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Dose uncertainties in case of insufficient body coverage during the radiotherapy CT simulation

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Introduction: In radiotherapy CT simulation, the simulated part of the body can be insufficient on the craniocaudal axis and there may be a lack of scattering material.Usually, the solution to this problem is resimulation, which delays the start of the treatment and adds a dose to the patient. This work examines the difference between the relevant doses for this problem and makes an assessment of the uncertainties of those doses by artificially adding slices through DICOM modifications of CT files, using MATLAB.

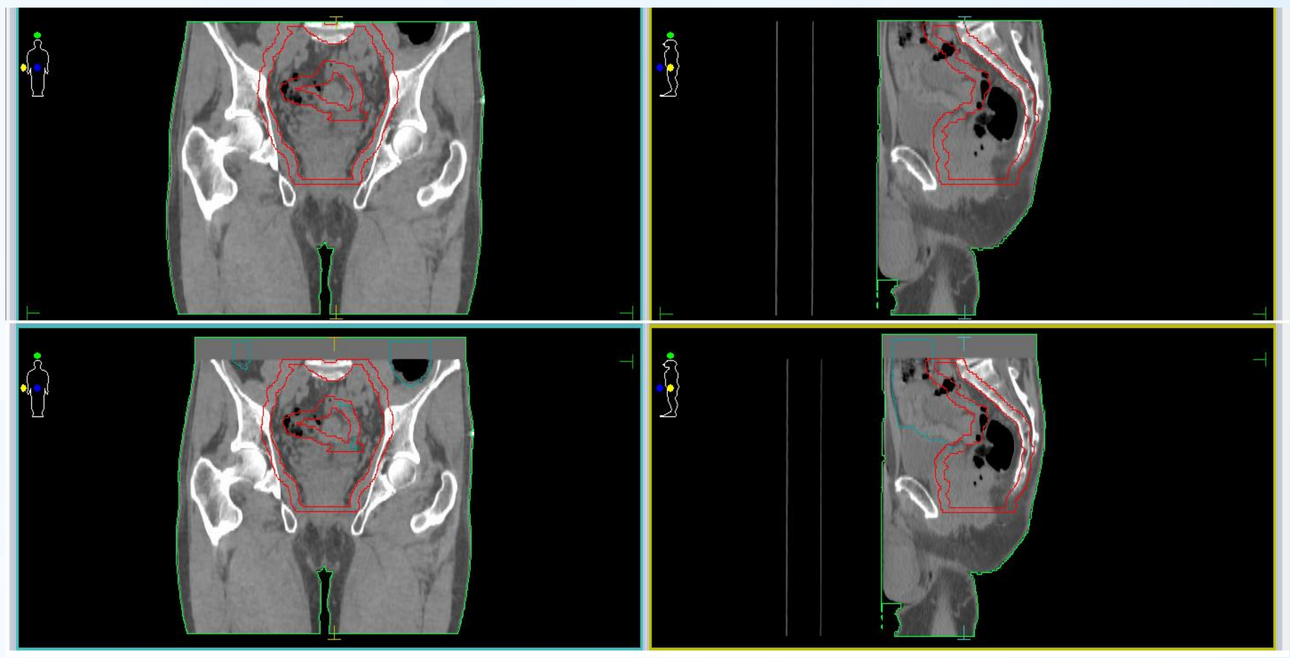

Fig.1: Example of artificially shortened(top images) and artificially extended(bottom images) CT series. The CT series in this example are extended as a copy of the last Body contour filled with HU for water.

Materials and methods: In this work, 35 patients with normal CT simulations in the pelvic region (gynecological, rectum) were processed and 3D-CRT plans were made in Monaco 5.11.03. Using the MATLAB program, the CT axial slices were deleted to the last slice on which the PTV was contoured in a superior direction for Head First positions, which simulates a situation in which the CT series has insufficient slices. This CT series were then artificially extended by 2.5 cm either as a copy of the last slice or as a copy of the last Body contour filled with HU for water. Intestine were taken into account as an organ at risk and were contoured up to 2 cm above the last slice of the PTV. To get the contour in the missing part of the CT simulation, the contour of the intestine from the last slice was copied to the next 2 cm. The plan from the normal CT series was then transferred to the other 3 modified CT series and the doses of PTV, CTV and intestine were compared. The volumes $V_{95\%,}$ $V_{98\%,}$ and Conformity index(CI) as defined in Monaco were compared for the PTV and CTV. Volume V_{45Gy} in absolute value and the total volume V_{tot} were compared for intestine as an OAR and the differences were defined as percentages of V_{45Gy} and V_{tot} of the original CT series.

Results: The results showed that there was up to 3% difference in $V_{95\%,}$ and $V_{98\%}$ for PTV and CTV between normal and shortened CT series. Between the artificially extended CT series and normal CT series the differences in these parameters were negligible. For OAR the mean difference in V_{45Gy} was 0.1% with SD od 1.7% which is not significantly different from zero for p=0.05 significance. Total intestine volume was smaller for artificially extended CT series for most of the cases and the mean difference was -2.6% with SD of 1.5%, which is significantly lower than zero for p=0.05 significance.

	PTV		Intestine	
	$\Delta V_{95\%}$	$\Delta V_{98\%}$	ΔV_{45Gy}	ΔV_{tot}
Mean	0.1	0.1	0.1	-2.6
Standard deviation	0.1	0.3	1.7	1.5
Standard error of the mean	/	/	0.29	0.25

Table 1: Mean and standard deviation for PTV and intestine. Differences between the two methods used for extension of the CT series were negligible.

Conclusion: The differences in respect to the original CT are negligible regarding the target, so the method can be used if the shape of the body contour doesn't change substantially. For intestine the results showed that there isn't a significant difference in V_{45Gy} , but there is a significant difference in V_{tot}, so all relative mode calculations will be affected by this difference.