

Multi-System Verification of Registrations Utilized in IGRT Processes

Y. Cui¹, J. M. Galvin¹, W. L. Straube², W. R. Bosch², J. A. Purdy³, A. Li⁴, Y. Xiao¹, ¹Thomas Jefferson University, Philadelphia, PA, ²Washington University, Saint Louis, MO, ³UC Davis Medical Center, Sacramento, CA, ⁴Medical College of Wisconsin, Milwaukee, WI

Purpose/Objective(s): Credentialing and verification are important parts of the process of using IGRT in clinical trials. This creates a need for re-registering images across different hardware and software platforms. The purpose of this work is to compare results when the IGRT process is repeated.

Material/Methods: For testing purposes, images and IGRT shift results from three different treatment systems (Tomotherapy CTrue, Elekta Synergy, Varian Trilogy) have been sent from various institutions to the Radiation Therapy Oncology Group (RTOG) for evaluation. Three head&neck and three prostate patient data from the treatment systems were used, and for each patient 2-4 daily image datasets were included. Cases from Tomotherapy were uploaded through Image Guided Therapy QA center (ITC) for de-identification and integrity verification. In all cases, daily shifts were re-calculated from registration of the planning CT with the daily IGRT data using three independent software systems (MiMvista, CMS Focal, VelocityAI). Similar volumes of interest (VOIs) and the same initial positions were used in registrations. For the cases from Elekta Synergy, two different slice spacings (1mm and 3mm) were used for CBCT sampling. Two different VOIs were used for CMS Focal. Five different VOIs (anterior, center, posterior, PTV+2cm, skin) were used in MiMvista for 1 prostate case.

Results: Not all systems were able to perform successful registration for all the cases. Only successful registrations were included in comparison. For the head&neck cases, the absolute values of differences of the registration results from different systems were 2.9 ± 2.4 mm (mean \pm SD; range 0.5-8.6mm, left-right), 2.5 ± 1.3 mm (0.5-4.9mm, superior-inferior), and 2.3 ± 0.9 mm (0.3-3.6mm, anterior-posterior). Out of 21 comparisons in head&neck cases, four (19%) had differences larger than 5mm in any of three dimensions, and ten (48%) had differences larger than 3mm but less than 5mm. For the prostate cases, the differences were 2.4 ± 2.0 mm (0.2-8.4mm), 2.2 ± 1.5 mm (0.0-5.1mm), and 2.0 ± 1.8 mm (0.0-6.3mm), in three dimensions respectively. Out of 24 comparisons in prostate cases, one (4%) had differences larger than 7mm, and seven (29%) had differences larger than 4mm but less than 7mm in any of three dimensions. The differences caused by the slice spacing variation were relatively small and the different VOIs in Focal and MiMvista also had limited impact on the registration results.

Conclusion: Significant differences were observed when different registration systems were used to obtain IGRT shifts from the same planning and daily image sets as compared with those shifts used for patient treatments. Careful examination and quality assurance of the image registration process are needed before considering margin reduction using IGRT.

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