Dosimetric evaluation of the feasibility of utilizing a reduced number of interstitial needles in combined intracavitary and interstitial brachytherapy for cervical cancer.

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INTRODUCTION

Boosting dose by HDR brachytherapy after external beam radiation is a standard treatment for cervical cancer. The Venezia™ applicator is a tandem and ring applicator with 12 or 16 needles as shown in **Figure 1**.Though it provides more degrees of freedom when optimizing the dose distribution, there are some possible side effects of repeatedly placing and removing needles through the course of treatment. It includes the risk of organ detriment via puncture of the bladder, rectum, bowel, sigmoid, and tissue collapse when the needle trauma is combined with the cancer tissue erosion. Bleeding can also be problematic.

PURPOSE

To evaluate the ability of the Venezia™ advanced multi-channel tandem and ring applicator to consistently produce dosimetrically comparable plans utilizing a reduced number of needle channels, to reduce the risk of secondary complications when boosting cervical cancer treatments with HDR brachytherapy.

METHODS

We evaluated 26 fractions from 13 patients who were treated with HDR brachytherapy using the Venezia™ applicator. The original plans included a full load of 12 or 16 needles, depending on ring size, including both parallel and 30^0 oblique needles. We replanned each original to 9 new configurations as shown in **Table-1**, each with a reduced number of needles. Comparisons included differences in percentage dose coverage to 90% of the high-risk CTV (HRCTV), and percentage dose to 2 cm^3 of the bladder, rectum, sigmoid, and bowel. We considered new plans "passing" if they remained within our standards (D90 > 100%, D2 cm^3 < 85% bladder, < 65% rectum, sigmoid, bowel), or did not perform worse than original.

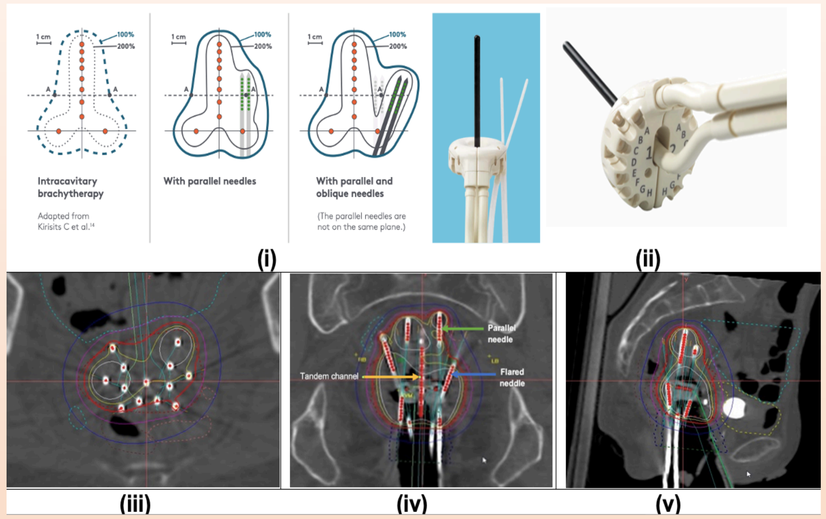

Figure 1: **(i)** Venezia applicator with oblique and parallel needles orientation[1]. (**ii) A, C, E, G** are the channels for **oblique needles**- and **B, D, F, H** for **Parallel needles[2]** and ovoid 1 is on Patient Left and Ovoid 2 is on Patient Right, **(iii)** Axial, **(iv)** Coronal, and **(v)** Sagittal, CT view of Venezia applicator with needle orientation during treatment.

Table 1. Nine new needle configurations:

Location of Needles Being removed	Number of Needles Removed	Name of Needle Configurations
Most Anterior Two Needles Removed	2	1A &2A
Most Posterior Two Needles Removed	2	1F & 2F
Most Anterior & Posterior Four Needles Removed	4	1+2 AF
Both sides Oblique Needles only Removed	6	BO
Both sides Parallel Needles Only Removed	6	PO
Only Left-sided Oblique Needles Removed	3	OBL
Only Right-sided Oblique Needles Removed	3	OBR
Only Left-sided Parallel Needles Removed	3	OPL
Only Right Parallel Needles Removed	3	OPR

RESULTS

The result has been described based on the two ways of needle removing in Tables 2 & 3.

