

Intra-Fraction Correction for Frameless Stereotactic Treatment to Trigeminal Neuralgia

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INTRODUCTION

Frameless image-guided radiosurgery is an effective approach for treating Trigeminal Neuralgia (IGSRS-TN) ¹⁻⁴.

Intra-fraction motion during a frameless cranial SRS treatment occurs due to mechanical deviation from couch rotation and patient motion despite the immobilization ⁵. Correction for such deviation is critical for IGSRS-TN because of longer treatment session from a much higher prescription dose, multiple arcs at different couch rotations in the plan, and sharper dose gradient from the use of tertiary conical cone.

AIM

In this study, we presented the intra-fraction motion assessment from 19 consecutive IGSRS-TN treatments at our institution, and results were compared with 121 randomly sampled regular intra-cranial SRS treatments where the same immobilization was used.

METHOD

- The study includes 19 consecutive patients treated from 03/2017 onward at our institution
 - Dose prescription is 85 or 90 Gy to isocenter.
 - The plans consist of 9 ~ 12 arcs using a 4 mm conical cone. An example of arc arrangement is shown in figure 1.
 - All patients were immobilized with stereotactic mask and positioned using the ExacTrac system.
- Prior to each arc, a pair of ExacTrac X-ray films was acquired and registered to planning CT at the planned couch angle
 - Any translational deviation per axis > 0.3 mm was corrected and followed by verification with a 2nd pair of ExacTrac films.
- Total elapsed time from the first to last arc, and 3D-deviation from initial pairs of x-ray films at each arc, and films capturing treated position, were collected.
- In comparison, intra-fraction 3D-deviation from 121 randomly sampled cranial SRS treatments with a dose ≤ 18 Gy, same immobilization, but a tolerance of 1.0 mm per axis evaluated once only mid-treatment, was also provided.

RESULTS

The regular intra-cranial SRS treatments were all delivered on the same treatment unit as the IGSRS-TN cases. A pair of ExacTrac X-ray films was acquired once mid-treatment and setup correction applied if deviation per axis is > 1.0 mm. ExacTrac imaging showed a mid-treatment deviation of 0.60 ± 0.27 mm (range 0.27 to 1.34 mm), relative to 0.33 ± 0.18 mm (range 0.18 to 1.23 mm) pre-treatment. Figure 2 shows the 3D deviation before- and mid-treatment, showing the degradation in the setup accuracy at mid-treatment ($p < 0.001$).

Elapsed time of IGSRS-TN treatment is 37.6 ± 9.8 min (range 24.7 to 58.8 min). A total of 197 arcs was delivered of the 19 IGSRS-TN treatments. Overall, correction was applied in 48% of the arcs. The correction decreased 3D-deviation by 0.30 mm in 27% of arcs, and 0.50 mm in 8% of arcs. Figure 3 shows the 3D-deviation from ExacTrac imaging at initial versus treated position prior to beam-on at each planned couch angle, being 0.39 ± 0.20 mm (range 0.05 to 1.06 mm) and 0.22 ± 0.09 mm (range 0.05 to 0.45 mm) respectively.

