Purpose

• The GammaKnife® Icon™ has an onboard cone-beam CT (CBCT) system for stereotactic localization, facilitating frameless treatments

• Patients receive a diagnostic MRI for target, OAR, and skull definition, which is registered to an in-mask CBCT for localization and planning (Figure 1)

• An alternate registration workflow is proposed: The MRI is registered to a diagnostic CT, which is then registered to the CBCT

• MRI and CBCT share limited mutual information; it is expected that including a diagnostic CT in the registration process will improve registration accuracy (Figure 2)

• We aim to quantify geometric and dosimetric differences between workflows, and to identify which situations are more susceptible to these differences

Methods

• A set of eight 4mm diameter spherical targets and one 0.14mm diameter target (Target 9) were created and transferred to the MRI for 12 patients (Figure 3)

• The MRI was registered to the diagnostic CT, then CT registered to CBCT

• Single-shot per target plans maximizing conformity and selectivity, while maintaining 100% target coverage were created for each patient

• The MRI was then registered to the CBCT directly and the plan was copied

• Differences in target locations and coverage between the workflows were recorded

• All registrations were done using GammaPlan's automatic registration process with a volume of interest (VOI) encompassing the whole skull

• All registrations were reviewed and determined to be clinically acceptable

Results

• The mean 3D displacement of target center position was $0.50 \pm 0.26$ mm (max=1.3 mm) (Figure 4)

• The mean decrease in target coverage was $4.4 \pm 5.2$% (max=32%) (Figure 4)

• Posteriorly located targets (3 & 6) had larger displacements because they were more greatly affected by pitch in the registration

• Smaller targets (9) are susceptible to larger losses of target coverage for a given displacement

Discussion & Conclusion

Our data indicate that geometric differences exist between the two workflows and that these geometric differences can result in marked losses of target coverage.

• Patients with posteriorly located targets are more susceptible to these differences, and should receive a diagnostic CT for registration purposes.

• Patients with CBCT volumes that do not capture base of skull may be more susceptible to differences between registrations. This may occur in patients with larger necks/shoulders as it is difficult to slide superiorly in the head/mask cup.

• This work was done using the entire skull as a VOI, which would be used in cases of multiple-target treatments. Future work will aim to quantify these differences in cases with single and non-spherical targets, and aim to determine the appropriate VOI when performing CBCT-MRI registrations.