Table 2 indicates overall passing plan rates based on the location of needles being removed. Removing only the two most anterior needles showed a **80.8%** passing rate. Removing only the most posterior two needles from both sides, or the most anterior and posterior four needles together, both showed a **65.4%** passing rate. Removing all six oblique needles showed a **19.2%** passing rate. Removing only left-sided or only right-sided oblique three needles showed **46.2%** and **23.1%** passing, respectively. Removing only right-sided or only left-sided parallel three needles separately showed **19.2%** and **34.6%** passing, respectively. Removing all parallel six needles showed a **11.5%** passing rate.

Table 2

Location of Needles Being removed	Overall % of Passing plan
1A & 2A	80.8%
1F & 2F	65.4%
1+2 AF	65.4%
BO	19.2%
OBL	46.2%
OBR	23.1%
OPL	34.6%
OPR	19.2%
PO	11.5%

Table 3. Overall passing plans with number of needles being removed. The removal of 2, 3, 4, and 6 needles showed 40, 36, 18, and 10 number of passing replans, while only two replans required a full needle load to maintain dosimetric quality.

Number of Needle being removed	Total number of passing plans / original
2	40 / 76
3	36 / 104
4	18 / 26
6	10 / 76

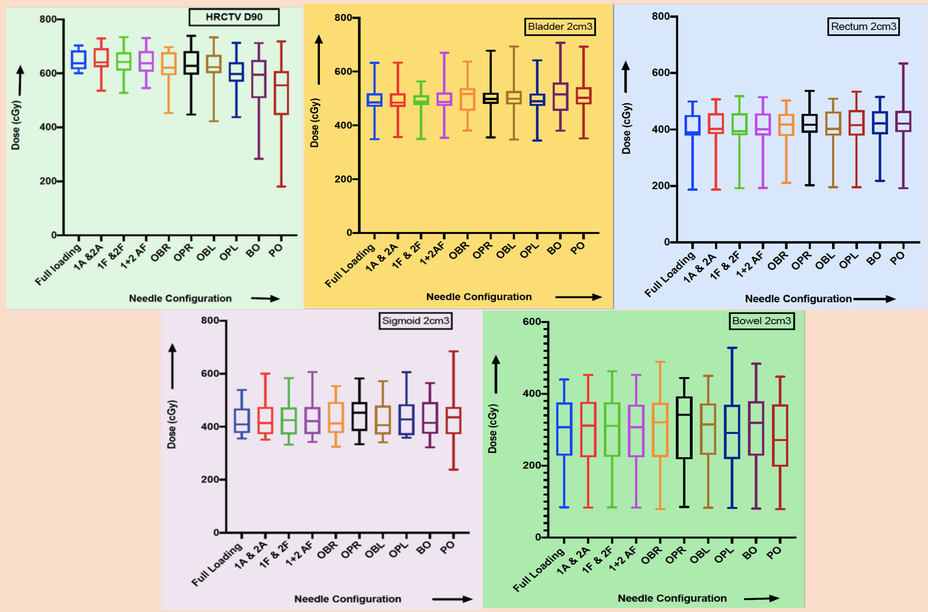

Figure 2: Dose distribution for full loading and replan with different needle configurations, based on HRCTV D90, Bladder 2 cm^3, Rectum 2 cm^3, Sigmoid 2 cm^3, and Bowel 2 cm^3, respectively. (Divisions of the plot represent quartiles).

CONCLUSION

This study indicates the potential for using a lesser interstitial needles with Venezia™ during combined intracavitary and interstitial HDR brachytherapy while maintaining dosimetric quality.

FUTURE WORK

Future work to accurately determine either specific needle placement, or the best pre-determined configuration, prior to the first fraction of treatment would lead to greatly reduced risk in the implementation of this brachytherapy applicator type.

REFERENCES

[1] Kirisits C et al. Int J Radiat Oncol Biol Phys 2006;65:624-630.
[2]https://www.elekta.com/dam/jcr:a2e61298-a209-4259-90f3

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