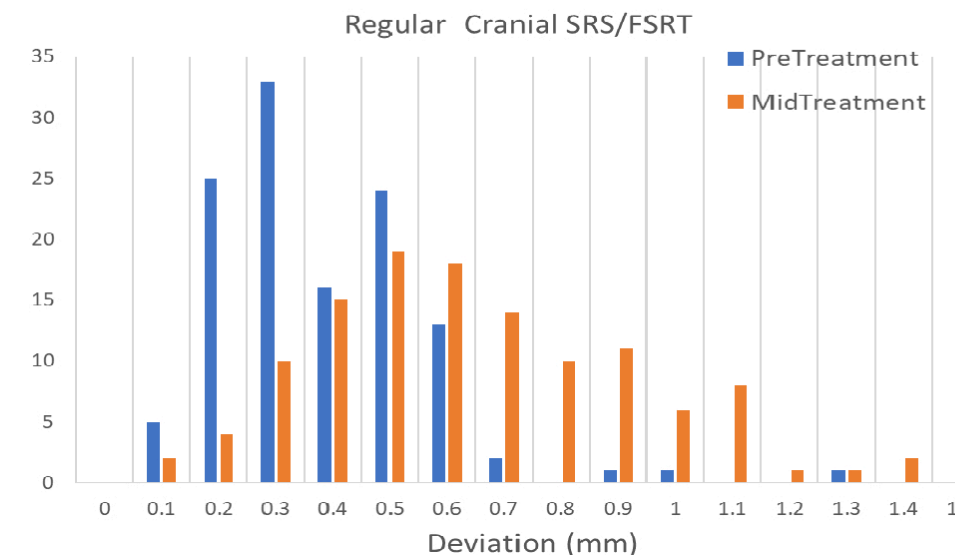


Figure 2. Deviation indicated by ExacTrac imaging before the first field and at mid-treatment for regular cranial SRS treatment (N=121)

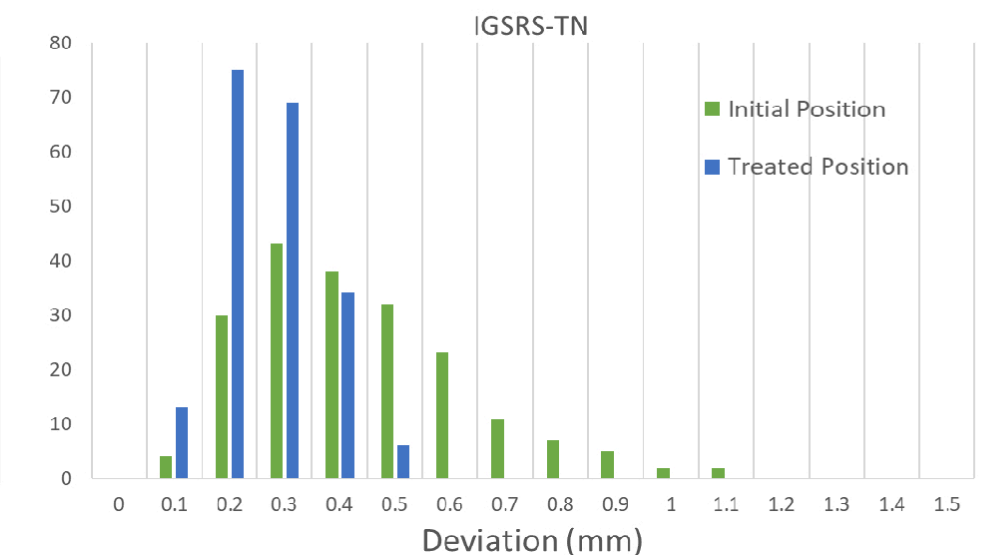


Figure 3. Deviation indicated by ExacTrac X-ray films at initial versus treated position at each arc (N=197) during IGSRS-TN

CONCLUSIONS

Setup accuracy degrades due to intra-fraction motion during frameless cranial SRS treatment.

Frequent intra-fraction correction is effective in maintaining setup accuracy for IGSRS-TN.

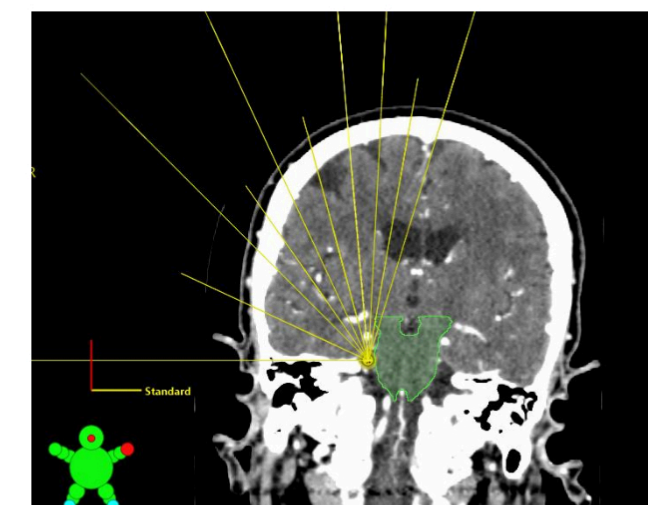


Figure 1. Typical arc arrangement for treating right sided Trigeminal neuralgia, shown on a coronal plane with arcs 10° to 25° apart.

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