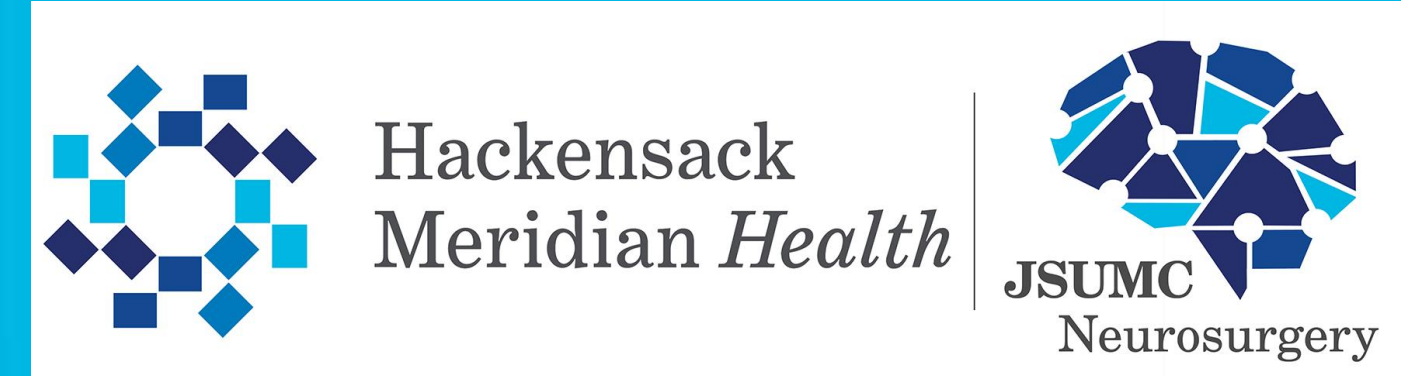# Gyroscopic Radiosurgery Patient Alignment Comparison: Shim Head and Shoulder Mask Versus Standard Head Mask

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Background & Objectives

- The ZAP-X is the newest cranial stereotactic radiosurgery (SRS) platform.
- Accurate positioning and immobilization are essential due to the high doses and precision required.
- Traditionally, standard of care for immobilizing patients undergoing linear accelerator-based SRS involves a full-head thermoplastic mask [1].
- In this study, patient alignment accuracy is evaluated for a shim head and shoulder mask compared to the standard head mask in ZAP-X SRS for the treatment of malignant and benign lesions.

