AbstractID: 13166 Title: Dosimetric consequences of rotational setup errors using direct simulation in a treatment planning system for fractionated stereotactic radiotherapy (SRT)

Purpose: To determine dose-delivery errors resulting from systematic rotational setup errors for fractionated stereotactic radiotherapy (SRT) using direct simulation in a treatment planning system (TPS).

Methods and materials: Ten patients who received IMRT of brain tumors were studied. Simulation of systematic rotation was done by applying a 3x3 rotation matrix to the original images and contours. Combined rotational errors of ±1°, ±3°, ±5° and ±7° and residual translation errors of 1 mm along each axis were simulated. The rotated images were re-imported into the TPS and the dose effects were evaluated by re-computing the dose distributions. Target volumes receiving ≥ 100% (V_{100Rx}), 93% (V_{93Rx}), and 110% (V_{110Rx}) of the prescription dose level and the volumes of the 6 organs at risk (OARs) receiving more than the tolerance dose levels were evaluated.

Results: The accuracy of the image rotation algorithm was validated using the image registration package within the TPS and was found to be within 0.5 mm/0.2° in translation/rotation transformation, respectively, and the volumes of the rotated contours are within 2% of the original contours. A systematic reduction in CTV coverage was observed, with the mean V_{100Rx} of the CTV to be 99.3±0.5% (original), 98.4±1.2% (±1°), 95.8±3.0% (±3°), 90.0±7.3% (±5°), and 81.4±13.1% (±7°). In most cases, OAR doses fell within the tolerance levels. However, for two cases where $D_{0.1cc}$ (dose to 0.1 cm^3) of the brain stem received close to the dose limit in the original plan, even a ±1° rotations had made $D_{0.1cc}$ > 55Gy, which exceeded our dose limit.

Conclusions: We conclude that for rotations less than ±3°, no action level is required; however, cases presenting extreme rotations and high doses in the brain stem should be investigated as routine practice. This procedure allows easy evaluation of dosimetric consequences when systematic rotational errors are present in patient setup.