Feasibility of Surface Tracking During Framed Stereotactic Radiosurgery

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Introduction

With framed stereotactic radiosurgery (SRS) treatments, there is an assumption that the patient is unable to move within this rigid immobilization. However, it has been reported that this assumption may not be correct.[1] Surface tracking during framed SRS would allow the patient's position to be confirmed throughout the treatment.

Surface tracking during frameless SRS is typically performed with an open-face mask to allow the direct visualization of the patient's face. A region-of-interest (ROI) is often defined as the open area of the mask, avoiding regions that may move (e.g., mouth, nostrils, and eyelids). With framed SRS, this same method is not possible due to areas of the face being obscured by parts of the head frame.

This work investigated the feasibility of accurately tracking patient positioning during framed SRS treatments using Varian Optical Surface Monitoring System (OSMS) with a modified ROI.

Methods

A Brainlab SRS head frame was placed on a Rando head phantom (Figure 1) with three implanted BBs at various locations in the brain (Figure 2). Treatment plans were created with isocenters centered on each BB.

The treatment plans were exported to OSMS. ROIs were defined in OSMS that avoided the posts of the head frame that obscured parts of the face (Figure 3).

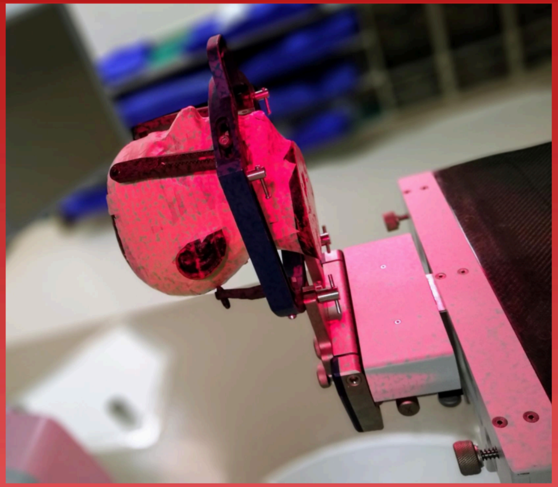

Figure 1:The Rando head phantom setup in the head frame. Note that areas of the face are obscured by both the posts and by the frame itself.

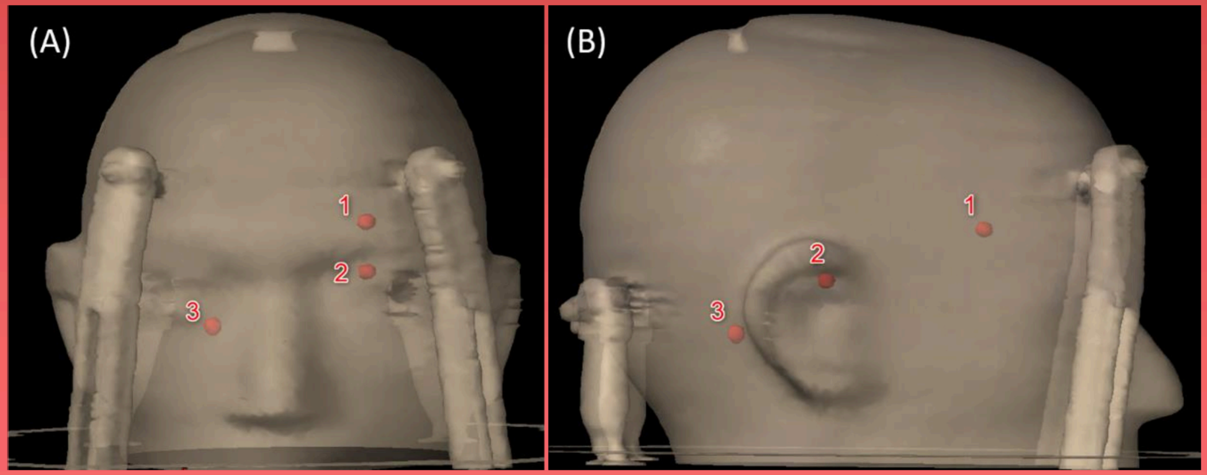

Figure 2: Anterior (A) and lateral (B) views of the locations of the BBs / isocenters within the Rando head phantom that were evaluated as part of this work.

The phantom was initially localized using CBCT with the couch at 0°. A new reference surface was acquired with OSMS after CBCT-guided shifts.

From 0°, the couch was rotated to +/-45° and +/-90°. At each couch angle, the OSMS offsets were recorded and an AP MV image was acquired using a 2x2 cm^2 MLC-defined field. The RIT software Winston-Lutz module was used to determine lateral and longitudinal offsets of the BB from the MV image. The OSMS-indicated offsets were compared to the RIT-determined offsets. This process was repeated for each isocenter

Additionally, the effect of having one of the OSMS cameras blocked during tracking was evaluated (i.e., gantry at +/-45°, depending on couch angle). OSMS offsets before and after a camera was blocked were compared at each couch rotation.

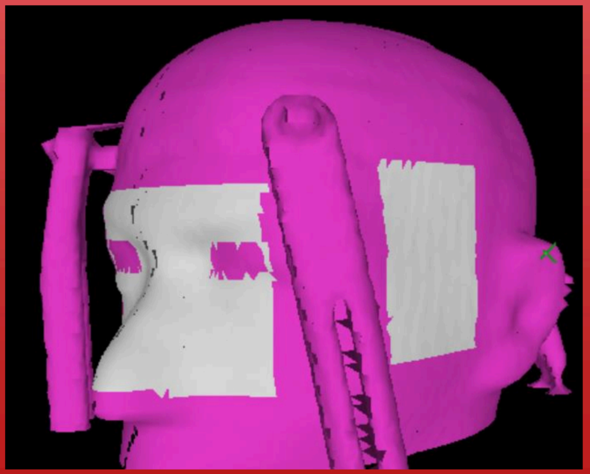

Figure 3:An ROI defined within OSMS that avoids areas that are obscured by parts of the head frame.

Results

The OSMS-indicated offsets were all within 0.76mm (total displacement) of the RIT-determined offsets of the implanted BBs for all three isocenters.

Vertical offsets were not evaluated radiographically due to the lack of imager clearance with the couch rotated, but the largest OSMS-indicated vertical offset was +/-0.1mm.

The largest change in OSMS-indicated magnitude offset (i.e., the vector sum of the translations) when a camera was blocked was 0.3mm and the largest change in any rotational offset was 0.3°.

Conclusions

OSMS demonstrated sub-millimeter agreement with Winston-Lutz analysis of implanted BBs at three locations within a head phantom. This accuracy supports the feasibility of tracking framed SRS patients with this system during treatment.

References

[1]Jursinic P. Comparison of Head Immobilization with a Metal Frame and Two Different Models of Face Masks. J Cancer Cure. 2018;1(1):36-40.