Methods

- Prospectively, 60 patients were evaluated consisting of 30 standard Fibreplast and Nanor head mask patients and 30 shim Efficast head and shoulder mask patients [2-3].
- Two shims were employed during head and shoulder mask creation.
- Alignment deviation > 2 mm in any direction and 1.5° in any rotation axis required a readjustment of the patient positioning.
- ZAP-X patient alignment accuracy was accessed through system log files obtained from the treatment console.
- Mask comfort was evaluated for 30 shim head and shoulder mask patients and 30 standard head mask patients using a Likert scale from 1-5 (1 = "very poor", 5 = "very good").
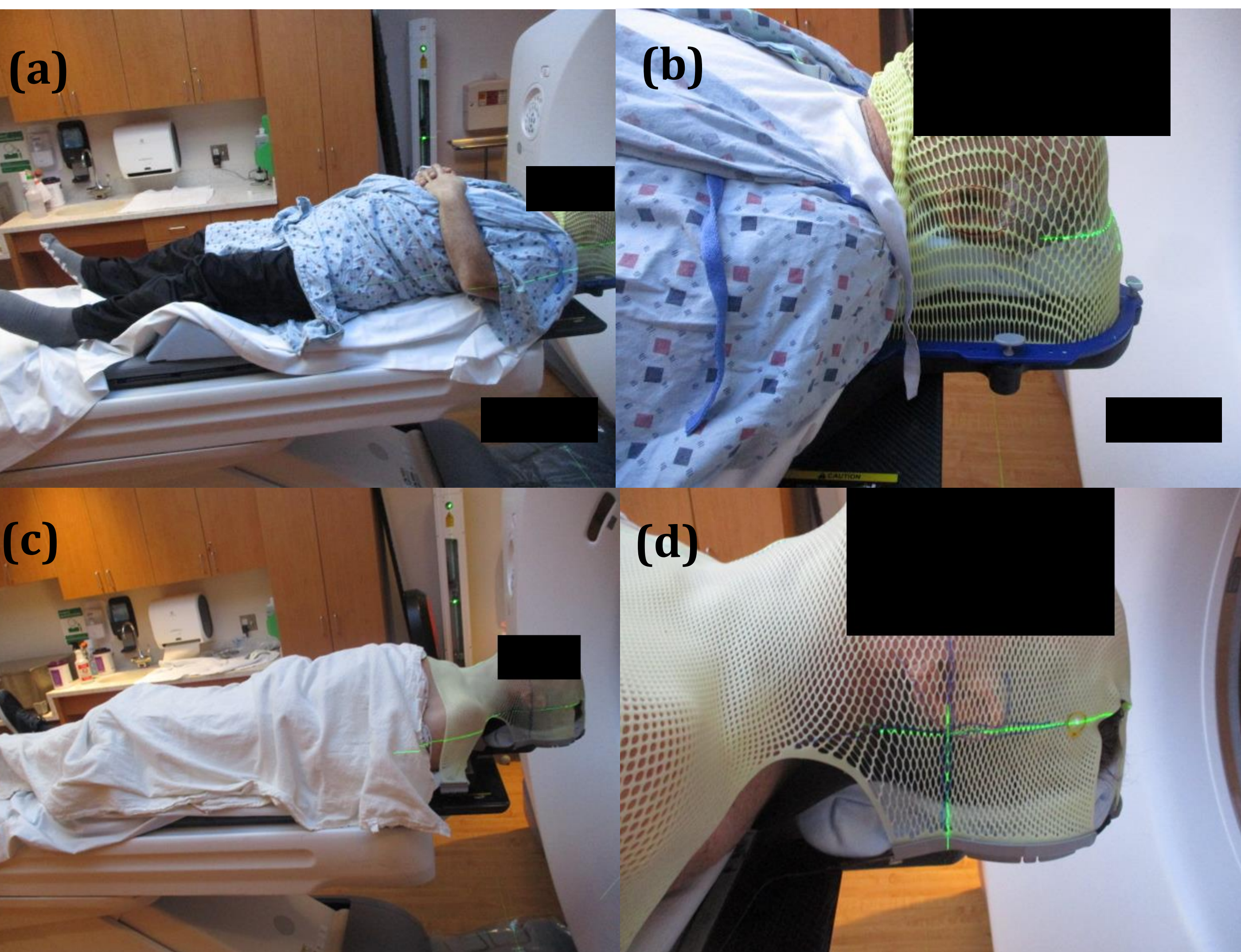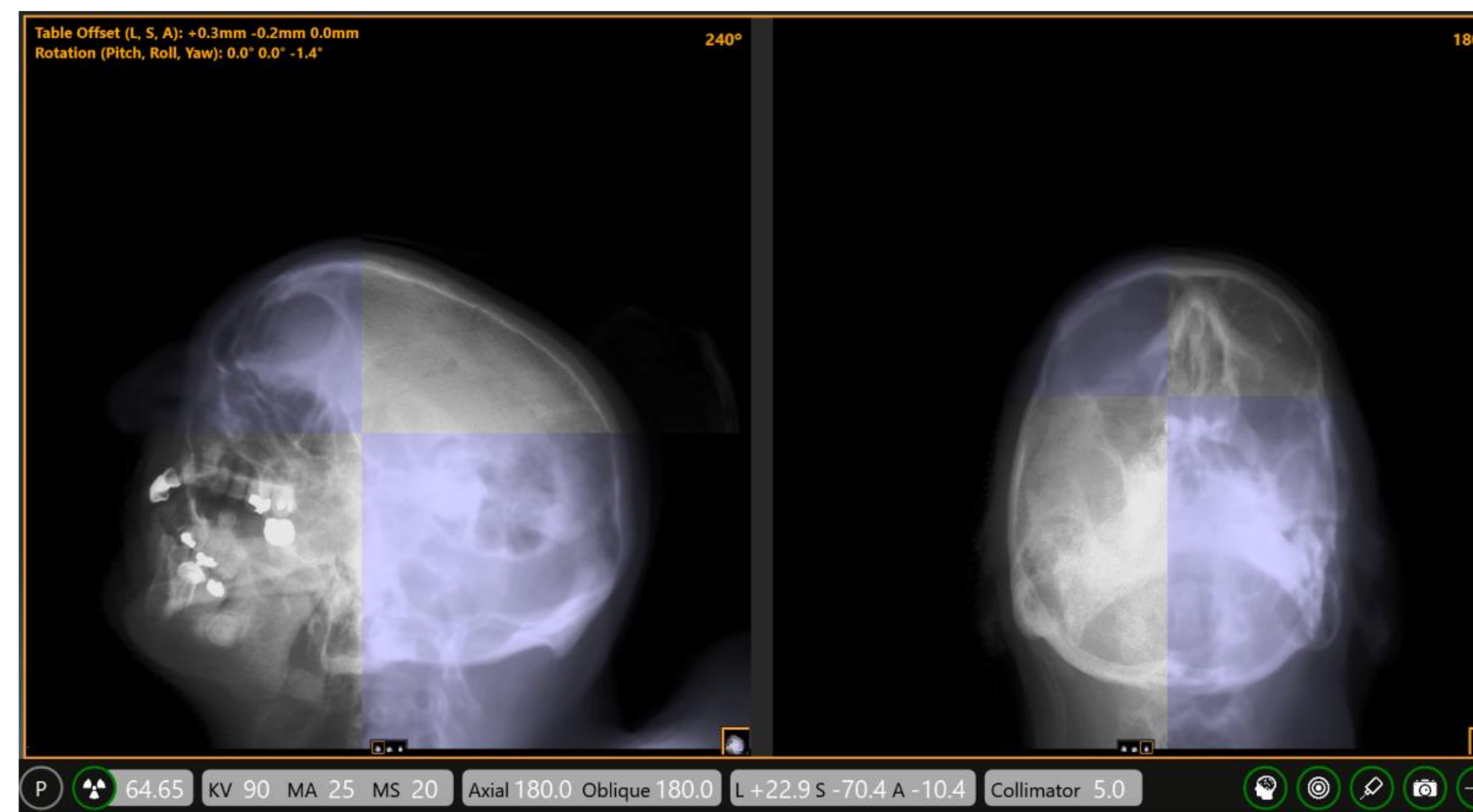

