Purpose:
Accurate Deformable Image Registration (DIR) algorithms are essential to clinical implementation of adaptive planning strategies hence finding validation strategies for DIR algorithms remains a pressing concern. Most validation efforts are based on contour or landmark tracking, thus sampling the Deformable Vector Field (DVF) relatively sparsely. The primary purpose of this work is to assess interchangeability of DIR algorithms in dose accumulation, and assess if contour based methods are sufficient to validate the equivalence of DIR algorithms.

Methods:
We registered peak inhale and peak exhale phases of thirteen lung patients using three DIR algorithms. The DVF maps were pairwise compared through voxel-by-voxel subtraction of vector fields. The vector difference maps were analyzed by building volume histograms on regions of interest. This method of analysis is directly relevant to the Dose Volume Histogram accumulation, as vector difference between the maps will be translated into a distance between dose interpolation points. We further compared Jacobian distributions for the three maps, as local derivatives of DVF maps would be important to any algorithm that attempts local density corrections. We performed contour based comparison of the three algorithms, to connect this validation method to prior work.

Results:
The volume histogram analysis shows that differences between DVFs in 2% tails of volume histogram are in the 1cm - 4cm range, although the contour-based analysis using Dice's Similarity Coefficient (DSC) would suggest that the three algorithms are nearly equivalent. For most structures, spatial differences between maps are below 0.5cm over approximately 70% of structure volume, and exceed 0.5cm over the remainder. Jacobian distributions differ significantly, implying that local density corrections are strongly algorithm dependent.

Conclusions:
Differences between algorithms are potentially significant for dose accumulation, and such differences are not revealed by contour based comparisons.

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