THE UNIVERSITY OF TEXAS
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Evaluation of Minimum Aperture Segment Size vs Plan Quality in IMRT Treatment Planning

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ABSTRACT

The influence of aperture segment sizes on Intensity Modulated Radiation Therapy (IMRT) treatment planning quality are significant from both a treatment delivery and a maintenance standpoint. Smaller sized apertures used in IMRT planning are known to be difficult to maintain due to the dependence on the accuracy of the small mechanical features in the treatment unit. Smaller multi-leaf collimators (MLCs) require a large quantity of intricate machinery to operate effectively. This study aims to measure the accuracy and validity of using larger IMRT segments, which could lead to machine development with larger MLC widths. The results show the use of larger aperture segment sizes may lead to less machine usage and possible future machine development using larger MLCs with a continued adherence to quality.

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INTRODUCTION

The standard practice at MD Anderson is to treat plans using IMRT with a 2 or 4 cm² aperture size. Treatment plan conformality and accurate doses to the targets and critical structures are ideal. There is an increase in probability of malfunction and IMRT failure due to the quality the machinery involved, This poses the greatest issue of treatment unit maintenance and its effects on treatment unit cost. The purpose of this study is to investigate larger aperture sizes that will meet all the planning qualities and potentially lowering the cost of treatment.

METHODS &MATERIALS

Ten cases, including five unilateral head and neck and five prostate cases, were selected for this study. Each IMRT plan was optimized to mimic the smallest approved aperture segment sized plan. The treatment planning system used to generate the plans was Pinnacle v 9.10 with Direct Machine Parameter Optimization (DMPO) algorithm for IMRT. All generated plans were further modified by using 2, 4, 6, 8 cm² aperture sizes for head and neck plans and 4, 6, 8, 10 cm² for all prostate plans. Plans were adjusted to achieve as close as possible the level of target coverage and critical structure sparing as the approved plan.

RESULTS

For all patients included in this study, clinically acceptable coverage to the CTVs was achieved between all segment areas of both the 4, 6, 8, and 10 cm² prostate and the 2, 4, 6, and 8 cm² head and neck IMRT plans. In comparison to the benchmark prostate and head and neck plans, an increase in segment area size did not show a significant difference in critical structure doses. However, *Fig 1* below illustrates the slight differences in isodose distribution of a prostate and head and neck case as the segment area size increases in both treatment locations.

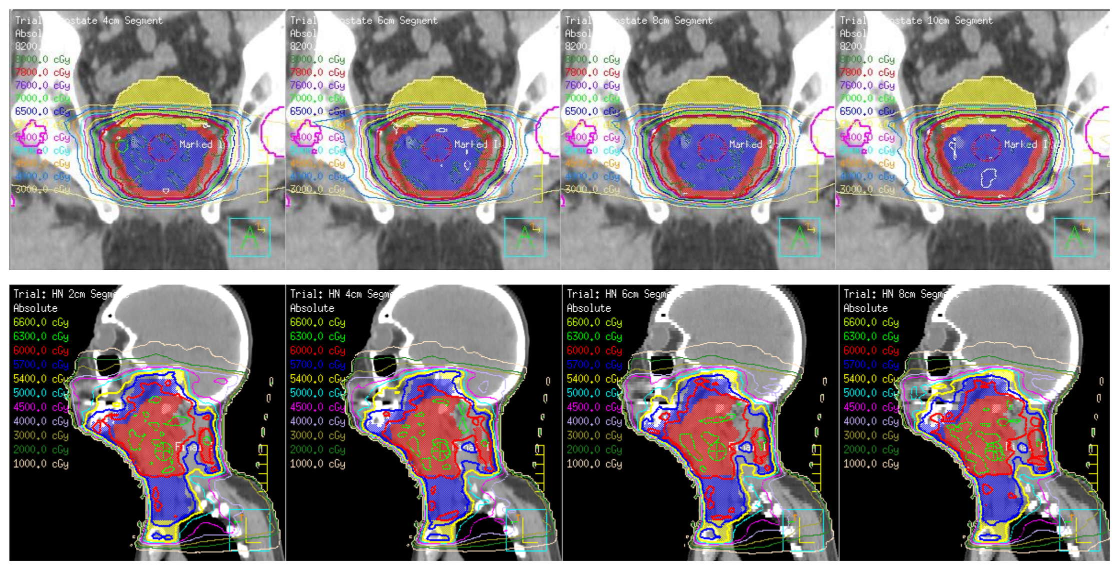


Fig. 1 Representation of isodose distribution in coronal view for Prostate and sagittal view for Head and Neck cases.

The data reveals no significant maximum cc of 0.01 change for cord and brainstem. In both cases the difference of only 2-3% was shown *(Fig 3*). The same 2-3% change appears on the pie chart for larynx and contralateral parotid where mean dose was used *(Fig 4).* The bladder and rectum graphical representation also shows a very marginal difference between various isodose lines coverage *(Fig 5).* There was no significant improvement or reduction in isodose lines for either segment size.

