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Eiland, R. B. ; Behrens, C. F. ; Sjöström, D. ; Maare, C. ; Paulsen, Rasmus Reinhold; Samsoe, E.

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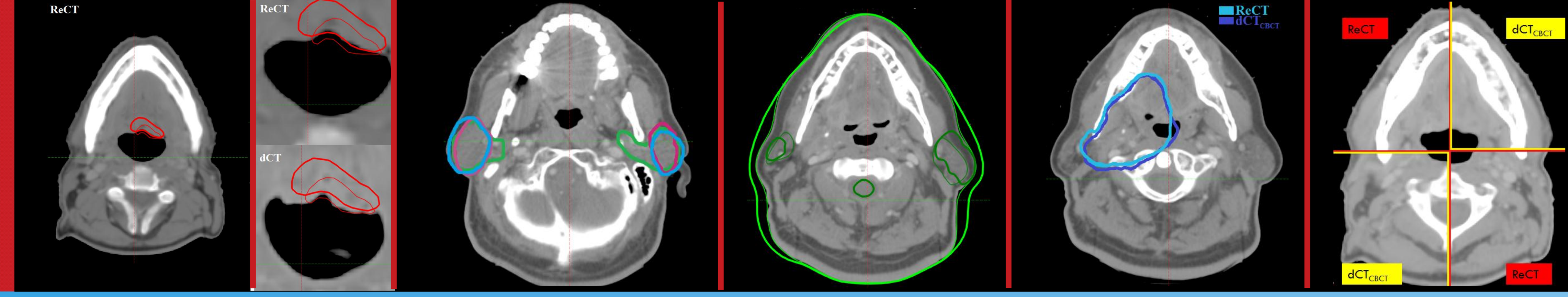


Dosimetric- and geometric evaluation of adaptive H&N IMRT using deformable image registration

R.B. Eiland[1,2], C.F. Behrens[1], D. Sjöström[1], C. Maare[1], R.R. Paulsen[2], E. Samsoe[1].
[1]Copenhagen University Hospital, Department of Oncology, Herlev, Denmark.
[2]Technical University of Denmark, Informatics and Mathematical Modeling, Lyngby, Denmark.

PURPOSE

Differences between planned and delivered dose can occur due to anatomical changes, which can emerge during RT treatment of H&N cancer patients. Adaptive RT has the potential to overcome this, utilizing deformable image registration (DIR).

The purpose of this study was to evaluate the performance of a DIR algorithm, using geometric and dosimetric measures.

METHODS

Seven patients treated with IMRT were included in this study, each with a planning- and midterm CT (pCT, ReCT) as well as a CBCT, acquired on the same day as the ReCT. ReCT served as the ground truth for evaluation of the DIR. A deformed CT (dCT) with structures was created by deforming the pCT and associated manually drawn structures to the CBCT.

