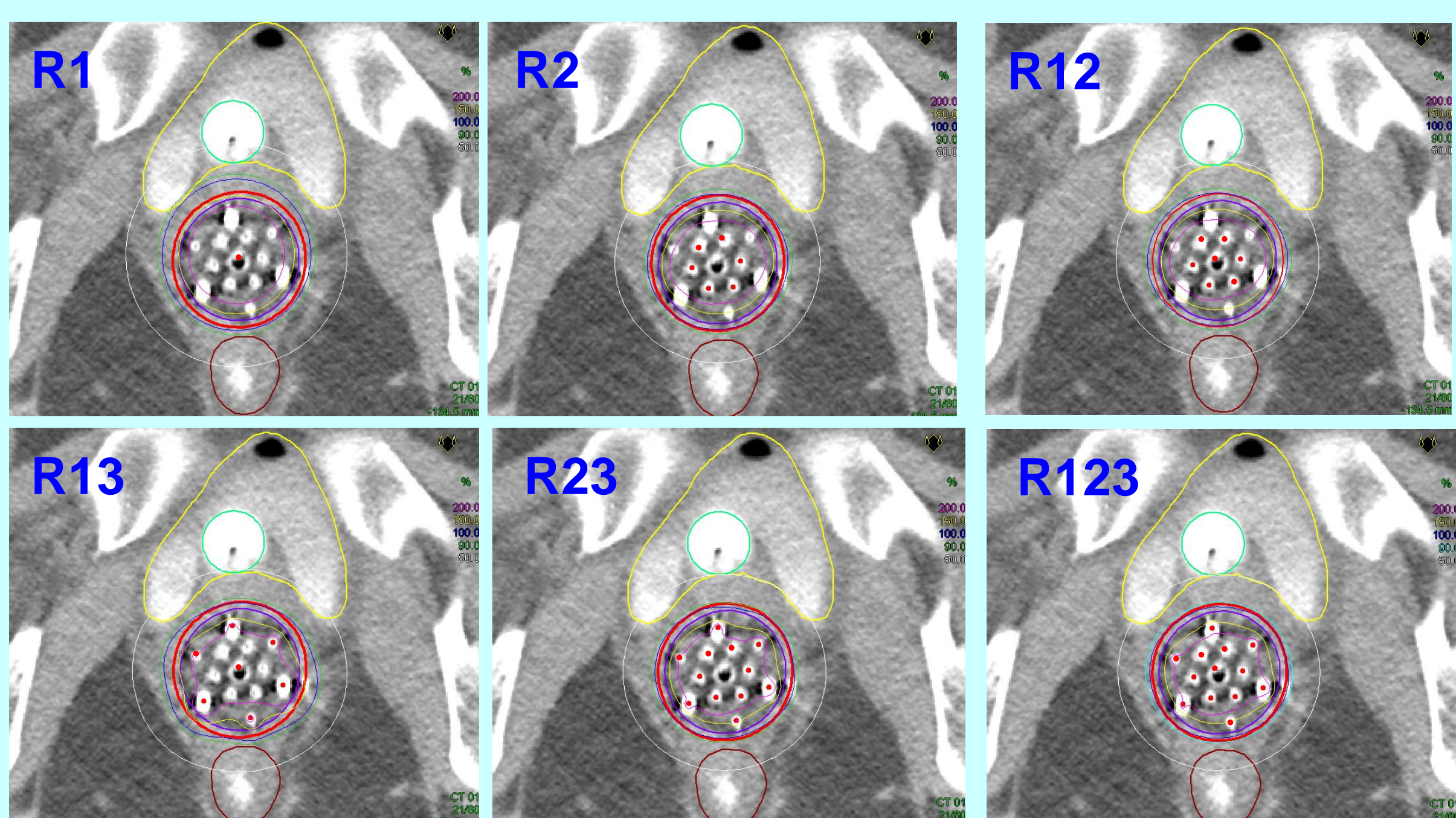


Fig. 3. 3D plans were generated in 6 different catheter arrangements: R1, R2, R12 (R1+R2), R13 (R1+R3), R23 (R2+R3), and R123 (R1+R2+R3). R3 plans were not created since the distal tip positions of the outer catheters are 12 mm away from the applicator do not typically provide clinically acceptable plans making superior target coverage non-optimal.

