



Dosimetric variation between manual contouring and auto segmentation for normal structures in intensity modulated radiotherapy

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INTRODUCTION

- Contouring is one of the time consuming yet most important part of the treatment planning process in radiotherapy.
- Auto contouring is one of the emerging tool for delineating the normal structures in busy radiation oncology department for saving considerable time¹⁻²

AIM

To compare variation between auto contoured and manually contoured structures used in the treatment planning and evaluate the dosimetric changes between them.

METHOD

- A total of 15 Head and neck and 15 pelvis patients were retrospectively analysed in this study.
- Normal structures were manually drawn in the computed tomography (CT) images in eclipse treatment planning system.
- Auto contouring module of the TPS called smart segmentation (version 13.5) was used to contour the same normal structures again.
- For head and Neck patients, spinal cord, brainstem, and parotids were delineated and for pelvis patients, bladder and rectum were drawn with this feature.
- The volumetric changes between auto segmented structures (ASS) and manually contoured structures (MCS) were analysed.
- The original treatment plans were assigned to the auto segmented structures and dosimetric analysis was done.

•Hausdorff distance² is defined in (I), that is, the function $f(t)$ specifies the Hausdorff distance between two sets A and B as a function of the translation t of the set B.

$$f(t) = \max(f_A(t), f_B(t)) \\ = \max \left(\max_{a \in A} d(a - t), \max_{b \in B} d'(b + t) \right) \\ = H(A, B \oplus t)$$

- 3D Slicer software (version 3.14) was used to calculate the hausdorff distance between ACS and MCS as shown in figure 3

RESULTS

- The mean Hausdorff distance between ASS and MCS of all cases were within 3 mm for spinal cord, Left Parotid Right parotid bladder Right Femur Head, left Femur Head and Bone marrow, but was 4.3 mm for brainstem and 15 mm for rectum.
- Mean deviation of maximum doses received was 5.6 Gy for spinal cord and 11.8 Gy for Brain stem.
- The average variation of mean doses were within 13 Gy for Parotids & Bone marrow and within 17.6 Gy for rectum.
- The average variation of mean doses for Bladder, Left Femur Head, and Right Femur Head was within 3.2 Gy.
- The dosimetric differences between ACS and MCS of Rectum, Spinal cord, and Brainstem is due to difference in number of slices in which contours are drawn .
- Bladder and femur heads have clear boundaries and so the auto segmentation does fairly well .

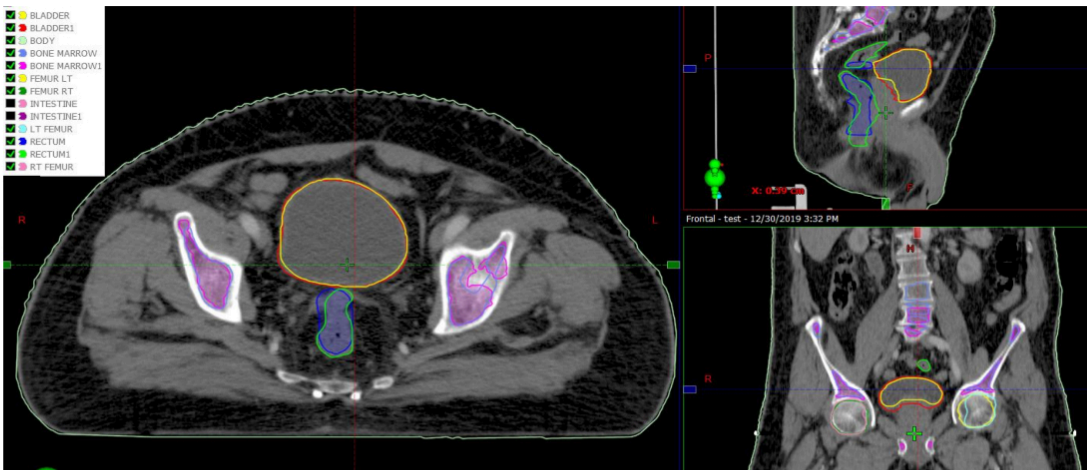


Fig1: CT image showing Both Manual Contoured Structure and auto Contoured Structures (Structure name followed by Numbering 1) for prostate case.a) Superior slice of prostate showing Bladder,Rectum and Bone Marrow.

