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Diffusion tensor tractography in the preoperative precise identification of the course of facial nerve in a meningioma of the cerebellopontine angle – Technical implications

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ABSTRACT

Background: Facial paralysis remains as one of the major morbidities of surgery of cerebellopontine angle tumors. The preoperative standard Magnetic Resonance Image does not identify, with precision, the path of the facial nerve.

Case description: The authors describe a case of a 56 years-old female with a cerebellopontine angle meningioma, submitted to preoperative Diffusion Tensor Tractography to identification of the course of the facial nerve, and correlate its position with the intraoperative findings. There was an accurate correlation between the path of the facial nerve revealed by preoperative DTT and the route of the nerve identified during surgery.

Conclusion: The preoperative identification of the facial nerve seems to be possible by tractography in meningiomas of the cerebellopontine angle. It is possible that this technique may have utility in larger tumors, where the intraoperative identification of the facial path can be more difficult.

1. Introduction

The increasing availability of the use of Diffusion Tensor Tractography (DTT) in the preoperative evaluation of the path of the facial nerve (FN) of vestibular schwannomas (VS) suggests its reliability as a noninvasive technique and its possible contribution in reducing morbidity related to FN [1–6]. The authors describe a clinical case of a cerebellopontine angle (CPA) tumor, where preoperative DTT showed the course of the facial nerve in its cisternal portion and its position in relation to the tumor.

2. Case 1

A 56-year old female with a six months evolution of tinnitus and imbalance was referred to our institution. The neurological examination was normal. Magnetic Resonance Imaging (MRI) revealed an extra axial lesion in the CPA, with dural enhancement, centered to the internal auditory canal, compatible with meningioma (Fig. 1).

The vocal and tonal audiogram were normal. Preoperative DTT revealed a posterior-inferior position of FN, in relation to the tumor (Figs. 2 and 3).

2.1. MRI protocol

MR imaging was performed with an Avanto 1,5 T scanner (Siemens, Erlanger, Germany) with 8-channel head coil. The MR protocol was implemented for this patient by author P.M.G.P. which includes axial DT (TR = 7100 ms, TE = 87 ms, b = 1000 s/mm^2, six-axis encoding, FOV = 230 mm, matrix = 128 × 128, slice thickness = 5 mm, slice spacing = 3 mm, averaging = 4), axial T2-CISS (TR = 5.9 ms, TE = 2.7 ms, FOV = 200 mm, matrix = 512 × 512, slice thickness = 0,9 mm, no gap), coronal T2-TSE (TR = 720 ms, TE = 15 ms, FOV = 200 mm, matrix = 448 × 252, slice thickness = 2,5 mm) and axial/coronal T1-SE (TR = 15 ms, TE = 4.7 ms, FOV = 200 mm, matrix = 256 × 256, slice thickness = 2,5 mm) obtained before and after a manual intravenous injection of standard dose (0.1 mL/kg) of gadobutrol (Gadovist®; Bayer Schering Pharma, Berlin-Wedding, Germany). Tractography was performed using software Volume One/dTV.II.

Abbreviations: CPA, cerebellopontine angle; MRI, Magnetic Resonance Image; DTT, diffusion tensor tractography; FN, facial nerve; VS, vestibular schwannoma.

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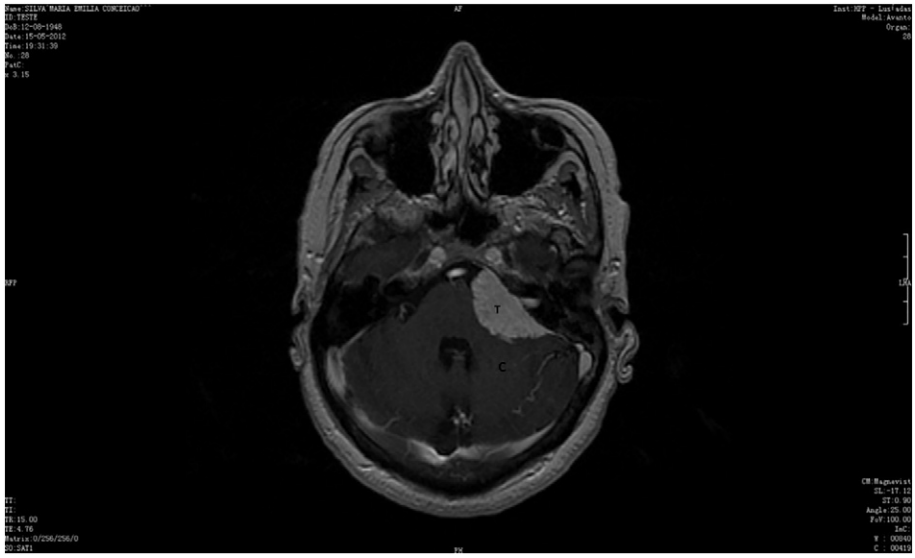

Fig. 1. Axial T1-weighted MR image with gadolinium contrast enhancement showing left-sided extra axial tumor, centered to the internal auditory canal (possible meningioma). T: Tumor, C: Cerebellum.

