

# Deformable Dose Mapping Accuracy Using a Framework for User-Intervened Correction of Deformable Registration



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### Purpose

To evaluate the accuracy of deformable dose mapping using a method for user-intervened correction of deformable registration.

### Methods

Two treatment plans were calculated on a 4DCT dataset from the POPI model(1-2). POPI2 was chosen due to significant respiratory motion between endinspiration to end-expiration (14.0mm +/- 7.2mm). Plans were created on the 0% phase for a mediastinal primary (MP) tumor and a lung primary (LP) tumor. The 0% phase CT was deformed to the 50% phase CT using a commercially available free-form intensity-based deformable registration method (MIM Software, Cleveland, OH). The MP and LP doses were deformed using the transformation between the 0 to 50% phases. Doses were recorded at 100 corresponding landmarks on each phase. Differences between expected dose and deformed dose were calculated for all corresponding points. This process was repeated using an interactive tool to influence the deformation through local alignments. Seven local alignments were used to guide the deformation and dose differences were again calculated.

# Figure 1





Treatment plan for mediastinal and lung primary tumors calculated on 0% phase and deformably transformed to the 50% phase. Dose differences were calculated for 100 landmark points.

### Figure 2 POPI with Landmark Points



POPI Model with manually identified points of interest on the 0% phase image. Corresponding points were also manually identified on the 50% image.

### Figure 3 Impact of Reg Refine Adjustments on Final Deformation



(a) Reg Reveal display demonstrating an area of concerning registration with poor matching between source and target within the sampling box (b) Improvement in deformation for the same target location but after locking local registrations with Reg Refine and rerunning the deformable registration.

# Table 1

# Dose Error Comparison Between Methods for Lung & Mediastinal Plans

Absolute Dose	Lung Plan		Mediastinal Plan	
Difference (%)	No LA	LA	No LA	LA
< 1%	41	60	40	48
1 to 2%	11	15	19	26
2 to 3%	10	9	7	12
3 to 4%	4	6	6	5
4 to 5%	7	5	3	2
> 5%	27	5	25	7

Dose differences for deformation with no locked alignments (No LA) and after locking 7 local alignments and rerunning the deformation using Reg Refine (LA).

# Results

The mean absolute percent difference in dose (Gy) for MP before and after locally guided deformation was 5.6 +/- 10.6% and 1.7 +/- 2.5% respectively (p=0.0002). The percentage of points with <2% dose difference were 59% and 74% respectively. The percentage of points with > 5% dose difference were 25% and 7% respectively. The mean absolute percent difference in dose for LP before and after locally guided deformation was 10.3 +/- 22.4% and 1.6 +/- 2.5% respectively (p=0.0001). The percentage of points with <2% dose difference were 47% and 65% respectively. The percentage of points with >5% dose difference were 27% and 5% respectively.

# Conclusion

A method for user-intervened correction of deformable registration provided accurate results for dose mapping with average dose deviations <1.7% even for a challenging subject with significant respiratory motion.

### References

- 1 Vandemeulebroucke J, Rit S, Kybic J, et al. Spatiotemporal Motion Estimation for Respiratory-correlated Imaging of the Lungs. Med Phys 2011; 38(1):166-178
- 2 http://www.creatis.insa-lyon.fr/rio/popi-model/