Abstract ID: 15461 Title: Quality assurance of deformation algorithms using a two-dimensional deformable phantom

Purpose: Clinical implementation of deformation algorithms requires dependable quality assurance techniques. A two-dimensional deformable phantom that can objectively verify the accuracy of the algorithms throughout an entire slice of the anatomy is proposed.

Methods: The phantom represents a single plane of the anatomy for a head and neck patient. Inflation of a balloon catheter inside the phantom simulates tumor growth. CT and camera images of the phantom are acquired before and after its deformation. Non-radiopaque markers reside on the surface of the deformable anatomy and are visible through an acrylic plate, which enables an optical camera to measure their positions; thus, establishing the ground truth deformation. This measured deformation can be directly compared to the predictions of deformation algorithms, using several similarity metrics, and it can be applied to create a simulated deformation for a patient CT, which can also be used to test algorithm accuracy. The ratio of the number of points with more than a 3 mm deformation error over those that are deformed by more than 3 mm was used for an error metric. A comparison of the deformation algorithm accuracy for the phantom CTs and the simulated CTs evaluates the adequacy of the phantom electron density heterogeneity.

Results: The balloon catheter deforms 32 out of the 54 surface markers by more than 3 mm. Different deformation errors result from the different similarity metrics. The most accurate deformation results for the phantom CTs had an error of 75%, compared to 25% for the simulated CTs.

Conclusions: The developed phantom demonstrates its utility for verifying deformation algorithms and determining which is the most accurate. The reduction of the deformable anatomy to a two-dimensional system allows for the use of non-radiopaque markers, which do not influence deformation algorithms. This is the fundamental advantage of this verification technique.