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FRAMELESS FIXATION SYSTEM FOR LINAC BASED INTRACRANIAL RADIOSURGERY HAS SUPERIOR POSITIONING ACCURACY COMPARED WITH THE ESTABLISHED INVASIVE FRAME SYSTEM

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Purpose:

The invasive frame is the golden standard for optimal fixation in linac- based stereotactic radiosurgery. This system is well established but has some disadvantages such as patient discomfort and lack of logistical flexibility. With the introduction of the frameless mask system in combination with a robotic table and the ExacTrac (ET) verification system (Brainlab), the question was posed as to whether this new approach could be a reliable alternative for the invasive frame, in particular with respect to the positioning accuracy. To answer this question we assessed the positioning accuracy of the frameless and invasive frame system.

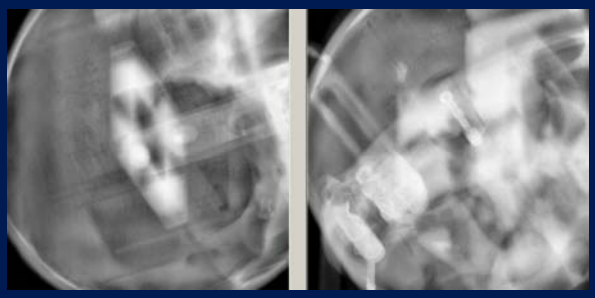

Fig. 1: X-ray images of the radiosurgery head phantom positioned with the invasive frame

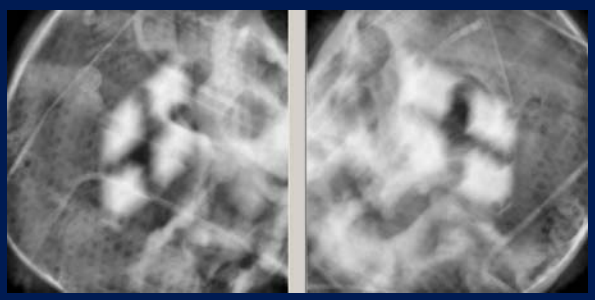

Fig. 2: X-ray images of the radiosurgery head phantom positioned with the frameless system

Methods and materials:

A radiosurgery head phantom was modified with a 12 mm^3 air cavity, designated as PTV, which is visible in kV-imaging. A CT-scan was used to delineate the PTV in iPlan-Image 3.0 (BrainLab). A treatment plan consisting of 2 orthogonal beams (6 MV, 18mm^2, aligned to the PTV) was created in Brainscan 5.31 and the treatment was delivered on a Brainlab Novalis linac. The positioning of the invasive head frame was performed by aligning the target positioner overlaying the laser lines. Positioning of the frameless mask system was executed with the ET 6D Infrared (IR)/X-ray system using the bony anatomy of the head phantom. ET (kV) images were used to validate the positioning accuracy of the invasive frame-based and the frameless radiosurgery. To assess the positioning accuracy of the invasive frame with the ET system a carbon plate with infrared markers was mounted on the frame. To estimate the positioning accuracy in different positions, the orthogonal X-ray images were obtained at different table-angles (i.e. 0-90°, 0-270°), and correction shifts were carried out from the fusion of these images to corresponding reference DRR's. For the frameless mask system, these shifts were done under guidance of the IR system. Shifts calculated for the invasive head frame are defined as unadjusted deviations since these deviation are not adjusted in daily practice.

Fig. 3: A radiosurgery head phantom positioned with the invasive head frame. Ready for ExacTrac usage.

Fig. 4: A radiosurgery head phantom positioned with the frameless system. Ready for ExacTrac usage.

Results:

The analysis of the ET-data shows that positioning accuracy of the frameless system was significantly better compared with the invasive system.

	Translation(mm)			Rotation (°)		
	Vert.	Long.	Lat.	Vert.	Long.	Lat.
Frameless system mean	0.0	0.1	0.1	0.1	0.0	-0.1
SD	0.2	0.3	0.2	0.3	0.2	0.3
Invasive system mean	2.0	-1.0	-0.5	-0.2	0.0	-1.1
SD	0.3	0.6	0.5	0.3	0.3	0.3

Table 1: ExacTrac –data Frameless system vs. Invasive system

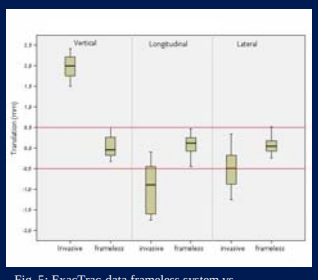

Fig. 5: ExacTrac-data frameless system vs. invasive system (translations)

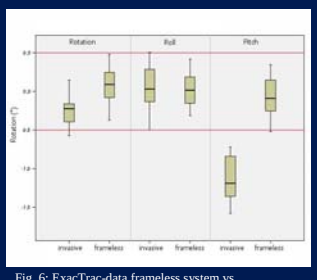

Fig. 6: ExacTrac-data frameless system vs. invasive system (rotations)

Conclusions:

•The frameless fixation system (BrainLab) for radiosurgery has a superior positioning accuracy compared with the invasive frame.
•Considering this outstanding positioning accuracy, the patient comfort and the logistical flexibility, the frameless system in combination with the robotic table and the ExacTrac-system, should be the first choice for head fixation in linac-based radiosurgery.

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