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Geometrical comparison measures for tumor delineation, what do they mean for the actual dose plan?

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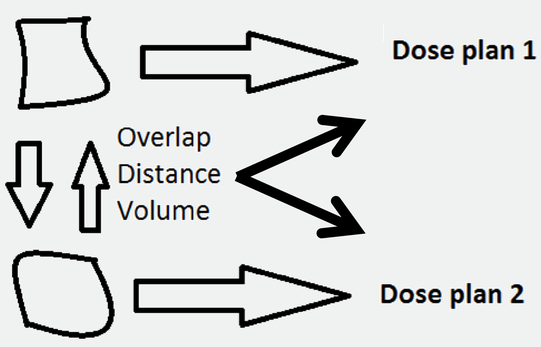
Purpose

Gross tumour volume (GTV) delineation is central for radiotherapy planning. It provides the basis of the clinical target volume and finally the planning target volume (PTV) which is used for dose optimization. GTV delineations are prone to inter-method and inter-observer variation.

In clinical studies this variation is commonly represented by geometrical volume comparison measures (GVCMs) as volume assessment, centre of mass and overlap. The correlation between these measures and the radiotherapy plan are however unclear. The aim of the present study is to investigate the correlation between GVCMs and the radiotherapy plans of patients with peripheral lung tumours.