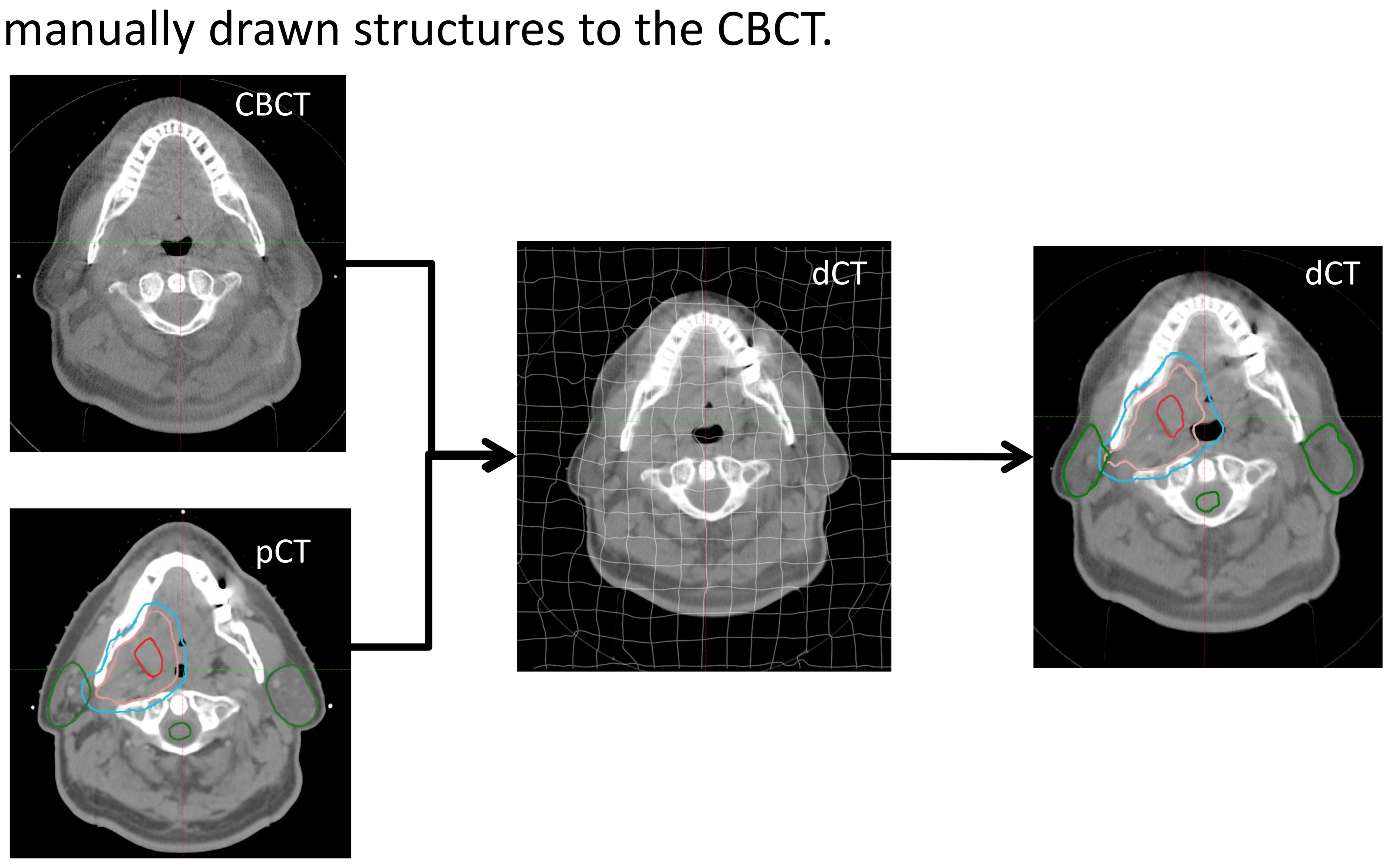
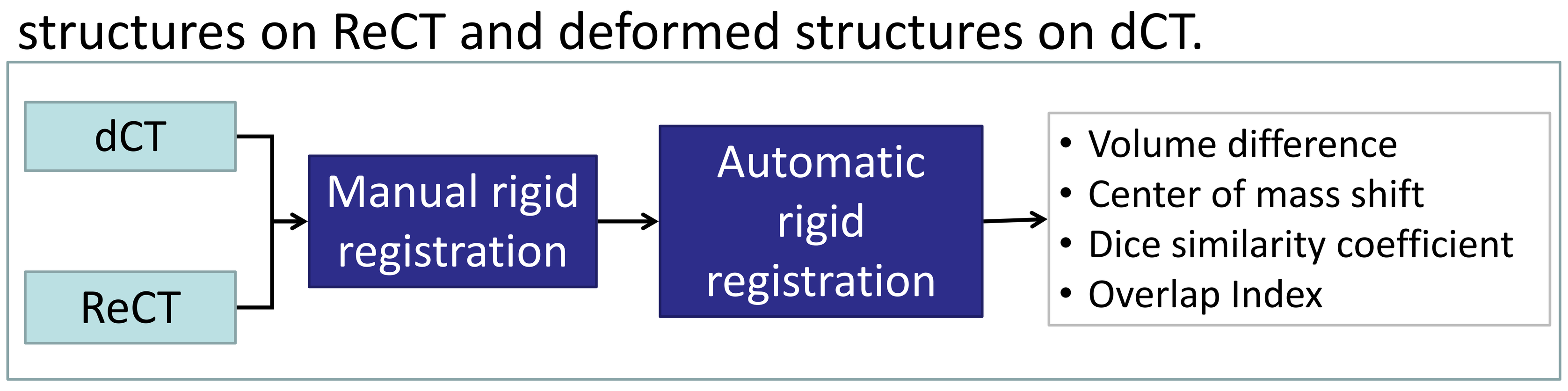


Figure 1: Creation of dCT and corresponding deformed structures. Structures are produced by applying the deformation field to the manually delineated structures on pCT

A commercially software using a Demons algorithm (SmartAdapt, Varian Medical System, v.11.0) was utilized. In the treatment planning system (Eclipse, Varian Medical system, v.10.0) the initial treatment plan was transferred to the dCT and ReCT and the dose recalculated.

