Auto-Planning for Cord Compression Patients Using Scripting and Cone-Beam Computed Tomography (CBCT)

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Purpose

Develop a simple, efficient, and low cost process that will be used to plan and treat emergent patients with cord compressions, without the need for a traditional CT simulation.

Methods and Materials

To determine whether or not treatment planning and dose calculation could be done on a CBCT, a retrospective plan comparison was done. This plan comparison looked at 10 patients, comparing the same treatment plan calculated on the following 4 scans: the sim CT, the sim CT with density overrides, the CBCT, and the CBCT with density overrides (Fig 1). The override values were determined by contouring bone, air, and tissue and looking at the mean density of those structures on the sim CTs (Fig 2). The sim CT with density overrides was included to validate these override values, both the method for contouring them and the HU values being used. The average of those mean values among all 10 patients was used as the override HU value. The % dose difference at iso and at dmax were then compared (Fig 3). The results indicated that plans calculated on CBCTs from our treatment machines were within 2% of the original plan on the sim CT, at both isocenter and dmax. Next, a database of patients was created utilizing Varian Eclipse's Smart Segmentation software that automatically contours several OARs and each individual vertebrae. The auto-planning script uses these vertebrae contours to auto-create a PTV, auto-create either an AP/PA, 3 field, or conformal arc plan, and prepare the plan for review and approval (Fig 4). After approval, a second script is utilized to speed up the physics 2nd check and therapist 2nd check process (Fig 5). Overall, this workflow has the potential to greatly reduce treatment planning time, the amount of time the patient is needed in the radiation oncology department, and reduce the cost in staff hours for the treatment center. The developed workflow could be done within a 30-45 minute time slot on the treatment machine (this is an average time and highly depends on the specific patient).

Conclusion

Treating patients with cord compressions emergently can be time consuming, stressful and costly for both the treatment center and the patient. This new workflow offers an accurate and efficient alternative for both treatment planning and treatment. This process eliminates the CT simulation and a majority of the contouring and treatment planning time, greatly reducing the burden on both staff and patient.

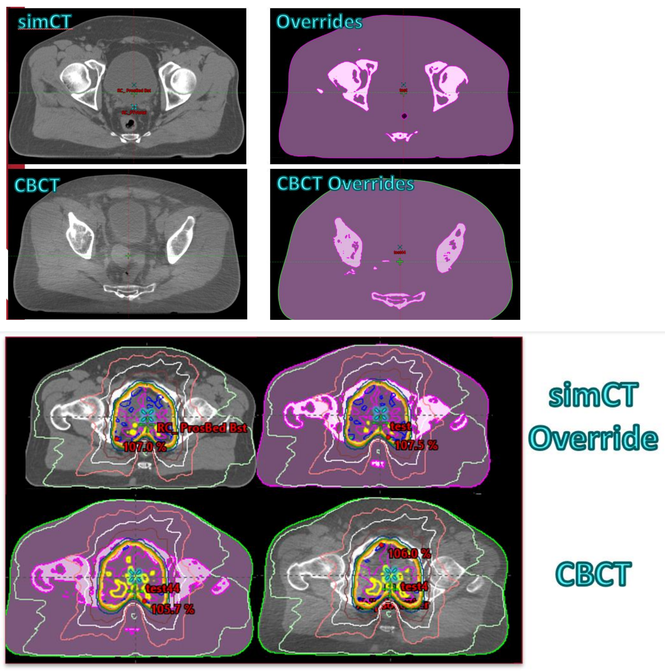
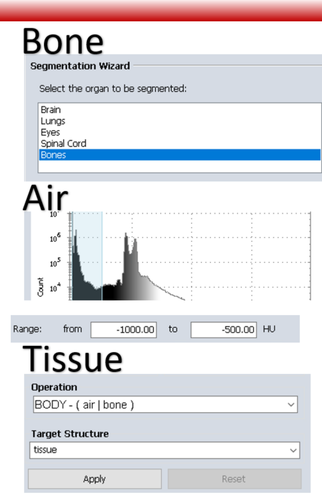


Figure 1: The same plan calculated on the sim CT, the sim CT with density overrides, the CBCT, and the CBCT with density overrides.



Override Values

	Air	Bone	Tissue
Pt 1	-744	462	-28
Pt 2	-842	440	-16
Pt 3	-674	495	-37
Pt 4	-715	456	2
Pt 5	-659	402	-4
Pt 6	-726	415	-23
Pt 7	-779	433	-28
Pt 8	-669	397	-54
Pt 9	-903	458	-42
Pt 10	-743	509	-27
	-745.4	446.7	-25.7

Figure 2: Different tissue contours used, along with the density override values (HU).

