Peripheral Tumor (mm)  
4.18  
4.7  
23.4  
0.58  

lines of plans resulted in lower Tumor was 26.9Gy. Is an emerging technology based on target the brain. Current treatment strategies are evolving as a result of advancements in radiation delivery, including Helical Tomotherapy. Tomotherapy is an emerging technology based mainly on the linkage and integration of known and widely-used technology in radiation oncology into a single system, i.e. a linear accelerator and computed tomography, allowing precise daily targeting of rotating IMRT fan beam using megavoltage CT (MVCT) guidance resulting in a highly conformal dose distribution.

In this study, we will compare 9 dosimetric plans between Gamma Knife (GK), and single fraction helical Tomotherapy in treating single to multiple brain lesions by examining the CTV coverage by the prescribed isodose surface. As GK is an accepted technology for stereotactic radiosurgery, our goal is to see if dosimetric equivalency between the two technologies can be achieved.

- **RESULTS**

With Tomotherapy, the range of median tumor doses was 19.9Gy – 20.15Gy, and median gEUD was 20.1Gy. With Gamma Knife (GK), the range of median tumor doses was 27.8Gy – 33.6Gy and the median gEUD was 28.6Gy. Median brain doses ranged from 0.09Gy – 1.08Gy for Tomotherapy and from 0.24Gy – 2.36Gy for GK. Median brain gEUD was 8.9Gy for Tomotherapy.

Representative DVH with GK and Tomotherapy planning are shown in Figures 3, 4, and 5. An example of the isodose distribution can be seen in Figure 2.

Table 1 demonstrates that GK delivers less radiation doses to the normal brain compared to Tomotherapy for small brain tumors <2 cm while Tomotherapy is superior in selected cases of irregular or multiple brain tumors. Table 2 demonstrates the median tumor and median brain doses for each individual case planned with GK and Tomotherapy for 9 out of 10 case scenarios. GK resulted in superior tumor gEUDs (Table 3). Even though Tomotherapy resulted in more favorable normal brain gEUDs, NTCPs were < 0.5% for both techniques.

Tables 2 and 3 also list the Normalized Tomotherapy Tumor, Brain and gEUD doses respectively. Even with the normalization, Tomotherapy plans resulted in lower Tumor gEUD compared to GK (22.87Gy vs. 27.37Gy respectively). TCP (Figure 6), however, was similar between Gamma Knife and normalized Tomotherapy.

A combination plan was generated using 8 lesions. Tomotherapy was able to treat all eight tumors simultaneously resulting in mean advancement of tumor and brain doses of 20.5Gy and 9.35Gy, respectively. Due to the maximum limit of 50 beams per plan, GK was unable to provide a treatment plan for all eight tumors.

Tomotherapy QA of the 7mm and central irregular lesion was performed (Figure 1). Tomotherapy was able to accurately deliver both the 7mm and the irregular planned doses. Treatment time was 10 minutes for 7mm and 38 minutes for the irregular lesion.

### METHODS AND MATERIALS

An Anthropomorphic Rando Head was used to compare Helical Tomotherapy and GK. Nine brain tumors of various shapes (spherical versus irregular), sizes (diameter range 7-40 mm) and location (center versus off-center in phantom) were used to generate ten plans, both for single and multiple tumors. The prescription dose was 20Gy. The dose was prescribed to the 100% isodose line. TOMO plans were equal to 70% isodose line for the Gamma Knife plans.

Normalized Tomotherapy Tumor, Brain, and gEUD doses were calculated. This was the ratio of Gamma Knife D_95 (dose at 99% of the volume) to Tomotherapy D_95 to ensure that the minimum tumor dose is equivalent with both treatment planning techniques.

Quality Assurance (QA) using Gafchromic Film was performed for two of the Tomotherapy plans (7mm central irregular tumor) to evaluate the accuracy in radiation dose delivery (Figure 1).

The following formulas were used to calculate Generalized Equivalent Uniform Doses for Tumor and Brain (gEUD), Tumor Control Probability (TCP), and Normal Tissue Complication Probability (NTCP):

\[
gEUD(D)=\left(\frac{\sum_i D_i^{\gamma}}{\sum_i D_i}\right)\sqrt{\sum_i D_i}\n
NTCP=\frac{1}{1+\left(D_95/gEUD\right)^\beta}\n\]

Where D=EUD, D=Dose, d_dose = dose to voxel i, N (gEUD)= Number of voxels in the structure of interest, \(\alpha, \gamma\) variable exponent parameter; \(\alpha=10\) for tumors and \(\alpha=5\) for brain; \(\beta=1\); \(\gamma=2\), \(DF=20\).\n
### CONCLUSIONS

- **GK** provides a dosimetric advantage for single small tumors of <2 cm while Tomotherapy may be superior in selected cases of larger, irregular or multiple brain tumors.

- GK resulted in higher TCP values while NTCP was below <0.5% in all cases.

- Clinical studies are needed to correlate these dosimetric findings with patient outcomes.