

# Surface Guided Imaging and Facial Motion with Open Face Masks

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## INTRODUCTION

Open face style masks have been researched as an immobilization method for stereotactic radiosurgery and head and neck cancers. Exposure of the patient's facial surface allows for clinical implementation of Surface Guided Radiation Therapy (SGRT) for patient positioning at set up and for motion management during treatment delivery. SGRT is a non-ionizing technique with sub-millimeter accuracies comparable to orthogonal imaging. This study addresses potential errors the system produces when using SGRT with open face style masks.

## AIM

To quantify falsely generated positional shift corrections from the SGRT system (Catalyst HD, CRAD) due to changes in facial expression for patients immobilized with open face style masks.

## METHOD

Volunteers (n=10) were immobilized in modified face style masks. Masks were spray painted matte black to maximize contrast between the skin and mask with the SGRT system. Four discrete SGRT regions of interest (ROI) were evaluated for each volunteer based on the exposed facial surface. Each SGRT ROI represented different mask openings readily accessible to radiation oncology clinics (Fig. 1). Peak isocenter shifts were recorded by the SGRT system in the translational and angular directions as participants opened their eyes and changed facial expressions (Fig. 2), without intentionally rotating their head. A relaxed facial expression with eyes closed was used as a baseline between experiments and the total isocenter vector shift was calculated (Fig. 5). This was performed in both standard and SRS specific resolutions with the CRAD Catalyst HD system.

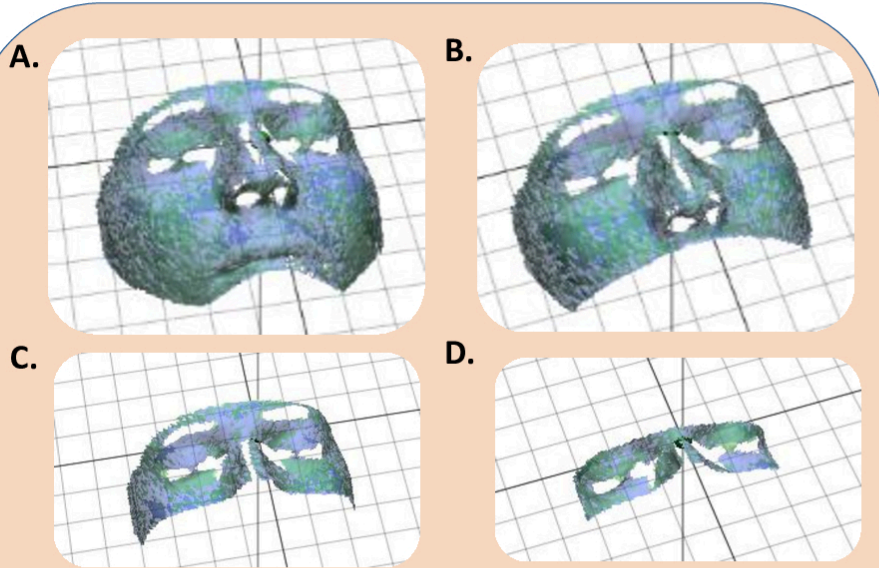


Figure 1. Four discrete SGRT ROIs were evaluated ranging from exposure of the entire facial area including the eyebrows, mouth and cheeks (A.) to only the eyes and bridge of nose (D.)