Differences from Treated Plan

	Override		CBCT Override		CBCT	
	Iso	Max	Iso	Max	Iso	Max
Pt 1	-0.1	1	-1.3	1.2	-1.2	0.4
Pt 2	0.2	-0.2	-0.1	-0.8	-0.6	-1.2
Pt 3	-0.1	-1	-1.7	-2.4	-1.8	-1.4
Pt 4	-0.5	-0.1	-5	-1.5	-3.6	-0.5
Pt 5	0.4	0	-3.3	1.1	-3.2	0.7
Pt 6	-0.3	0.7	-1.4	-0.2	-1.2	-0.3
Pt 7	0.4	0.6	-1.4	0.5	-1	0.6
Pt 8	0.4	2.8	-1.9	-1.6	-0.9	0.2
Pt 9	-4.9	0	-1	0.7	-3.4	-0.4
Pt 10	0.2	-0.2	-0.2	-1.4	-0.2	-0.8
Avg.	-0.43	0.36	-1.73	-0.44	-1.71	-0.27

Figure 3: The % dose difference between the plan calculated on the sim CT at iso and dmax.

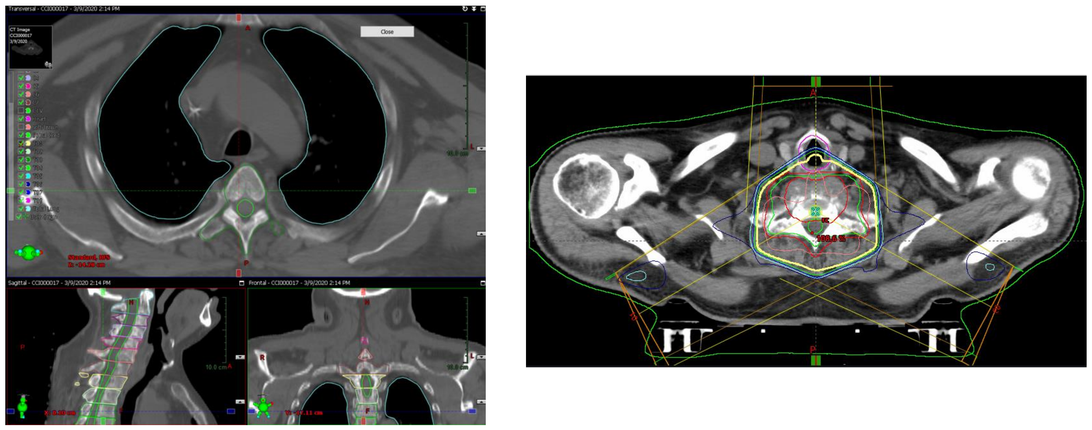


Figure 4: Example output from the Smart Segmentation and planning script.

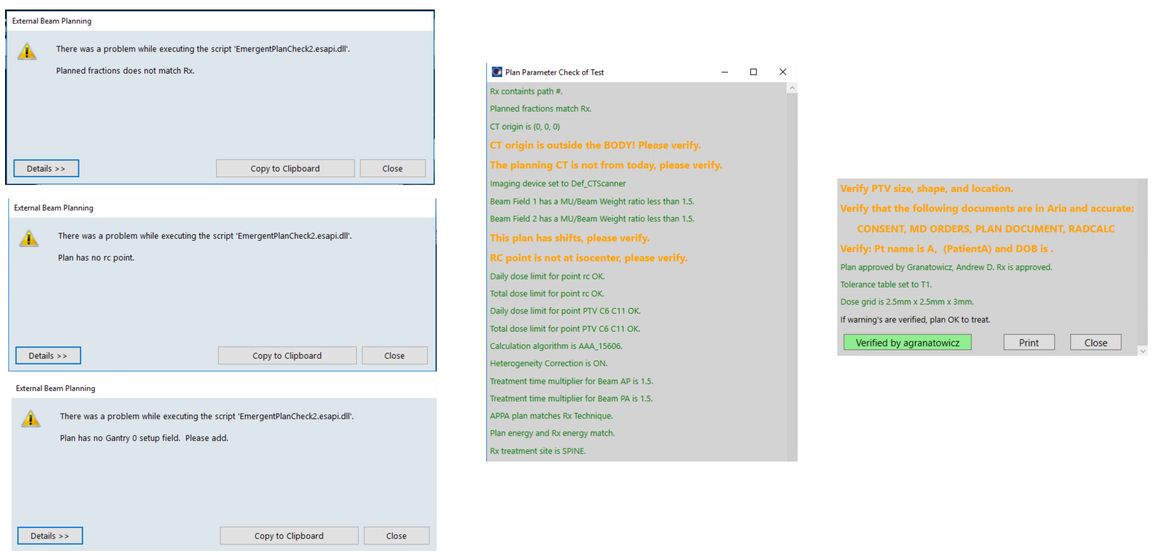


Figure 5: Example output from the second check script.