Improving tractography in brainstem cavernoma patients by distortion correction

Sebastian Ille, MD1,2; Marc Grziwotz1,2; Maria, Wostrack, MD1; Bernhard Meyer, MD1; Sandro M. Krieg, MD1,2

*both authors contributed equally

1Department of Neurosurgery; 2TUM-Neuroimaging Center, Klinikum rechts der Isar, Technische Universität München, Germany

**Background**

The resection of brainstem cerebral cavernous malformations (CCM) harbors the risk of damaging the corticospinal tract (CST) and other pathways. Hence, the visualization of these pathways potentially supports the pre- and intraoperative planning in patients who undergo resection. However, diffusion tensor imaging fiber tracking (DTI FT) at brainstem level suffers from distortion due to field inhomogeneities and eddy currents because of diffusion gradients. The study aims to detect differences of the CST tractography between the standard technique and an additional distortion correction in brainstem CCM patients.

**Methods**

We included 25 patients with a mean age of 46 ± 18 years who underwent resection of brainstem CCM, among them 11 (44%) women and 14 (56%) men. Patients suffered from hemorrhage in 24 cases. We performed an anatomy-based tractography of the CST with a mean minimal fractional anisotropy of 0.22 ± 0.04 before and after cranial distortion correction (CDC). For our analysis we used pre- or postoperative DTI sequences and Brainlab Elements.

**Results**

Overall, the application of CDC led to a more precise CST tractography regarding its true anatomical localization in all cases. As measured by the distance to the basilar artery, the CST was located significantly more ventral by a mean of 1.5 ± 0.5 mm (6.1 ± 2.6 mm before CDC vs. 4.6 ± 2.1 mm after CDC; p < 0.0001). As measured by the distance to the clivus, the CST was located more ventral by a mean of 1.7 ± 0.5 mm (8.9 ± 2.6 mm vs. 7.2 ± 2.1 mm; p < 0.0001). Aberrant fibers could be reduced by CDC in 44% of the patients. We could find a mean difference of the CST volume of 0.6 ± 0.8 cm³. Furthermore we could not detect motor deficits after resection of “distorted” fibers.

**Conclusion**

By the present results we are able to show that CDC improves the tractography of the CST in brainstem CCM patients regarding its true anatomical localization. As a next step, our results have to be evaluated using intraoperative neuromonitoring in a larger cohort.

![Fig. 1: Schematic illustration of the Cranial Distortion Correction method applied to DTI and based on T1-weighted MRI data (Hiepe, P., 2017).](image1)

![Fig. 2: The figure shows a fiber tracking of the CST before (orange) and after (blue) distortion correction.](image2)

![Fig. 3: The left graph shows the distance of the CST to the basilar artery without and with CDC (with mean and SEM). The right graph shows the same parameters, but measured by the distance to the clivus.](image3)