Effect of Applicator Removal from the Target Volume for Cervical Patients Treated with the Venezia HDR Brachytherapy Applicator

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INTRODUCTION

When analyzing the target DVH parameters, the applicator volume is partially included in the target volumes. The volume of the applicator does not significantly influence the parameters as long as it is small compared to the target volumes. Currently, there is no consensus on how to deal with the applicator's volume for dosimetric evaluation [1].

The Venezia applicator (Elekta, Sweden) includes lunar ovoids , intra-uterine tandem, and vaginal caps (Figure 1). The combination of all the components make it relatively large compare to the targets. Therefore, it is of clinical importance to evaluate the dosimetric effects after subtraction the applicator from the target volume.

AIM

In this study, we investigated the dosimetric and radiobiological (i.e. TCP) effects of applicator volume removal for cervical patients treated with the HDR brachytherapy using the Venezia applicator.

METHOD

- There were a total of 25 cervical cancer patients (54 plans), ranging from FIGO IIA to IIIC, treated with external beam radiation therapy (EBRT) followed by HDR brachytherapy.
- Patients were treated with 7Gy for 4 fractions (23 cases), 8.5Gy for 4 fractions (1 case), and 5.5Gy for 4 fractions (1 case). Five patients were treated with the applicator (intra-uterine tandem and rings) combined with multi-channel vaginal caps and interstitial needles.
- Targets and OAR DVH parameters for the composited EBRT and brachytherapy doses followed the GEC-ESTRO and the ABS recommendations [2, 3].
- The brachytherapy plans were transferred from Oncentra planning system to MIM software (version 6.8, MIM Inc.,USA).
- The applicator and vaginal caps were contoured with the minimal Hounsfield unit (HU) value of 200.

- Both EBRT and brachytherapy doses were computed as biologically equivalent doses in 2-Gy fractions (EQD2) for dose composite.
- The contoured Venezia applicator and needles were appropriately subtracted from the gross tumor volume (GTV), HR-CTV, and IR-CTV to generate new target contours GTVsub, HR-CTVsub, and IR-CTVsub, respectively (Figure 2).
- Dosimetric parameters including D90, D50, D30, V150, and V200 and radiobiological parameters, TCP, were evaluated and compared.

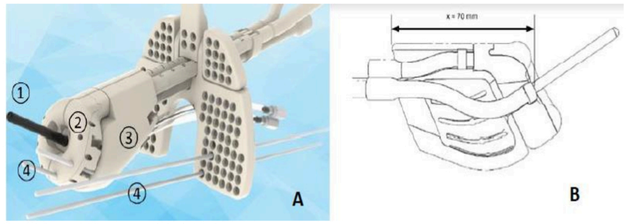

Figure 1. (A) Illustration of the Venezia advanced applicator: (1) Intrauterine tandem; (2) Lunar shaped ovoid rings; (3) Vaginal caps; (4) Interstitial needles. (B) Sagittal view of the Venezia applicator with caps.

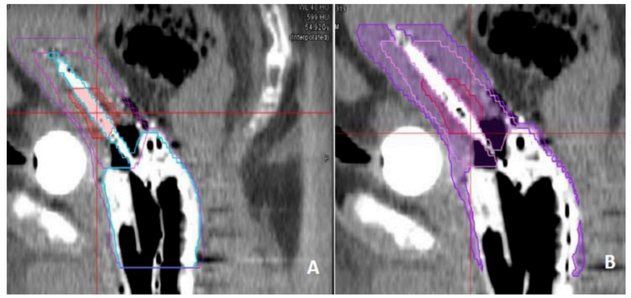

Figure 2. Illustration of target and applicator contours. Red: GTV; Pink: HR-CTV; Purple: IR-CTV; Blue: applicator. (B) Illustration of GTVsub (red), HR-CTVsub (pink), IR-CTVsub (purple)

RESULTS

- The average volume changes in GTV, HR-CTV and IR-CTV after applicator removal were 1.4+1.5cm3, 15.7+6.6cm3, and 33.4+15.1cm3, respectively.
- After applicator removal, average changes in D90 of GTV, HR-CTV, and IR-CTV were in the range of 2.1% to 7.5% where the impact on IR-CTV was the highest (Table 1).
- Applicator removal resulted in significant changes in small volume parameters (D50 and D30) and high dose parameters (V150 and V200) for HR-CTV and IR-CTV.
- One case with vaginal caps and IR-CTV limited around the caps demonstrated the maximal change of 57.1% in IR-CTV D30, 42.6% in IR-CTV D50, 42.3% in V150, and 29.7% in V200.
- The maximal change in TCP for all the targets ranged was 0.8%. There was no significant difference in TCP changes for all the targets after applicator removal.

Table 1. Changes in DVH parameters and TCP of GTV, HR-CTV and IR-CTV after applicator removal

Targets	Parameters	Mean±SD (%)	Min (%)	Max (%)	Median (%)	p-value
GTV	ΔD90	2.1±0.8	0.9	3.9	1.7	0.61
	ΔD50	3.1±1.7	0.5	15.5	3.8	0.40
	ΔD30	6.2±3.8	1.9	28.3	5.7	0.23
	ΔV150	2.2±1.7	0.1	7.7	2.3	0.58
	ΔV200	5.1±3.9	1.3	23.2	4.8	0.22
	ΔTCP	0.1±0.3	0.0	0.5	0.3	0.78
HR CTV	ΔD90	4.6±2.8	1.5	14.5	4.6	0.09
	ΔD50	10.7±5.9	3.1	27.0	10.9	0.01
	ΔD30	14.9±8.5	3.7	46.2	14.5	<0.01
	ΔV150	8.9±5.1	3.1	28.3	9.8	<0.01
	ΔV200	10.8±4.4	2.9	28.1	10.7	<0.01
	ΔTCP	0.1±0.4	0.0	0.8	0.4	0.68
IR CTV	ΔD90	7.5±5.2	1.8	26.7	5.9	0.18
	ΔD50	12.8±8.4	3.5	42.9	11.3	<0.01
	ΔD30	17.5±10.9	3.0	57.1	18.1	<0.01
	ΔV150	11.3±8.1	1.9	42.5	11.6	<0.01
	ΔV200	8.6±4.7	1.0	30.0	8.6	<0.01
	ΔTCP	0.3±0.3	0.1	0.7	0.5	0.77

DISCUSSION

- Applicator removal has more impact on D50 and D30 which agrees with the statement that small volume DVH parameters are more affected when more applicator volumes are included in the target contours.
- Compared to the tandem and ovoid rings, vaginal caps were not used for delivering high doses (e.g. 150%-200% PD) or even full prescription dose to the target.
- Although plans with vaginal caps showed higher changes in some DVH parameters, there was no significant difference in changes of DVH parameters between two groups (p>0.05).

CONCLUSIONS

Inclusion or exclusion of the Venezia applicator contour has significant impact on small volume and high dose DVH parameters of the target and should be specified in dose reporting. The applicator removal has limited effect on target D90 and TCP evaluation.

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