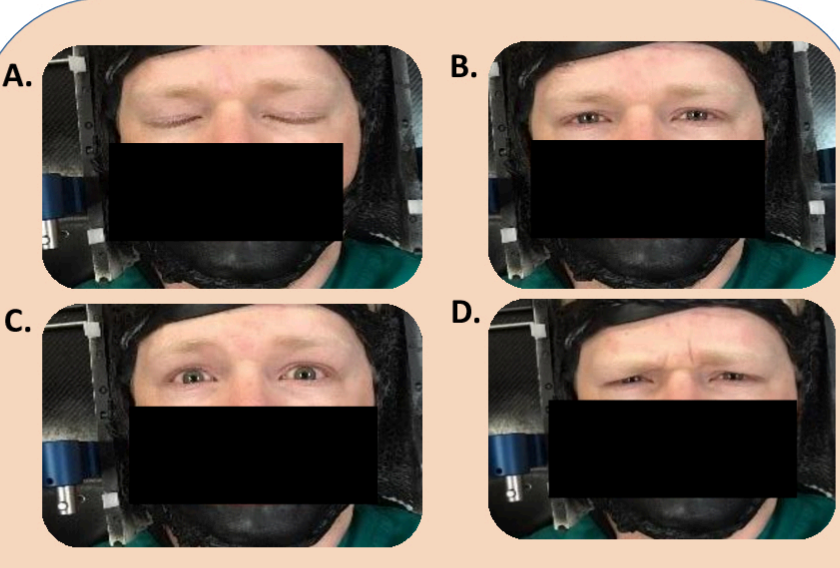


Figure 2. Changes in facial expression by one volunteer demonstrates (A.) eyes closed, (B.) eyes open, and changes in facial expression. Volunteers were asked to simulate an emotional response such as (C.) fear and (D.) annoyed.

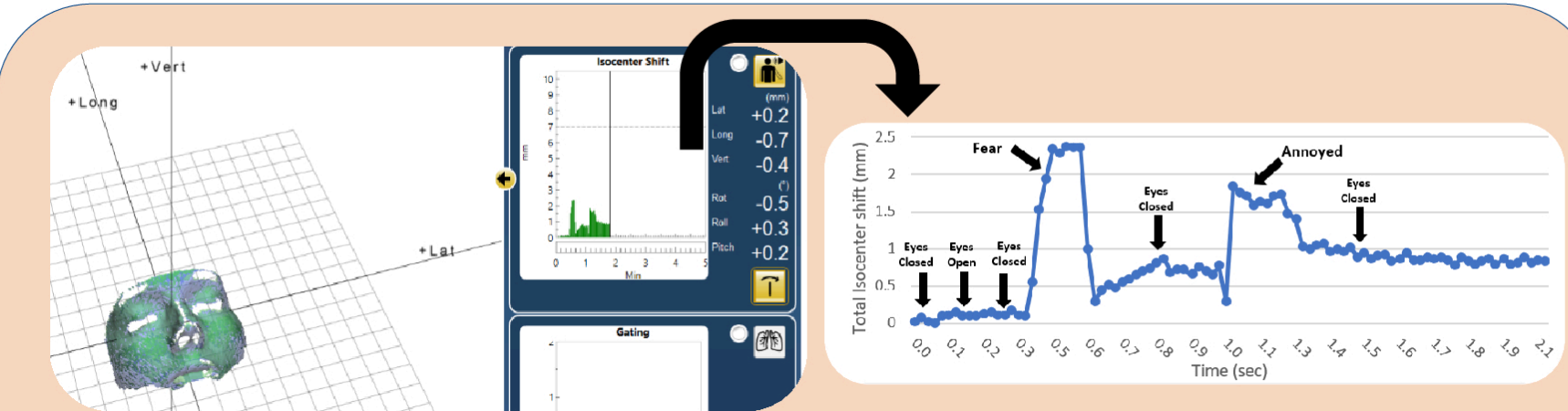


Figure 3. (A.) Example of clinical SGRT display (CRAD Catalyst HD) during experiment shows ROI monitored and isocenter shift. (B.) Close up of Real time SGRT data demonstrates isocenter shift for the experiment as the volunteer opens and closes their eyes and changes facial expression. The isocenter shift remains below 1mm for eyes open and closed and exceeds 2mm when changing facial expression.

## RESULTS

The average isocenter shift observed due to changes in facial expressions ranged from 1.42mm for SRS specific to 1.65mm for standard resolutions for all ROIs analyzed. Positional corrections were amplified by the SGRT system when smaller ROIs were monitored. Shifts generated in SRS resolution had less spread in values when compared to standard resolution as participants changed facial expressions and opened their eyes.

## CONCLUSIONS

False positional corrections can be generated by a SGRT system due to changing facial expressions. These errors are further influenced by size of ROI and camera resolution. Clinics using SGRT for motion management for patient's immobilized in open face masks should maximize topographic anatomical information, such as the nose or mouth, of the exposed facial surface to reduce tracking errors. These false corrections should be taken into consideration in the treatment planning and delivery process.