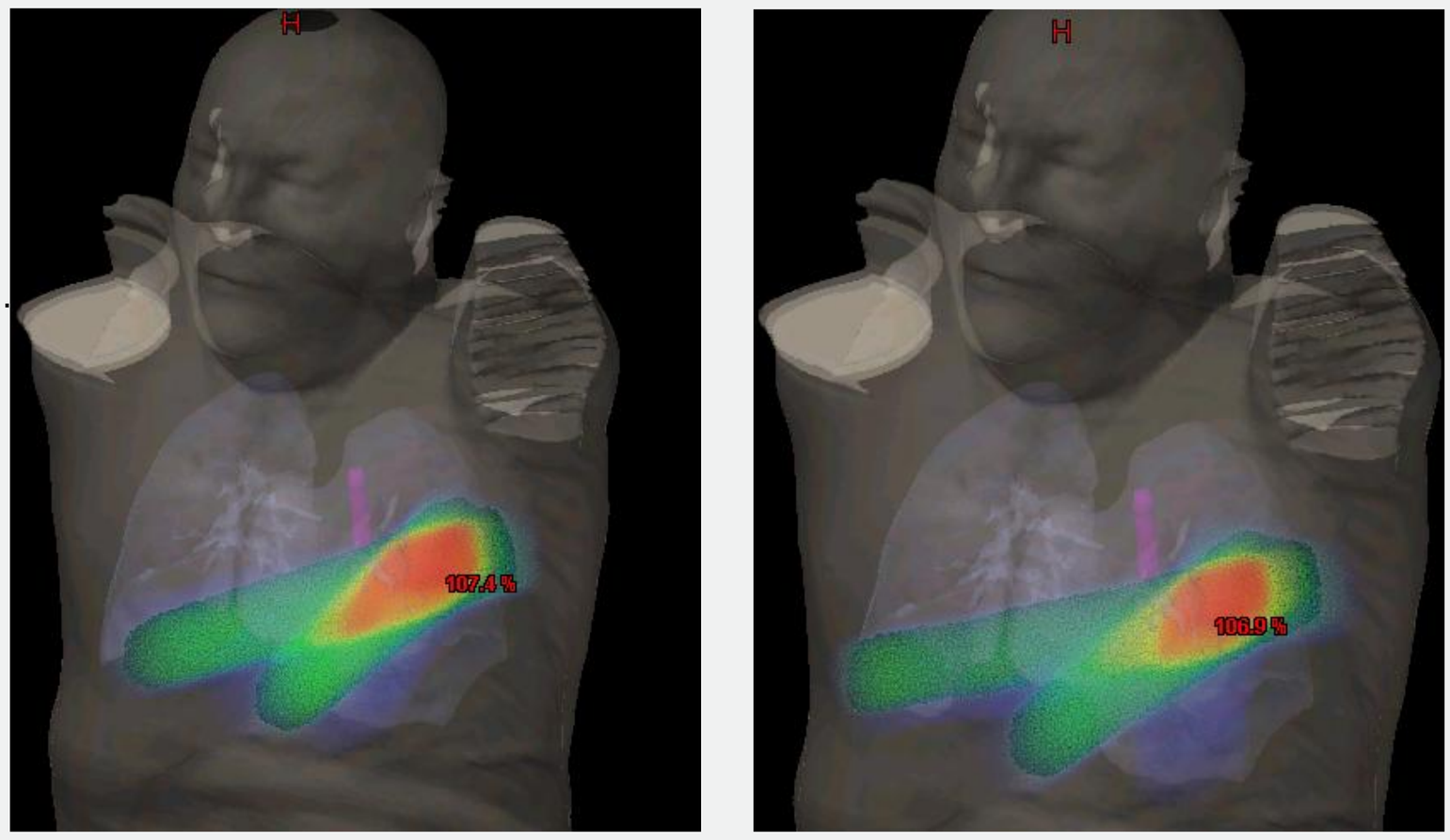


Conceptual example of the connection between GVCM and dose

Materials & Methods

Peripheral lung tumours of 10 patients referred for stereotactic body radiotherapy in 2008 were delineated by 3 radiologists and 3 oncologists. From these GTV delineations 6 different radiotherapy plans with RapidArc© were created for each patient using the same procedure for creation of PTV and dose optimisation. For each patient the volume receiving 90 % of the prescribed dose (V90) and the minimum dose that 90 % of the volume receives (D90) was extracted for the 6 delineations on each of radiotherapy plans.

GVCMs as Dice overlap coefficient, mismatch, volume difference, center of mass distance, and Haussdorff distance were extracted between each pair of the delineations of GTV for each patient.



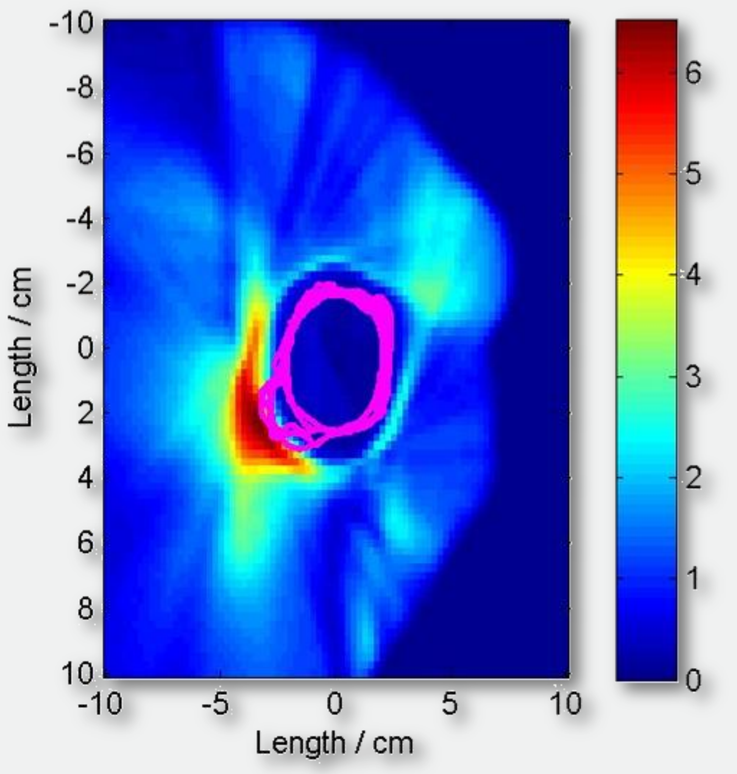
Two different plans on the same patient. The difference between the plans is due to the different GTV used.

Mismatch was defined as the volume of a GTV delineation outside the GTV delineation used to create the PTV divided volume of the GTV used to create the PTV. The Pearson correlation between the GVCMs and their corresponding difference in V90 and D90 was calculated and their statistical difference from zero and each other was tested with a t-test with a p-value of 0.05.

Results

The V90 and D90 were extracted for the 6 different PTVs on the 60 radiotherapy plans. The standard deviation for V90 and D90 were 5.5 % of the volume and 4.1 Gy respectively,

The standard deviation in one image plane of one patient can be seen in the figure. All the correlation coefficients were found significantly different from 0. The correlation coefficient for mismatch was significantly different from all the other GVCMs for both V90 and D90. The correlation coefficient for center of mass was significantly different from the volume difference for D90.



Standard deviation of the different radiotherapy plans in one plane for one patient. GTV contours in magenta. The values given in the value bar indicates the standard deviation in Gy.

Conclusions

Mismatch between GTVs is significantly more correlated with V90 and D90 than other GVCMs. Mismatch between GTVs could be used as a indicator for difference in V90 and D90 of their corresponding radiotherapy plans.

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