Accuracy of a patient positioning system for image-guided frameless stereotactic IMRT treatments

O.S. Dohm[1], A. Hönes[2], F. Paulsen[3], M. Alber[1]

[1]Forschungssektion Biomedizinische Physik, Universitätsklinikum Tübingen, Germany
[2]Abteilung Medizinische Physik, Universitätsklinikum Tübingen, Germany
[3]Abteilung Strahlentherapie, Universitätsklinikum Tübingen, Germany

Purpose

In our clinic we use frameless IMRT stereotactic treatments for brain metastases (Figure 1). The scotch cast masks used for such treatments have a reproducibility of 3 mm and 3 degrees for translational and rotational displacements. While translational displacements can be corrected easily using the standard table an additional device is needed to correct rotational errors. In this work we present data showing the capabilities of an in-house constructed device for such corrections.

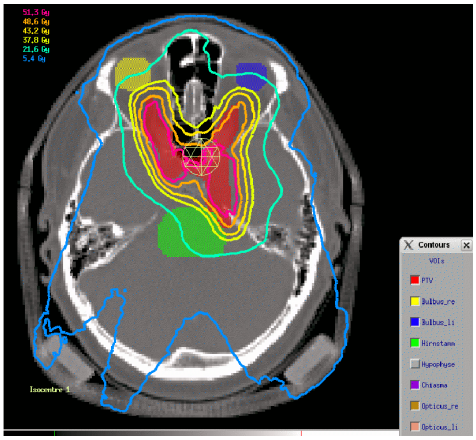

Figure 1: Axial slice containing the target volume and the organs at risk. The colored lines give the dose distribution.

Materials/Methods

To mount the scotch cast masks on the ELEKTA iCouch (ELEKTA, Crawley UK) table a device was constructed which allowed corrections around the patients longitudinal and lateral axis from ± 3 degrees (henceforth referred to as "mask-mount", Figure 2). After positioning the patient by the room lasers a CT was made using the ELEKTA XVI system. This CT is matched to the planning CT and a physician evaluates whether a correction is needed with regard to the safety margin. In case of a correction another CT is made to verify the adjustments.
To evaluate the data without correction the first CT was used, for the data with correction we used the second

Figure 2: The adjustable mask-mount system. One can see the black knobs to adjust the angles.

Results

Table 1 shows the evaluation of two selected patients over their complete treatment without corrections, while table 2 shows the evaluation including all corrections. It can be seen that the use of a daily online-setup protocol primarily reduces the standard deviation of the errors, while the mean values are of comparable values for online-correction and without correction. With the mask-mount it was possible to reduce the standard error of the rotations to 0.4-0.7 degrees.
For clinical practice it is also noteworthy that the whole treatment of a patient, including positioning, correction and IMRT treatment, lasts only about 15 minutes for fractionated and about 1 hour for single fraction treatments.

patient		l-r [cm]	c-c [cm]	a-p [cm]	pitch [deg.]	roll [deg.]	yaw [deg.]
1	mean	-0.05	-0.04	-0.04	-0.53	-0.27	0.01
	st. dev.	0.10	0.09	0.05	0.91	1.05	0.51
2	mean	0.02	0.03	-0.03	-0.11	0.11	-0.15
	st. dev.	0.07	0.07	0.05	0.56	0.70	0.23

Table 1: Translational and rotational deviations for the two patients if no angular correction would have been applied.

patient		l-r [cm]	c-c [cm]	a-p [cm]	pitch [deg.]	roll [deg.]	yaw [deg.]
1	mean	0.00	-0.01	-0.02	-0.34	-0.22	-0.05
	st. dev.	0.05	0.05	0.05	0.67	0.66	0.45
2	mean	0.01	0.02	-0.02	0.06	0.10	-0.08
	st. dev.	0.06	0.06	0.06	0.43	0.45	0.24

Table 2: Deviations in translation and rotation after the correction with the adjustable mask-mount system was applied.

Conclusions

It could be shown that the mask-mount system in combination with the scotch cast masks provides an easy to use and precise system for patients getting frameless stereotactic treatments. The standard deviation of the mask system is 0.5 mm for translational and 0.7 degrees for rotational errors. Therefore it is possible to treat even patients having a tight 2 mm safety margin. Because of the accuracy and the short treatment time the mask-mount is an efficient device for clinics that do not have a robotic couch up to now.