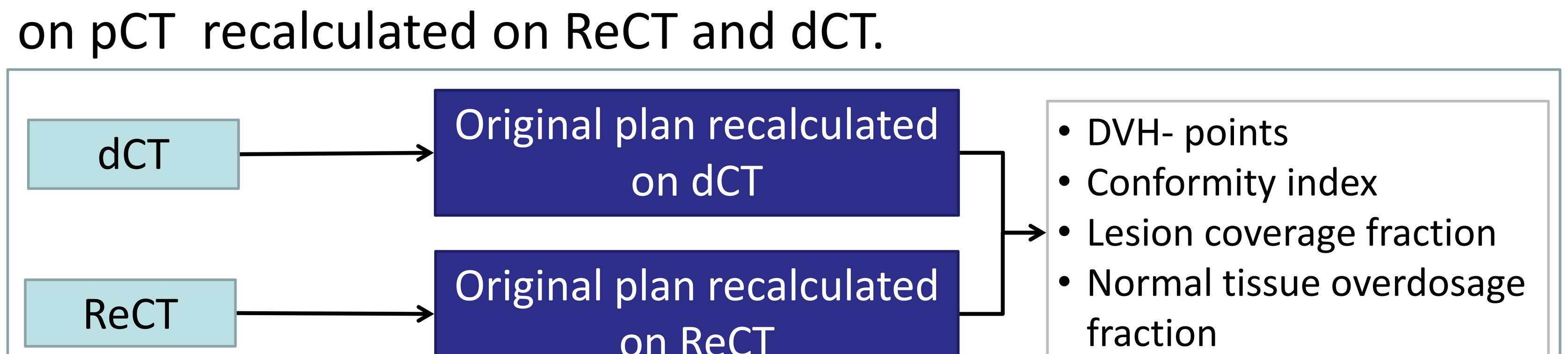
GEOMETRICAL COMARISON

Geometrical comparison was based on the manually delineated structures on ReCT and deformed structures on dCT.



DOSIMETRIC COMPARISON

Dosimetric comparison was based on the original plan conducted on pCT recalculated on ReCT and dCT.



RESULTS

GEOMETRIC COMARISON

	# pt.	Relative volume* [%]	Center of mass shift [Cm]	Dice similarity coefficient (DSC)
GTV-N	7	18.2 (-12.1;50.0)	0.24 (0.15;0.59)	0.68 (0.48;0.82)
GTV-T	6	36.9 (-12.2;169)	0.29 (0.16;1.8)	0.67 (0.26;0.81)
Parotid dxt	7	-15.4 (-27.7;16.7)	0.47(0.16;0.54)	0.76 (0.69;0.80)
Parotid sin	7	-23.1 (-42.1;3.4)	0.38 (0.15;0.75)	0.71 (0.60;0.85)
Spinal Cord	7	-22.9 (-43;39.1)	0.76 (0.16;1.1)	0.72 (0.60;0.77)

Table 1: Geometrical comparison of selected target and OAR structures. Represented as: median (range). DSC = $(2(V_{ReCT} \cap V_{dCT}))/(V_{ReCT} + V_{dCT})$. * Volume relative to ReCT

DOSIMETRIC COMPARISON

		pCT	dCT	ReCT	P-value*
GTV-T	D_{50} [%]	99.6±1.5	100±0.8	100.2±0.5	0.76
	D_{98} [%]	98±5.1	98.2±0.9	98.0±1.1	0.83
	D_{2} [%]	102.3±6.4	102.6±1.1	102.4±0.6	0.50
Parotid dxt	D_{mean} [Gy]	30.1±11.9	31.1±12.0	27.3±14.3	0.29
Parotid sin	D_{mean} [Gy]	24.9±5.7	25.0±5.8	27.7±8.7	0.29
Spinal cord	D_{max} [Gy]	43.1±1.9	43.0±1.3	41.7±3.8	0.42

Table 2: DVH-Points for selected target and OAR structures represented as median ±SD. *paired t-test between ReCT and dCT, α = 0.05

Table 3 present measures for plan conformity. Figure 2 visualize the volumes used for the computation.

