Dosimetry Comparison of Jaw Tracking Technique (JTT) and Static Jaw Technique (SJT) in Single Isocenter Multiple Metastases (SIMM) Cranial Stereotactic Radiosurgery (SRS) Treatment Planning Using Volumetric Modulated Arc Therapy (VMAT)

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INTRODUCTION

SRS is an increasingly favored treatment option for patients with multiple brain metastases. One major treatment planning approach is using single isocenter to plan for multiple lesions with VMAT technique. Normal brain dose spillage is the primary challenge compare to conventional single isocenter single target treatment. Modern linear accelerator provides JTT to move jaws as close to MLC aperture as possible to reduce dose leakage and transmission through MLC. This study is performed to compare the dosimetric difference for SIMM-SRS with and without JTT.

METHOD

Six patients with total thirty-seven lesions (range:3-11) treating with ten treatment isocenters of SIMM-SRS with SJT were selected and re-planned with JTT. Treatment plans were created with Eclipse treatment planning system (PO 15.6, AAA 15.6, 1mm dose calculation grid size) and were delivered with TrueBeam STX linear accelerator equipped with HDMLC and 6 DOF couch. Optimization criteria and dose normalization method were kept identical for both SJT and JTT. Normal brain dose at V1Gy, V3Gy, V5Gy, V10Gy and V12Gy were compared between two planning techniques. Two-tailed paired t-test was applied in this study for statistical significance comparison.

RESULTS

All the plans with both STT and JTT meet the clinical requirements on conformity index (CI), gradient index (GI) and OAR dose constraints. The average minimum dose to PTV, CI and GI were 97.97±1.89% vs. 97.18±2.22%, 1.34±0.14 vs. 1.31±0.12, and 4.98±1.23 vs. 5.19±1.35 for STJ and JTT, respectively. The average normal brain (brain-PTV) dose of SJT and JTT were V1Gy - 465.95±282.59cc vs. 420.52±42.54cc (p=0.004), V3Gy – 69.33cc±52.36 vs. 64.75±48.78cc (p=0.007), V5Gy – 21.66±15.21cc vs. 21.81±15.63cc (p=0.33), V10Gy – 5.88±3.81cc vs. 6.01±3.97cc (p=0.10) and V12Gy–3.98±2.55cc vs. 4.03±2.61cc (p=0.16).