2.2. Operation and postoperative course

The patient underwent a left suboccipital craniotomy in a right park bench position, with electrophysiological monitoring of FN (Xomed NIM-3®, Medtronic, USA). The FN was identified at a posterior-inferior position in relation to the tumor (Figs. 4 and 5), in complete accordance with preoperative DTT. The tumor was completely removed using standard microsurgical techniques, with preservation of all structures (Fig. 6) and the postoperative period was uneventful, with no neurological deficits. Histological examination revealed a meningothelial meningioma (World Health Organization Classification of Tumors of the Central Nervous System) [7].

3. Discussion

Intra-operative injury of FN accounts for the morbidity of patients following CPA tumors surgeries, with special emphasis on the vestibular schwannomas, due to its high incidence. DTT of the FN is a noninvasive imaging technique used in many surgical centers [8,9]. Although we use, routinely, intraoperative electrophysiological monitorization of the FN, preoperative identification of the path of facial and facial/vestibular complex by DTT can be used as an additional information to the surgeon.

In this case, we examined the reliability of preoperative DTT, by determining the position and distortion of the facial nerve and correlated with the in vivo findings during surgery.

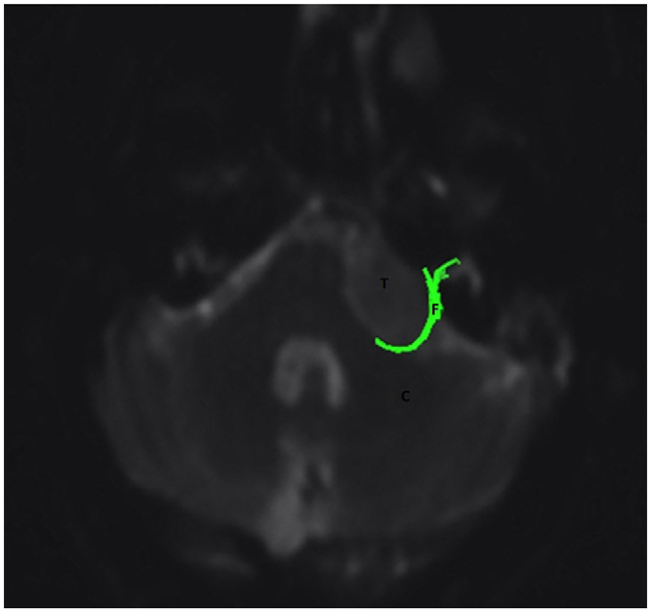

Fig. 2. Axial T2-weighted MR image: DTT revealing the course of facial nerve, posterior to the tumor (green line). T: Tumor, C: Cerebellum, F: Facial.

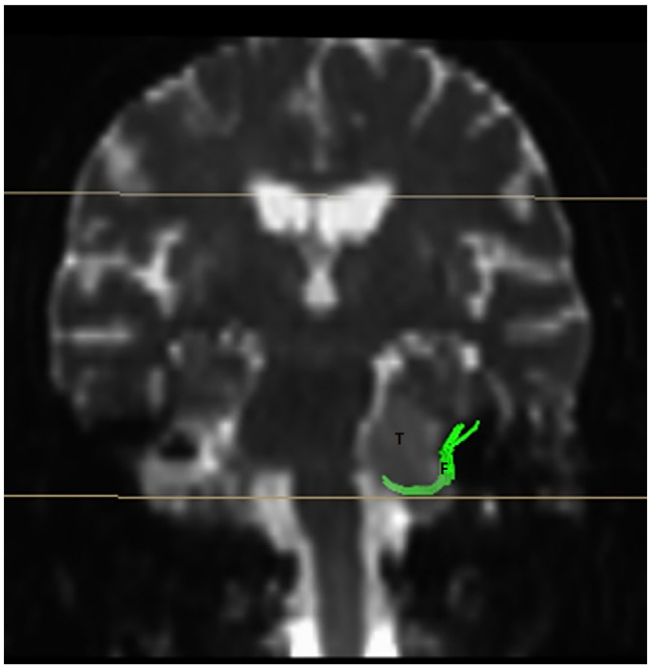

Fig. 3. Coronal T2-weighted MR image: DTT revealing the course of facial nerve, inferior to the tumor (green line). T: Tumor, F: Facial.