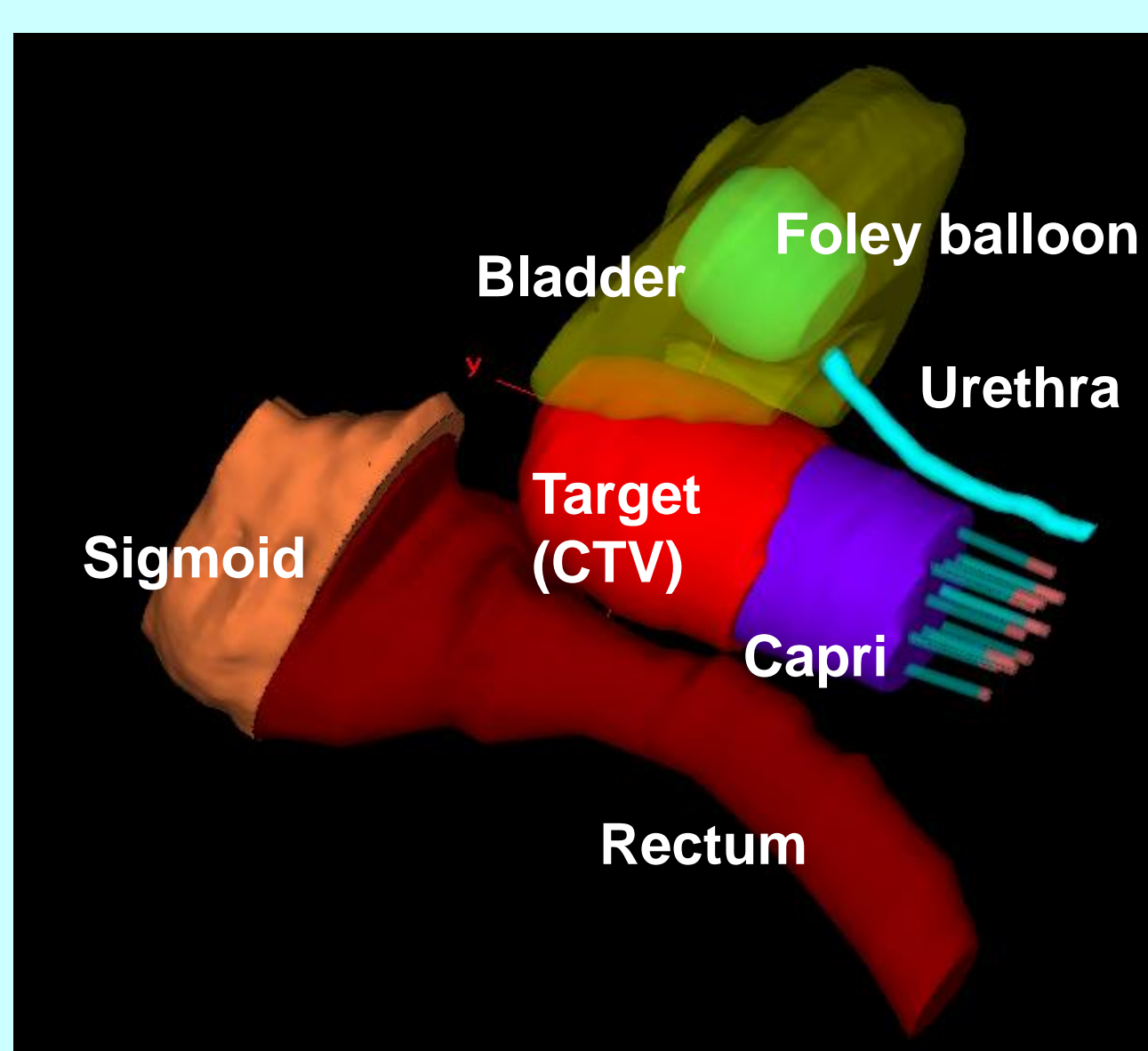


Fig. 4. CTV, OARs, and Capri applicator contours.

- A total of 78 plans were generated using Oncentra MasterPlan (Nucletron, Netherlands) to deliver 6.0 Gy per fraction to the clinical target volume (CTV).
- The CTV was defined as a 2 mm circumferential shell extending 4 cm in length around the Capri device.
- Foley catheter and rectal contrast were used to assist in contouring OARs (bladder, rectum, sigmoid, and urethra).

- Inverse planning simulated annealing optimization was applied to ensure >99% target coverage and minimal dose to OARs.
- Statistical significance was evaluated with a two-tail paired t-test to rule-out the null hypothesis of no difference between the reference plan R123 vs the other catheter combinations in terms of target coverage and doses to OAR.