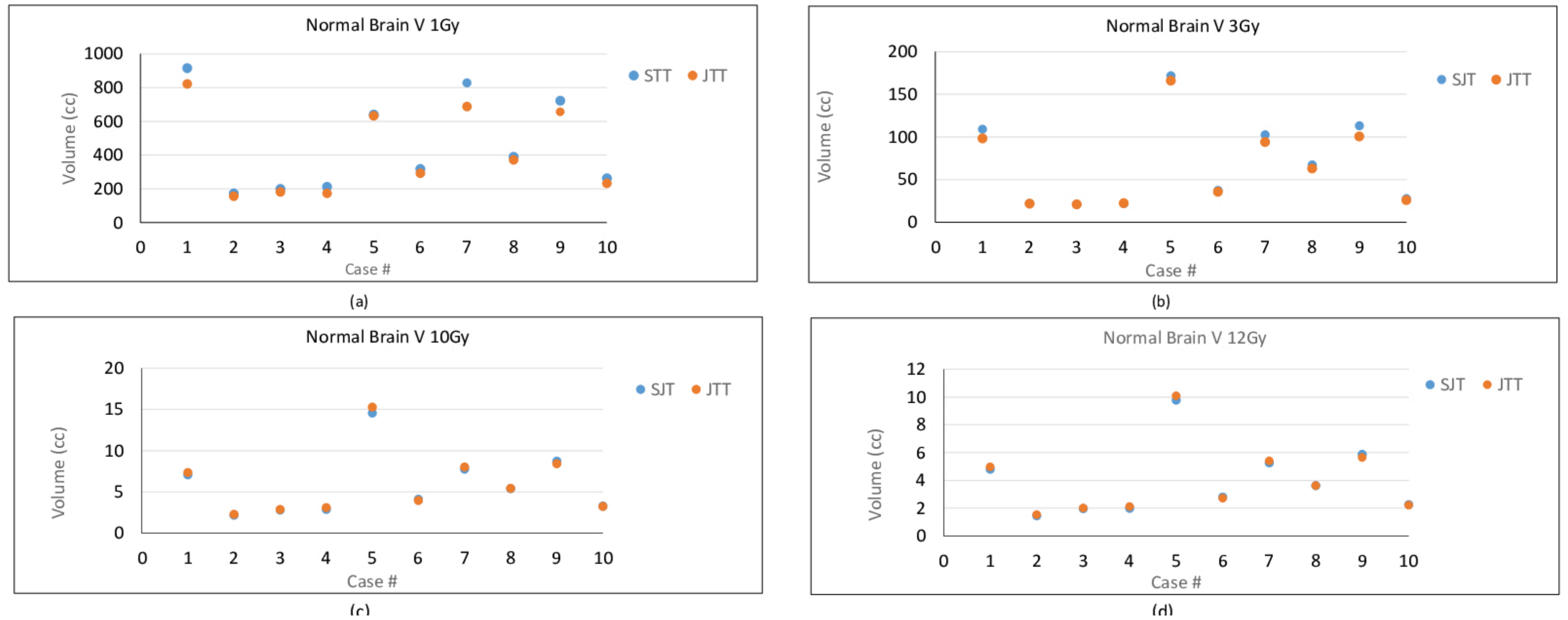

Figure 1 Normal brain dose comparison in difference dose levels between SJT and JTT. (a) V1Gy (b) V3Gy (c) V10Gy (d) V12Gy. JTT shows significant improvement in normal brain V1Gy and V3Gy, and the differences decrease in V10Gy and V12Gy dose level.

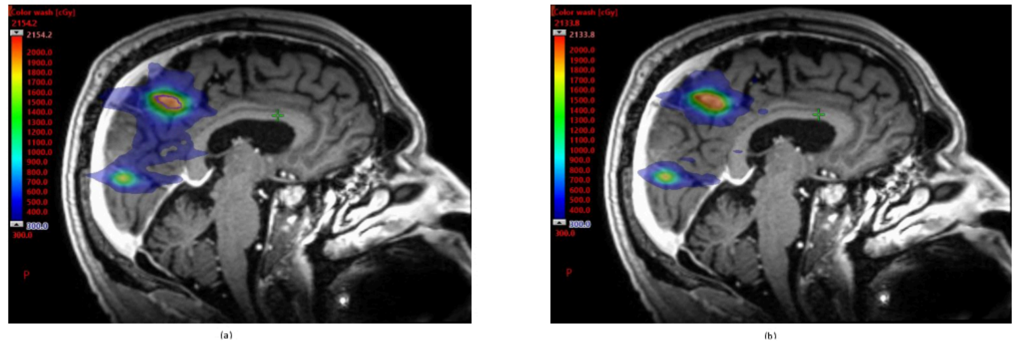

Figure 2 Isodose distribution comparison between (a) SJT and (b) JTT. The color wash dose level was shown in 3Gy dose level. It was clearly shown that the 3Gy dose in between lesions was reduced with JTT.

INNOVATION/IMPACT

The dosimetric benefits of jaw tracking technique in treatment planning have been well-studied for conventional and stereotactic treatments to lung, prostate and head and neck. However, there are limited results in investigating whether this approach can provide similar benefits when planning single isocenter multiple metastases (SIMM) stereotactic radiosurgery (SRS). Our study compared static jaw technique (SJT) and jaw tracking technique (JTT) in planning SIMM-SRS and it showed JTT can significantly reduce normal brain dose in 1-3Gy dose level and maintains the same plan quality in terms of PTV coverage, CI and GI. Although clinical consensus on normal brain dose constraints in cranial radiosurgery is focused on intermediate dose level - V10Gy < 10cc and V12Gy <8cc, reducing low dose spillage in normal brain not only abides the ALARA rule but will also give more freedom in treatment planning when patients return for re-treatment to new lesions in brain.

CONCLUSIONS

JTT can significantly reduce the low dose (1-3Gy) to normal brain while achieving similar treatment plan quality as SJT, so it should be considered to apply for SIMM-SRS planning.

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