Figure 1. (a) and (b) standard Fibreplast and Nanor head mask (c) and (d) Efficast head and shoulder mask.

	Pitch	Roll	Yaw
Rotation (+ / -)	+	+	+
How to reposition patient	Move chin down toward chest	Roll head toward patient left	Move top of head toward patient right

Figure 2. The patient alignment process involves a sequence of 3D alignment steps using non-coaxial kV x-ray images from multiple gantry angles. The images are co-registered to digitally reconstructed radiographs generated from the initial CT used in the treatment plan. The initial auto-alignment before treatment was approved by a radiation oncologist. Alignment deviation of more than 2 mm in any direction and 1.5° in any rotation axis would require a readjustment of the patient positioning and repeating auto-alignment and radiation oncologist approval. If > 5 gantry locations with MV dosimetry deviation of more than 10% exist, physicist investigation is required. Treatment would be stopped for further investigation with the vendor if > 10 gantry locations with MV dosimetry deviation of more than 10% exist.

Results

Table I. Mask parameter results for Fibreplast and Nanor head mask and Efficast head and shoulder mask. Two-sample t test with Welch correction was performed for mask comfort comparison. Two-sample Wilcoxon rank-sum (Mann-Whitney) test was performed for readjustments, setup time, and offset comparisons.

Parameter	Mask	Average	Median†	Range	P‡
Comfort	Fibreplast (n = 30)	4.1 ± 1.0	4 (3.5, 5)	2 − 5	0.0345
	Efficast (n = 30)	4.7 ± 0.7	5 (4.5, 5)	3 − 5	
Readjustments	Fibreplast (n = 30)	5 ± 4	4 (1, 7)	0 − 13	0.0194
	Efficast (n = 30)	2 ± 3	1 (0, 4)	0 − 12	
Setup time (min)	Fibreplast (n = 30)	17 ± 11	15 (7, 24)	1 − 47	< 0.001
	Efficast (n = 30)	10 ± 10	4 (2, 11)	1 − 51	
x-offset (mm)	Fibreplast (n = 30)	0.0 ± 0.4	0 (-0.15, 0.14)	-3.94 − 4.31	0.406
	Efficast (n = 30)	0.0 ± 0.3	0 (-0.12, 0.11)	-2.76 − 2.48	
y-offset (mm)	Fibreplast (n = 30)	0.0 ± 0.3	0 (-0.11, 0.11)	-6.57 − 2.28	0.0014
	Efficast (n = 30)	0.0 ± 0.3	0 (-0.08, 0.11)	-3.06 − 3.61	
z-offset (mm)	Fibreplast (n = 30)	0.0 ± 0.3	0 (-0.12, 0.14)	-3.12 − 6.53	0.453
	Efficast (n = 30)	0.0 ± 0.3	0 (-0.11, 0.12)	-3.01 − 2.22	
Pitch-offset (°)	Fibreplast (n = 30)	0.1 ± 0.8	0.15 (-0.61, 0.79)	-2.79 − 2.04	< 0.001
	Efficast (n = 30)	0.0 ± 0.5	-0.09 (-0.46, 0.72)	-2.64 − 2.01	
Roll-offset (°)	Fibreplast (n = 30)	-0.2 ± 0.8	-0.20 (-0.87, 0.36)	-3.05 − 2.40	< 0.001
	Efficast (n = 30)	0.0 ± 0.6	-0.16 (-0.72, 0.26)	-1.87 − 1.68	
Yaw-offset (°)	Fibreplast (n = 30)	0.0 ± 0.8	-0.22 (-0.62, 0.62)	-2.18 − 2.71	< 0.001
	Efficast (n = 30)	0.0 ± 0.8	-0.12 (-0.52, 0.50)	-2.11 − 2.08	

†Median (interquartile range: p25, p75)
‡$P < 0.05$ significance

- Mask comfort improved significantly (P = 0.0345).
- The shim mask significantly reduced y-offset (P = 0.0014), pitch-offset (P < 0.001), roll-offset (P < 0.001), yaw-offset (P < 0.001), number of readjustments (P = 0.0294), and setup time (P = 0.0017).
- There was no significant difference in x-offset (P = 0.406) and z-offset (P = 0.453).

Conclusion

- The shim head and shoulder mask improves immobilization in ZAP-X treatments, leading to greater targeting accuracy and reduced treatment times.

References

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