Results

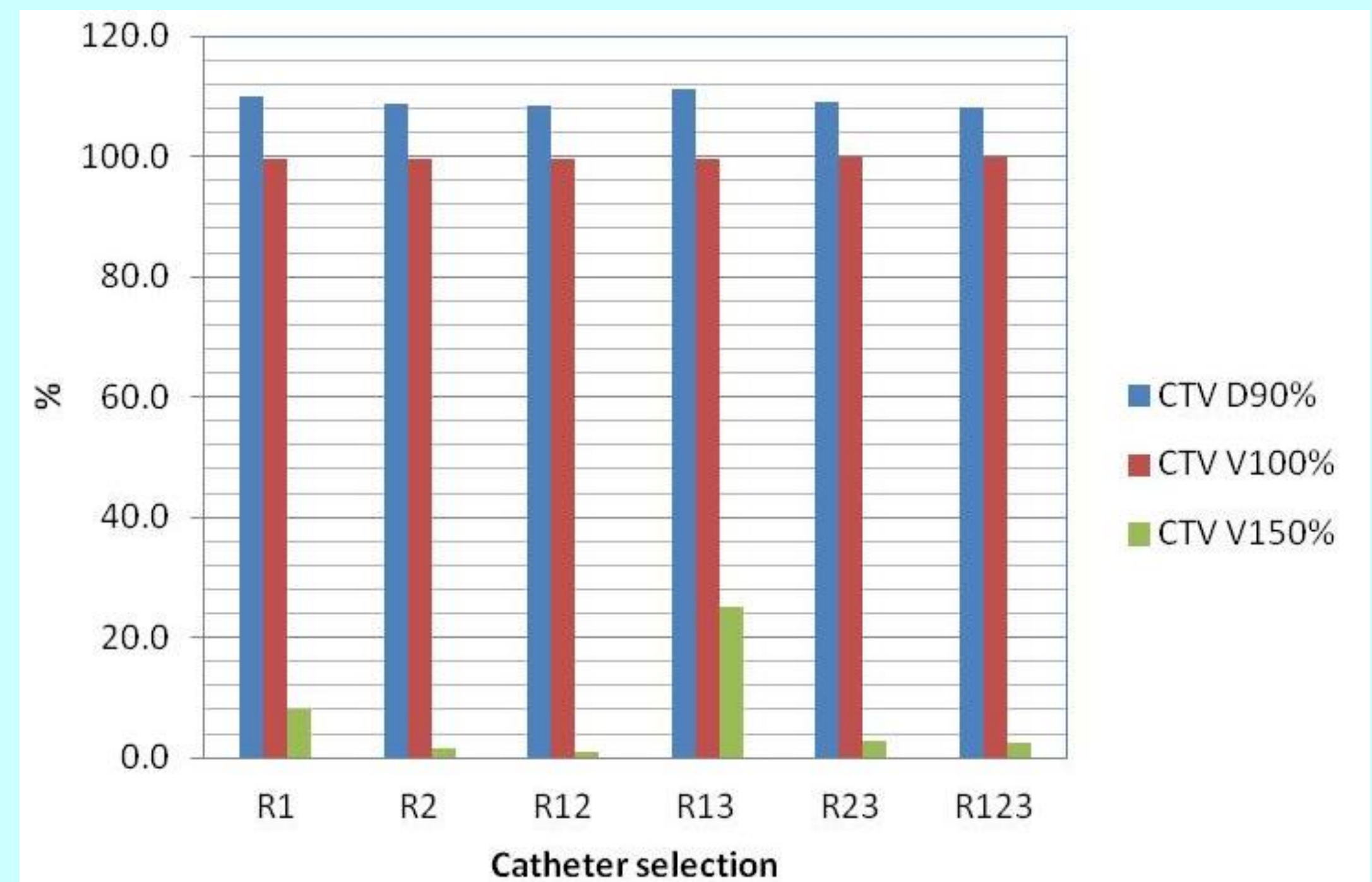


Fig. 5. Target coverage. D90 is defined as the minimum dose received by 90% of CTV. V100 is CTV receiving 100% of the prescribed dose.

Target Dose Coverage (V100 and D90):

- By study design, there were no differences in target V100 or D90 between plans.

Target hot spot (V150):

- V150 was significantly lower for R123 vs R1 (8.1% vs 2.3%, $p < 0.02$).
- R12 had the lowest V150 (1.1%) while R13 had the highest (25.0%) which correlates with the proximity of catheters to the vaginal surface.

Catheter Selections	Dose to the OARs as % of Prescription							
	Bladder D0.1cc	Bladder D2cc	Bladder Dmean	Rectum D0.1cc	Rectum D2cc	Rectum Dmean	Urethra D0.1cc	Urethra Dmean
R1	92.3	73.6	28.5	102.1	79.3	34.5	52.3	41.1
R2	79.6	65.6	25.9	82.3	65.7	28.7	47.6	37.2
R12	79.2	65.6	24.7	82.2	65.3	28.5	47.7	37.4
R13	79.6	65.5	24.4	83.3	65.9	28.3	44.3	33.8
R23	74.0	61.4	23.4	78.5	62.5	26.8	42.2	32.5
R123	73.9	61.4	23.0	77.9	61.9	26.3	42.8	33.0

Table 1. Dose to the OARs. D0.1cc is the minimum dose in the most irradiated 0.1 cc tissue volume.

OAR Doses:

- R1 had significantly higher doses to all OARs compared to R123 ($p < 0.001$).
- R23 vs R123 did not show significant differences in doses to OARs. This suggests that not all 13 catheters are need to produce maximum organ sparing.

Conclusions

- >99% target coverage can be achieved with a single or multichannel approach, but multiple channels significantly decrease the V150 and doses to OARs.
- Optimal plans with the Capri can be achieved using just R12 (lower V150 but higher dose to OARs) or R23 (higher V150 but lower doses to OARs) demonstrating that utilizing 13 channels does not improve optimization.
- The Capri applicator design improves dosimetry over single channel applicators but the ideal vaginal cylinder design is still a work in progress.

Bibliography

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