CYLINDER POSITIONS' STUDY FOR ENDOMETRIAL CANCER TREATMENT WITH THE FRACTIONATED HDR BRACHYTHERAPY

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INTRODUCTION

Endometrial Cancer

- About 63,230 new cases will be diagnosed while about 11,350 women will die from cancers of the uterine body in US.[1]
- Endometrial cancer is the fourth most prevalent cancer in the United States.[2]
- Dose constraints to organs at risk (OAR) required by American Brachytherapy Society (ABS) are[3] :

Rectum and Sigmoid	Bladder
point dose < 75% of prescribed dose	Point dose < 85 % of prescribed dose
D_{2cc} < 70-75 Gy EQD_2	D_{2cc} < 90 Gy EQD_2

- High dose rate (HDR) brachytherapy is a highly localized mode of radiation therapy that has a very sharp dose fall-off.[4 ,5]
- Smallest movement of the vaginal cylinder can potentially result significant dose variation to OAR

PURPOSE

- To study and analyze the applicator position in the coordinate system from the initial fraction in comparison with subsequent fractions over the entire multi fractionated treatment

Clinical Case Selection

- 30 patients' data with endometrial cancer (all stages) were selected
- An HDR remote afterloader V3 from Elekta/Nucletron with Iridium-192 source (active length 3.5 mm) had been used.
- Dose fractionation regimens varied from 4 Gy to 7 Gy, 1 or 2 fractions per week.
- Multichannel cylinder applicator had been used.
- All critical organs had been reconstructed with a portion of the inserted cylinder's surface as CTV or PTV.

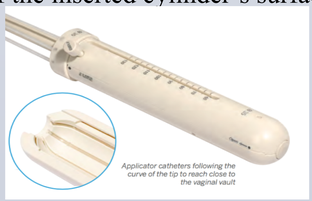

Figure 1: Vaginal Cylinder

MATERIALS & METHODS

- All 118 CT sets were exported from Oncentra and imported into Eclipse with their plan's structures and doses.
- For each patient, the first set of CT images, of the first fraction, was registered with the subsequent treatment plans' CT sets using Varian's auto-match and manual rigid registration tools.
- After the registration, all the structures from each treatment fraction were copied into the initial CT scans, and the normalization percentage to the specific fraction was applied.
- Vaclock and a special underwear had been used to fix the applicator's position in regard with the patient's anatomy.

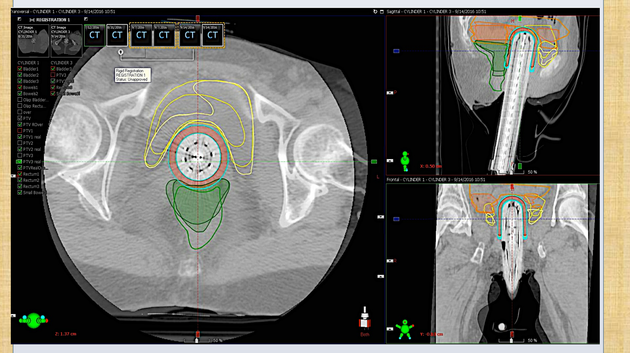

Figure 2: Rigid registration of two CT sets.

- A MATLAB based rigid registration method for 3D point-clouds was employed to determine rotation (Euler angles) and translation of the implanted cylinder precisely. It is shown in Figure 3
- Digital Imaging and Communications in Medicine files (DICOM) was imported in the Computational Environment for Radiotherapy Research (CERR) and the coordinates of the PTV voxels was exported to a text file in order to calculate the cylinder rotation and translation. [6]
- The MATLAB script was written to use the extracted cylinder coordinates and register 3D point clouds using iterative closest point (ICP) algorithm.[7]

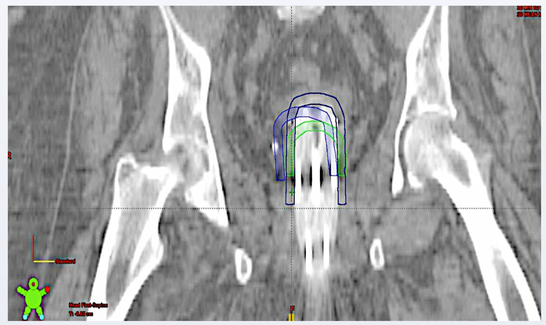

Figure 3: Inter-fractionation cylinder placement variances

RESULTS

- The cylinder inter-fractionation placement histograms were plotted in Figure 4.
- Translation was calculated and found zero for all implanted cylinders.

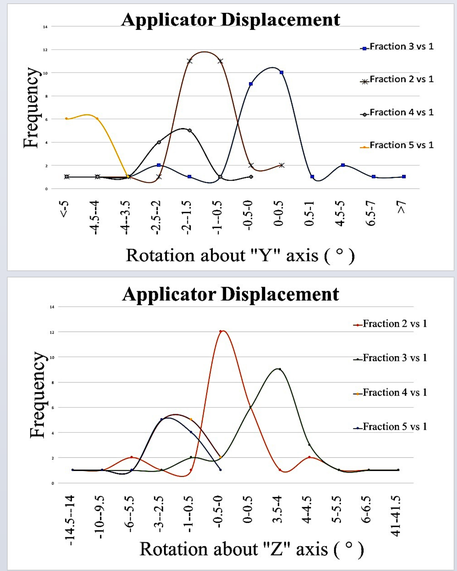

Figure 4: Applicators displacement histogram

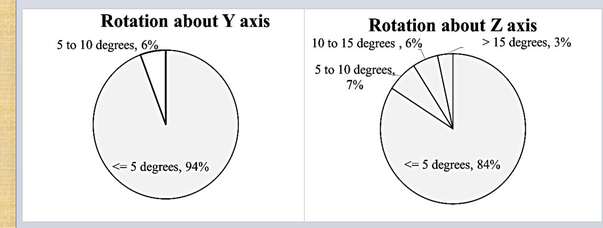

Figure 5: The cylinder rotations about Y and Z axes for the initial fraction is compared with the subsequent fractions for each patient case.

CONCLUSION

- We evaluated the cylinder position for each fraction compared to the initial plan based on a 3D point-cloud rigid registration.
- We conclude that there are no significant rotation and translation variations to be found in the evaluation of the cylinder position in the coordinate system for the initial fraction compared to the subsequent fractions.
- However, immobilization devices need improvement in order to minimizing any cylinder displacement and also to prevent any displacement during transportation and treatment delivery.

FUTURE WORK

- It would be useful to research any correlations between the dose differences and the applicator placement.

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