A Novel MRI-SIM Technique for Localization of Head and Neck Cancer Patients Using Immobilization and Surface Coils: Initial Clinical Experience

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Purpose/Objective(s): To investigate the feasibility of developing a geometrically accurate MR imaging protocol at 1.5T for patients immobilized with the type S frame for head and neck radiotherapy.

Materials/Methods: Protocol optimization was undertaken using a GE Optima 450 70cm wide bore MR-SIM unit commissioned for radiotherapy planning. MRI images (from the base of brain to below the clavicles) were acquired in five volunteers using an 8 channel phased array coil placed over the head and neck region while each subject was immobilized in the treatment position with a five point thermoplastic device. Pulse sequence parameters for 3DT1, T2 FRFSE and T2 CUBE (including matrix, slice thickness, bandwidth) were optimized to maximize SNR while minimizing the effect of chemical shift. MR image quality was rated by two independent Radiation Oncologists benchmarked against “gold standard” reference diagnostic images. Phantom measurements were then performed to quantify system related residual geometric distortions after application of a commercial gradient distortion correction algorithm for the effective FOV and the pulse sequences utilized. The optimized protocols were used to image five patients undergoing head and neck radiotherapy. MR and planning CT images were fused in the ECLIPSE treatment planning system using mutual information algorithm. Image quality, distortion and accuracy of image registration using internal anatomical reference landmarks (multiple regions of interest in the head, neck and thorax) were evaluated.

Results: A high resolution MR-SIM imaging protocol (3DT1, T2 FRFSE and T2 CUBE) was developed with 3mm slice thickness/no gap that covers the base of brain to below the clavicles. From phantom studies, residual distortions were found to be < 1.0 mm within a 8 cm radius and < 1.5mm within a 12 cm radius of the scan centre. Image deformation was minimized in the head and neck region due to the reproducibility of image localization between CT and MRI. In terms of registration accuracy, anatomic landmark displacements in the x, y and z direction relative to CT were <2mm for all landmarks in the head and neck region but up to 6 mm in the thorax.

Conclusions: We have developed a novel MRI-SIM technique that provides good image quality for patients immobilized for head and neck radiotherapy and is now in clinical use.