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Clinical application of the Accuform Shim on the Solstice SRS System for SRS treatment delivery

Introduction

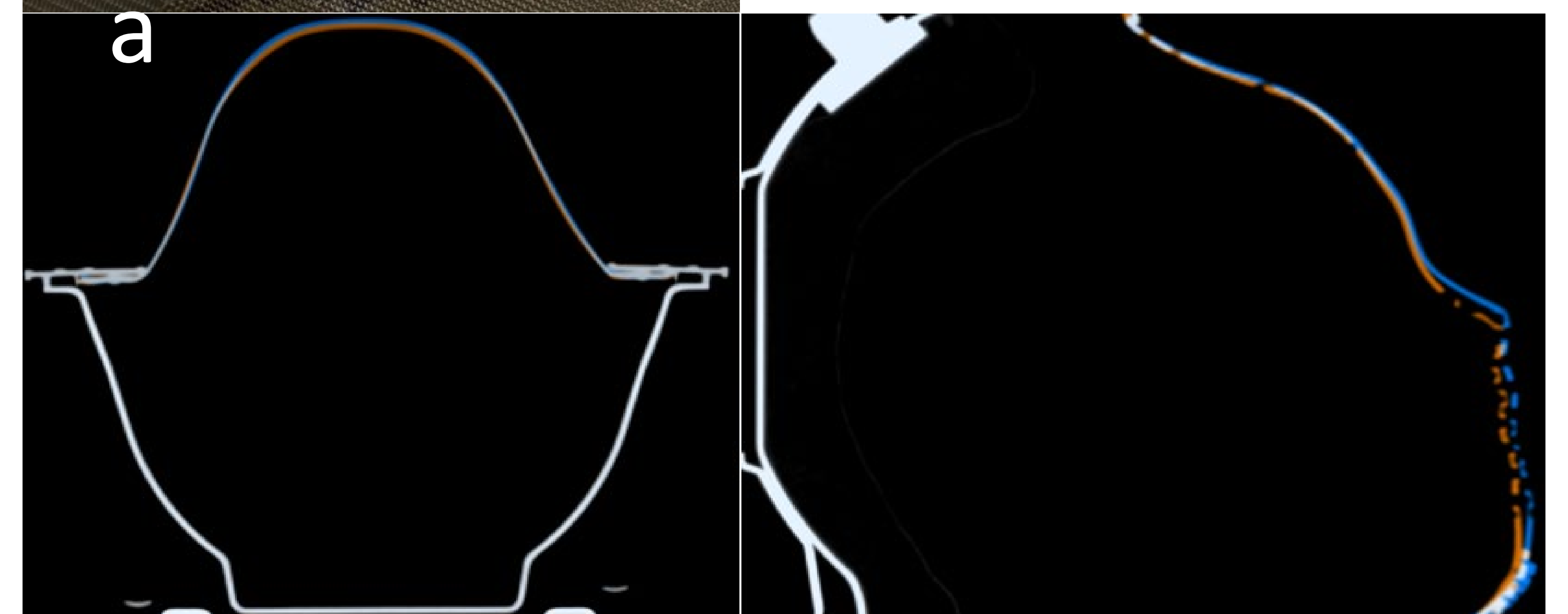
The Solstice SRS system has proven to achieve sub-millimeter positioning accuracy for SRS brain metastases treatment. A rigid mask plays a crucial role in keeping the patient firmly fixated but it shouldn't be too tight to cause any discomfort. All patients receiving SRS brain metastases treatment are prescribed dexamethasone and some patients may experience swollen face as side effect. Such effect combined with possible shrinkage of the mask may lead to extreme discomfort for some patients especially during a prolonged non-coplanar treatment delivery. Recently, CIVCO Radiotherapy has introduced the AccuForm Shim, which aims to increase patient's comfort. The purpose of this study is to investigate the effect of the shim and it's possible impact on the treatment accuracy.

Method

The shim is a thin polyolefin foam sheet measuring 23 x 9 x 0.15cm. It is placed above the accuform cushion during the CT-scan (Fig. 1a) and then removed during radiation treatment to offset any possible mask shrinkage or facial swelling of the patient. First, the immobility and comfort of the mask were evaluated on 5 volunteers. 2 masks were made with ("shim-mask") and without the shim for each volunteer. After the mask hardened for days, feedback of the volunteers for both mask was collected. These masks were also scanned and registered to quantify the differences. We then applied this technique to 10 SRS patients, 2 masks were made prior to CT-scan. The patients were subsequently scanned with the shim in combination with the shim-mask for treatment planning. At the day of the treatment, both masks were tested on the patients to determine the mobility and comfort of the patient and later the patients were treated with the shim-mask. An extra CBCT were acquired after the treatment to determine the overall setup accuracy of the treatment.



Figure 1a: The shim is placed above the AccuForm head cushion during the CT-scan and it is subsequently removed during radiotherapy treatment. 1b: Differences between 2 masks made with (blue) and without (orange) the shim in transversal (left) and sagittal (right) planes. The differences vary between 1 to 4mm and are more prominent in the nose/cheek's area.



Results

4 out of the 5 volunteers reported extra comfort with the "shim-mask" meanwhile 1 reported no difference. From the 10 SRS patients, the response for overall stability of both masks was comparable, but 80% of the patients reported more comfort with the shim-mask and 60% felt more comfortable during the placement of the mask. The RTT also reported that the shim-mask was easier to apply on the patients in 60% of the cases while the rest reported no difference. Scan of both masks shows difference varies between 1 to 4mm and are mostly in the nose/cheek's area. The setup accuracy in all 6 different directions are shown in table 1. For translational directions, the mean was <0.1mm while the STD was <0.5mm. The largest shift was 1mm, which was detected in the vertical direction in 2 cases. For rotational directions, the mean, STD and maximum were <1°.

Table 1: Setup accuracy for the 10 SRS patients treated using the Solstice system in combination with the "shim-mask"

	Lateral, mm	Longitudinal, mm	Vertical, mm	Pitch, °	Roll, °	Yaw, °
Mean	0.03	0.05	0.07	-0.01	0.10	0.16
Standard Deviation	0.32	0.25	0.48	0.22	0.18	0.37
Max	0.7	0.5	1.0	0.5	0.3	0.9

Conclusion

To ensure the sub-millimeter accuracy of SRS treatment delivery, every change in the process must be investigated thoroughly. In this study, we show that by adding the shim during the process of mask-making can provide extra comfort to the patient during treatment delivery without compromising setup accuracy.