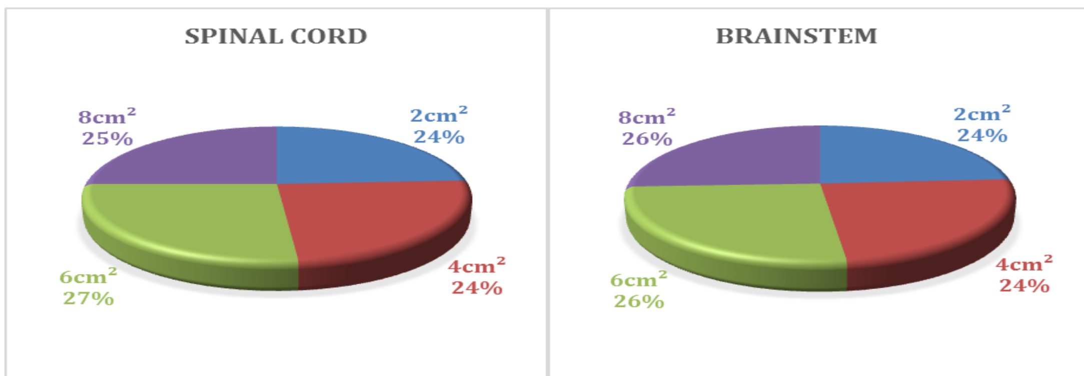


Fig. 2. Representation of Max CC volume to critical structure.

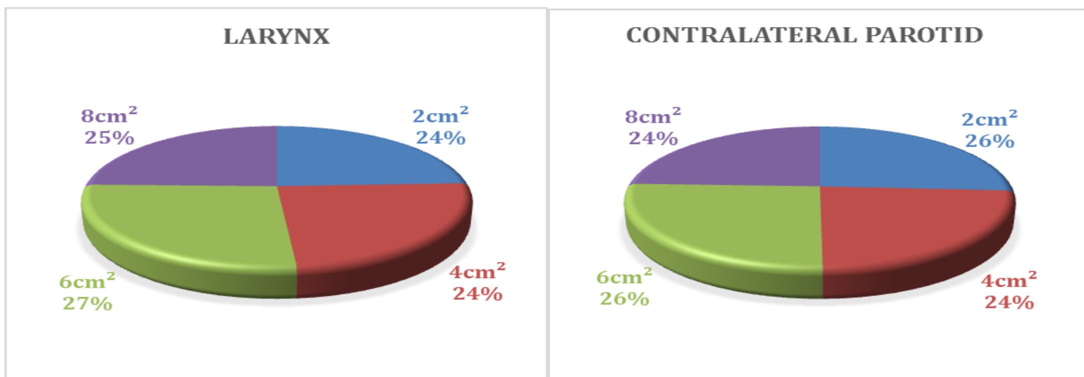
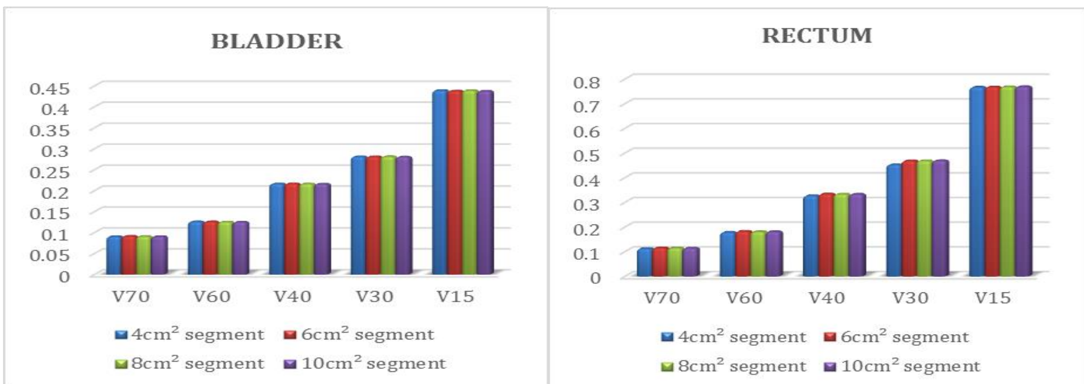


Fig. 3. Representation of Mean dose to critical structure.



Fig, 4. Comparison of various isodose lines for different segment sizes.

CONCLUSIONS

Plans treating with IMRT technique using a 2 or 4 cm² aperture size are planned with the belief of better conformality to the target and overall homogeneity of the plan. These treatment units that can produce such small aperture segment sizes are made with an increased amount of small mechanical features to maintain a high level accuracy using MLCs. A major concern of the treatment unit initial cost and maintenance is this complex machinery. This study set out to research if a treatment plan using a larger aperture size could mimic a successful treatment plan that used a small aperture size. The results revealed as the aperture size increased, the coverage and critical structure sparing remained constant. This concludes that a decreased cost in a machine unit could be achieved by reducing its complexity without worry of losing the rate of successful treatment plans. This study can be strengthened further by increasing the sample size and introducing the research design across other cancer treatment types.

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