Diffusion Tensor Imaging Tractography for facial nerve preservation

Predicting the course of the facial nerve in the cerebellopontine angle (CPA) on preoperative imaging for vestibular schwannoma (VS) may help guide surgical resection and reduce complications.

The stretched nerve is usually located on the anterior surface of the tumor from the middle of the tumor to the superior surface (72.6%).

It is rarely displaced inferiorly and even less often posteriorly. It is routine to use the monitoring of VII nerve function during surgery and a posterior location of the nerve can be excluded before opening the capsule by using stimulation. If this step is followed, the surgeon can assume that in most cases, the stretched nerve is anterior to the tumor and at the level of the internal auditory meatus (IAM) or superior to this. If the nerve is not splayed then it can be followed from the IAM and the brainstem. Dissection should not put traction on the nerve away from the IAM or brainstem, as gentle traction at 90 degrees to the direction of the nerve is safer. For most patients, these assumptions and this technique will result in a good outcome.

Pre-operative identification of an inferiorly displaced facial nerve or a splayed nerve would be helpful in avoiding an intra-operative injury. It is often not possible to dissect a splayed nerve off the capsule without having a functional loss. Pre-surgery detection of the position of the VIIth nerve would allow an alternative surgical approach such as partial resection or planned grafting. If the nerve is identified as being inferior, then unnecessary retraction of this part of the capsule could be avoided. In this study, the technique did not identify the splayed nerves; it was only helpful in alerting the operating surgeon as to the location of the VIIth nerve. This information did improve results in this study but further work is required before concluding that this should be a routine investigation.

When trying to achieve good outcomes for patients, extra information should always be considered valuable. However, differences in technique, technical failures (10%), lack of concordance between the imaging and operative findings (2.5% in this study and 24.5% in others) mean that DTI evaluation of the VIIth nerve should considered an evolving technique [1)].

Results from a review of Baro et al. have confirmed that preoperative fiber tracking for facial nerve identification during large vestibular schwannoma surgery is valuable and reliable. However, the included studies were not comparable in terms of images, acquisitions, or postprocessing elaboration. Larger series and homogenous magnetic resonance imaging parameters are required to strengthen these findings [2)].

Intraoperative validation of this novel approach is challenging. Currently, validation is based on operative report descriptions of the course of cranial nerves but yields a simplified picture of the three-dimensional (3D) course of CN VII. In a study, Epprecht et al. investigated the accuracy of tractography with detailed patient-specific 3D-printed VS tumors.

Epprecht et al. compared tractography with the intraoperative 3D course of CN VII. The surgeons were blinded to tractography and drew the intraoperative course of the CN VII on a patient-specific 3D-printed tumor model for detailed comparison with tractography.

Of 20 patients, one was excluded due to subtotal removal and inability to assess the CN VII course. In the remaining 19 patients, 84% (16/19) tractography was successful. In 94% of tumors with tractography (15/16), the intraoperative description of CN VII course matched the tractography finding. The maximum distance, however, between the tractography and the intraoperative course of CN VII was 3.7 mm ± 4.2 mm.

This study presents a novel approach to CN VII tractography validation in VS. Although descriptions of CN VII intraoperatively match tractography, caution is warranted as quantitative measures suggest a clinically significant distance between tractography and CN VII course [3].

The object of a study is to evaluate the feasibility of using diffusion tensor imaging-based fiber tracking (DTI-FT) to visualize the FN.

Data from 15 patients with acoustic neuromas were collected using 3-T MRI. The visualized FN course and its position relative to the tumors were determined using DTI-FT with 3D Slicer software. The preoperative visualization results of FN tracking were verified using microscopic observation and electrophysiological monitoring during microsurgery.

Preoperative visualization of the FN using DTI-FT was observed in 93.3% of the patients. However, in 92.9% of the patients, the FN visualization results were consistent with the actual surgery.

DTI-FT, in combination with intraoperative FN electrophysiological monitoring, demonstrated improved FN preservation in patients with acoustic neuroma. FN visualization mainly included the facial-vestibular nerve complex of the FN and vestibular nerve [4].

Diffusion tensor tractography (DTT) effectively revealed the location of the facial nerve (FN), including cases in which the FN was membranoid or passed through the interface between an area exhibiting cystic changes and the tumor nodule. Fibers aside from the FN and the TN were revealed by DTT in patients who retained functional hearing. Penetrating fibers were also found using DTT. This technique can be useful during VS resection [5].

Yoshino et al. visualized facial or vestibulocochlear nerves in nine of 11 patients (81.8%). For the first time, DTT proved able to visualize not only the facial nerve but also the vestibulocochlear nerve in VS patients. Despite our findings, good methods for distinguishing whether a visualized nerve tract represents facial nerve, vestibulocochlear nerve, or only noise remain unavailable. Close attention should therefore be paid to the interpretation of visualized fibers [6].

References

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