Performance of Two Open-Faced Thermoplastic Masks for SRS Immobilization

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Introduction

- Open-faced thermoplastic masks are used for immobilization in stereotactic radiosurgery (**SRS**) to achieve submillimeter treatment accuracy.
- Thermoplastic masks have construction differences that may impact immobilization.
- Masks investigated were the dual-layer Orfit mask and the single-layer Ring the Bell (**RTB**) Medical mask.
- RTB has practical advantages over Orfit, including lower cost and faster shipping times.

Purpose: Compare the performance of two commercially available mask designs using phantom-based testing and a prospective clinical evaluation.

Methods

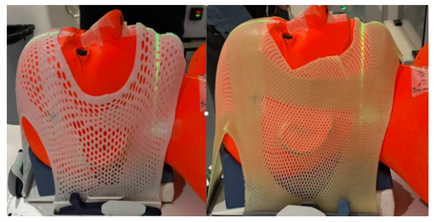

Figure 1. *Ring the Bell (CO3-24VR-O, Left) and Orfit (33759/16MI/12MI+ N, Right) masks.*

1. **Mask Shrinkage Evaluation**
   - Masks molded to an anthropomorphic phantom following vendor specifications.
   - Shrinkage quantified by measuring inter-point distances post-fabrication + weekly intervals.

2. **Phantom Force Study**
   - 5-60 N forces applied to anthropomorphic phantom at 11 locations (***Figure 2***) to simulate patient motion.
   - Translational, rotational displacements measured with Varian Identify surface guidance system.

3. **Prospective Patient Study**
   - 20 SRS patients accrued (10 Orfit/10 RTB).
   - Performance was assessed using:
     - Number of excess CBCTs acquired.
     - Setup accuracy and intrafraction motion based on CBCT shift values.
   - Equivalence between mask systems assessed using two one-sided tests (**TOST**).

Results

- Time dependent shrinkage (***Figure 3***) between mask systems was similar, with mean changes from baseline landmark distances on order of ~1 mm week-to-week.

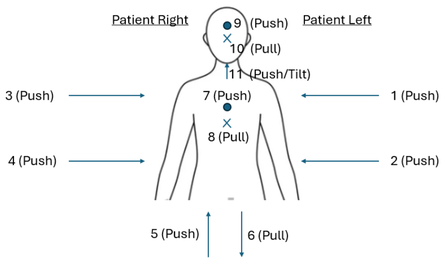

Figure 2. *Application positions of 5-60 N forces on anthropomorphic phantom.*

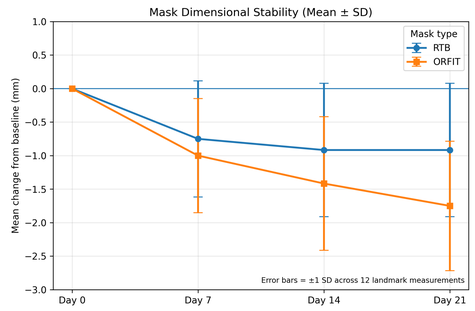

Figure 3. *Time dependent shrinkage characteristics of RTB and Orfit masks.*

- Force-motion responses were similar in all six directions for both masks over a range of forces. Compiled results of all rotations and translations (***Figure 4***) demonstrate similar distributions for both masks.

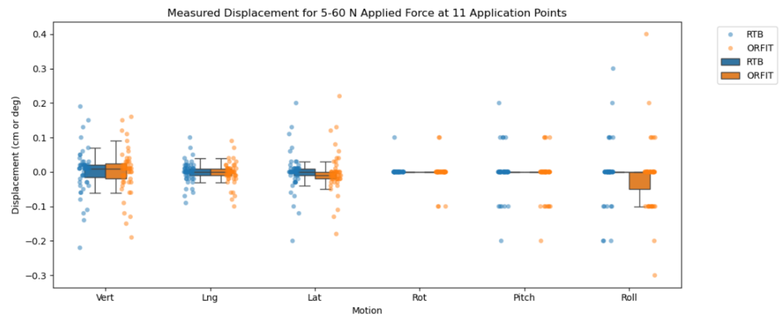

Figure 4. *Measured displacement under force for Orfit and RTB masks.*

- Patient study results indicate that there were no statistically significant differences in intrafraction motion (***Figure 5, Top***).
- There were also no significant differences in translational offset during setup, however equivalence could not be confirmed for rotational setup values.

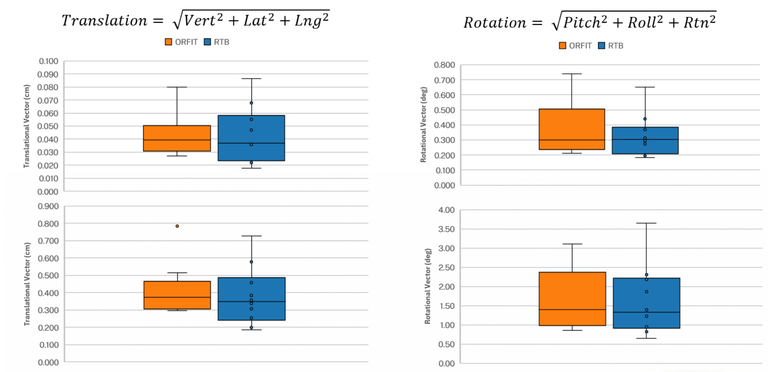

Figure 5. *Translational and rotational vectors acquired from CBCT shift values for intrafraction motion (Top) and setup accuracy (Bottom).*

Discussion

- Similar immobilization performance noted across all tested force levels.
  - This represents a range higher than forces experienced during clinical treatment, which are approximately 4-8 N.[1]
- Although intrafraction motion equivalence was confirmed, rotational setup accuracy equivalence could not be confirmed through TOST.
  - Limitations - small cohort size, one challenging patient setup in RTB cohort.
  - With increased training, experience, setup quality expected to be similar.
- Surface guidance accuracy was maintained with change in facial cutout between masks.

Conclusion

- The RTB mask system:
  - Demonstrated shrinkage and immobilization characteristics comparable to the Orfit system.
  - Was successfully integrated into the clinical surface-guided SRS workflow.
  - Offers benefit of lower price point, significantly faster shipping times.

Despite construction differences, the RTB system demonstrated comparable performance to the Orfit system. This supports the feasibility of the RTB mask as an alternative immobilization solution for open-faced intracranial SRS within a surface-guided radiotherapy workflow.

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More Info

Please scan to read the full abstract

References

1. You W, Chen C, Chu H et al Quantifying thermoplastic mask quality for precision radiotherapy in head and neck cancer: A 3D stress test and 6D-axis error analysis. Medicine (Baltimore). 2024;103(44):e40365.