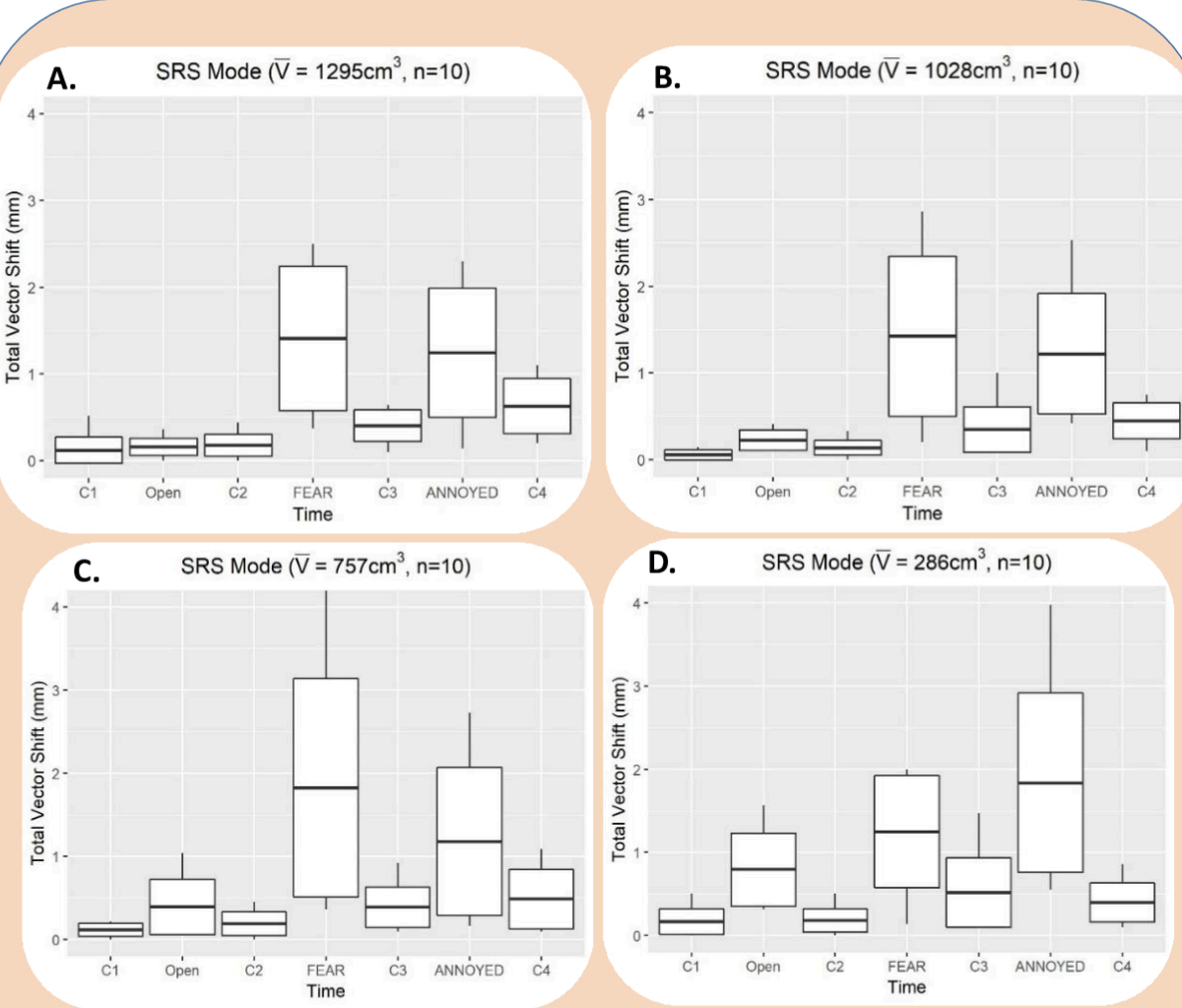


Figure 5. Peak isocenter shifts recorded in SRS resolution for each ROI for each activity. The mean ( $\mu$ ), one standard deviation from the mean ( $\mu \pm \sigma$ ), and the maximum/minimum range of the data is represented by the center line in the box, the ends of the box and the lines extending off the box. Eyes closed and open on average remain below 1mm while changes in facial expression (Fear and Annoyed) have on average an isocenter shift >1mm.