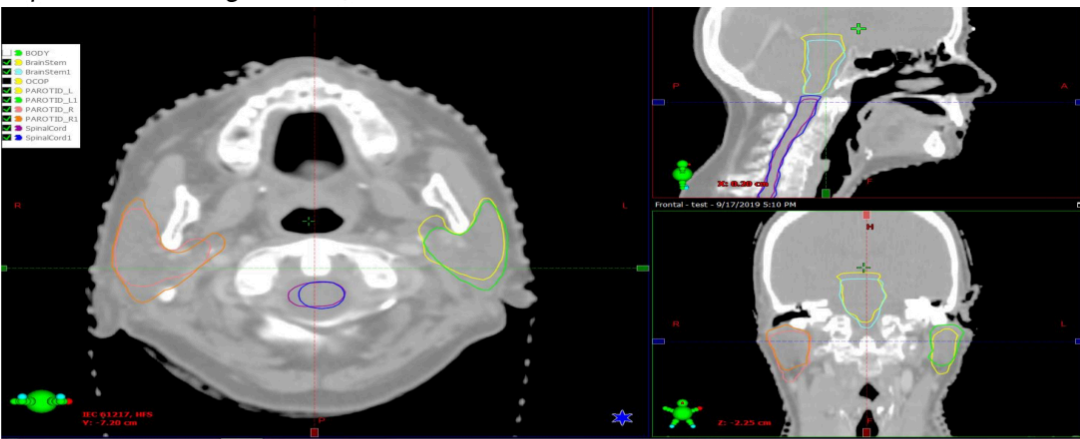


Fig2: CT image showing Both Manual Contoured Structure and auto Contoured Structures (Structure name followed by Numbering 1) for Head Neck Case

Metric		Bladder		Rectum		Femur Rt		Femur Lt		Bone marrow	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Difference in Hausdorff distance(mm)	Max	16.4	11.6	90.1	36.8	22.2	40.3	12.9	15.9	45.8	15.8
	Average	2.0	1.5	15.0	10.0	2.2	2.6	2.3	2.6	2.7	0.7
	95%	7.0	5.5	44.6	18.4	6.4	7.9	7.0	7.9	11.4	5.1
Volume difference (cc)	Mean	11.5	8.0	49.3	21.3	17.9	44.4	17.7	42.2	10.9	8.2
Mean Dose difference (Gy)	Mean	2.8	4.2	17.6	18.0	2.8	3.1	3.1	4.2	6.8	4.7

Table 1: Dosimetric Metrics for normal structures of Prostate Cases

Metric		Spinal Cord		Brain Stem		LT PAROTID		RT PAROTID	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Difference in Hausdorff distance(mm)	Max	27.0	26.5	16.2	9.9	14.1	2.6	14.5	4.2
	Average	2.9	2.1	4.3	3.0	2.7	0.4	2.7	0.7
	95%	13.9	13.5	10.2	5.3	7.8	1.7	7.8	2.4
Volume difference (cc)	Mean	10.2	7.4	10.5	12.2	12.3	9.0	19.8	10.8
Max Dose Difference (Gy)		5.6	8.5	11.8	15.9	-	-	-	-
Mean Dose difference (Gy)		-	-	-	-	9.3	6.1	12.5	6.2

Table 2: Dosimetric Metrics for normal structures of Head and Neck Cases

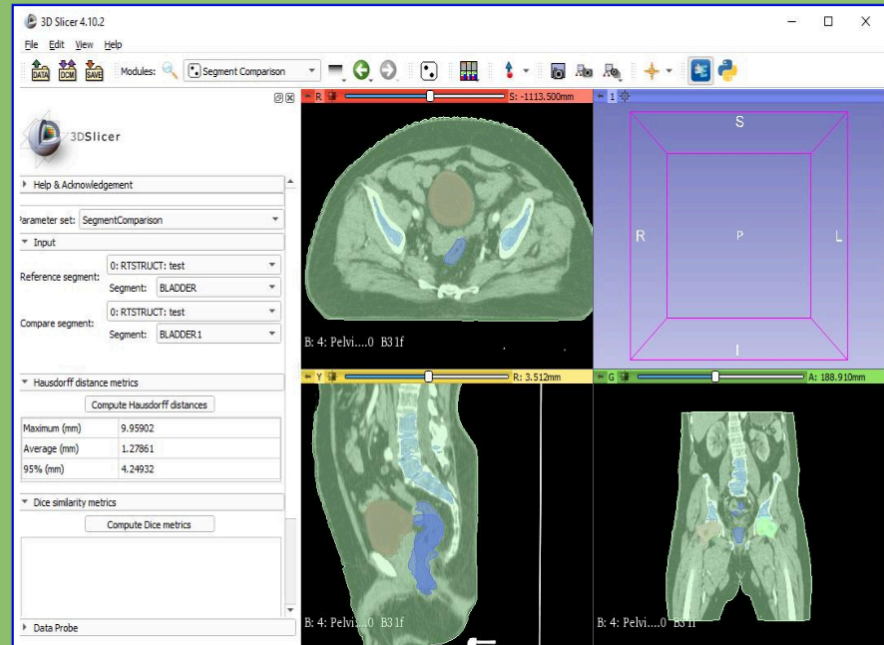


Fig3: Screen Shot of 3D slicer showing a prostate case with a module for calculating hausdorff distance between ACS and MCS of bladder

CONCLUSIONS

Our study shows that auto segmentation creates structures with appreciable similarity to the manually drawn structures. Whenever it is used, a manual intervention is required to correct the minor deviation particularly in structures like brainstem, rectum and parotids.

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