AbstractID: 6534 Title: Objective assessment of deformable image registration in radiotherapy - a multi-institution study

Purpose:
The looming potential of deformable alignment tools to play an integral role in adaptive radiotherapy suggests a need for objective assessment of these complex algorithms. Current studies of accuracy require analytically generated deformations applied to sample image data, or use of contours or bifurcations, with inherent uncertainty as well as potential bias, as these visible features are likely to dominate the local deformation parameters.

Method and Materials:
A deformable phantom was embedded with 48 small radiopaque markers, placed in regions varying from high contrast to roughly uniform regional intensity, and small to large regional discontinuities in movement. CT volumes of this phantom were acquired in two different deformation states. After manual localization of marker coordinates, images were edited to remove the markers. The resulting image volumes were sent to 4 collaborating institutions, each of which has developed previously published deformable alignment tools routinely in use. Alignments were done, and applied to the list of reference coordinates. The transformed coordinates were compared to the actual marker locations.

Results:
5 alignment techniques were tested from the 4 institutions. All algorithms performed generally well, as compared to previous publications. Average errors in predicted location ranged from 1.7-3.9 mm, depending on technique. No algorithm was uniformly accurate across all regions of the phantom, with maximum errors ranging from 5.5 – 15.4 mm. Larger errors were seen in regions near significant shape changes, as well as areas with uniform contrast but large local motion discontinuity.

Conclusion:
An objective test of deformable alignment is feasible. Reasonable accuracy was achieved, although variable errors in different regions suggest caution in globally accepting the results from deformable alignment. Valuable feedback from investigators is being applied to development of further generations of deformable phantoms for alignment experiments.

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