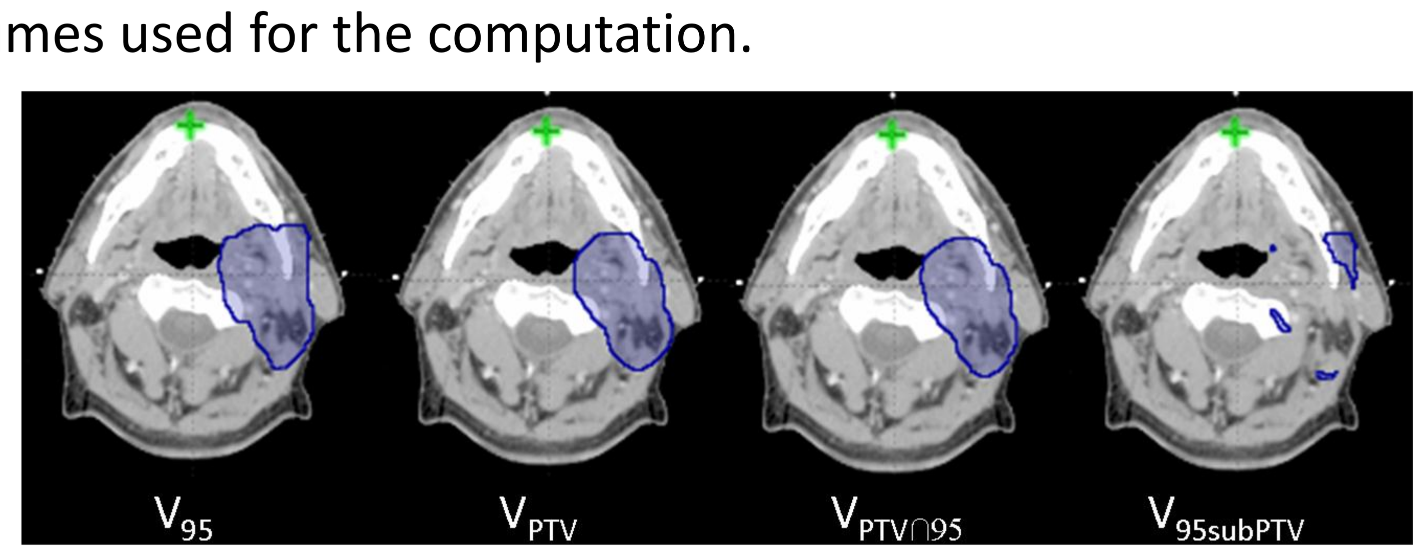


Figure 2: Visualization of volumes used for computation of plan conformity

	pCT	dCT	ReCT	P-value*
Conformity Index (CI) (1)	1.2±0.1	1.2±0.1	1.5±0.3	0.11
Lesion coverage fraction (LCF) (1)	0.98±0.09	0.96±0.04	0.94±0.05	0.30
Normal tissue overdosage fraction (NTOF) (0)	0.19±0.07	0.23±0.06	0.32±0.12	0.02

Table 3: Measures of plan conformity±SD. CI= V_{95} / $V_{PTV,}$ LCF= $V_{PTVand95}$ / $V_{PTV,}$ NTOF= $V_{PTVsub95}$ / $V_{95.}$ Numbers in brackets symbolize optimal value. *paired t-test between dCT and ReCT α = 0.05.

CONCLUSION

Reasonable results were obtained for geometric measures. However with some variation; GTV was influenced by the shape and size of trachea. Different delineation approaches of the parotid gland had influence on the variation. Large variation was observed for spinal cord. No significant difference with regard to values of DVH-points for all structures. CI and LCF obtained similar values for pCT, ReCT and dCT. Values of NTOF revealed significant difference between ReCT and dCT. **Deformable image registration for use in adaptive radiation therapy presents a promising tool**.

Presented at ESTRO 31, 9-13 May 2012, Barcelona, Spain, Rikke.Busch.Eiland@regionh.dk