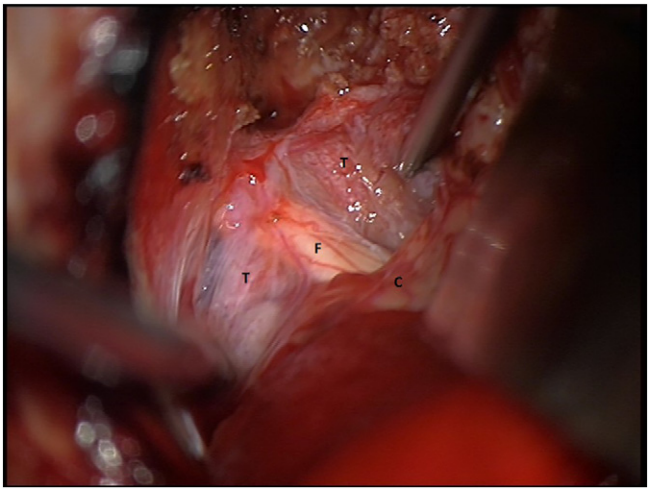

Fig. 4. Intraoperative images (surgical microscope): Facial nerve in a posterior-inferior position relative to the tumor, prior to the opening of the arachnoid. T: Tumor, C: Cerebellum, F: Facial.

The surgical technique used in this patient was a standard procedure and it was not directly influenced by the preoperative DTT results. However, a priori knowledge of the posterior deviation of the facial nerve was used as a landmark for the surgical manipulation of the tumor.

It is necessary to improve image definition of tractography and distinguish the FN from the vestibular nerve. This may be important in patients with useful hearing and other solid tumors of CPA, as VS. Currently, in our institution, tractography of FN is performed preoperatively in patients with space-occupying lesion of the CPA above 3 cm or in surgical procedures that we predict some morbidity in relation to the facial nerve.

Like any imaging technique, the user experience is essencial to obtain and interpret their results. The same applies to the tractography, so it is crucial to get experience in various types of tumors of CPA. But this also could be a limiting factor in interpreting the results.

In the future, possibly, this technique may be able to identify other cranial nerves in the posterior fossa, helping to reduce the postoperative morbidity of large CPA tumors. It may have also an important role in the diagnosis of other pathologies, like trigeminal neuralgia, where exists nerve deformation, visible in trigeminal tractography.

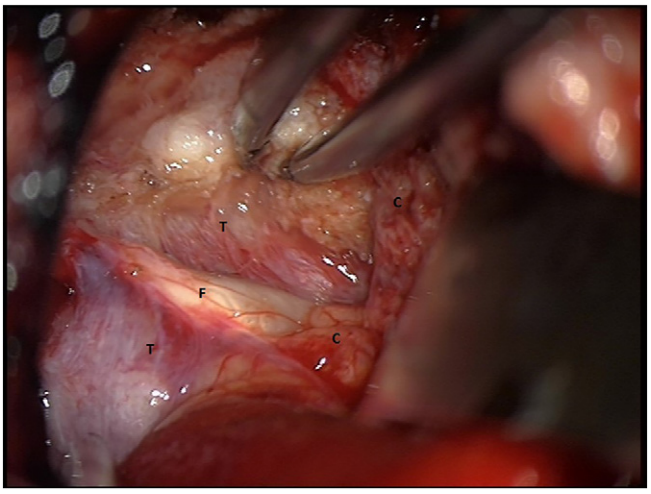

Fig. 5. Facial nerve in a posterior-inferior position relative to the tumor, after opening the arachnoid. T: Tumor, C: Cerebellum, F: Facial.

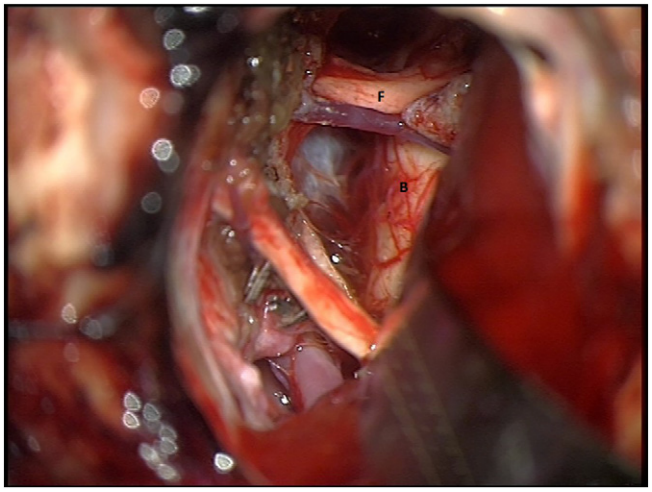

Fig. 6. Final image (surgical microscope). Complete removal of the tumor with preservation of cranial nerves. F: Facial, B: Brainstem.

Conflict of interest

The authors declare that they have no conflict of interest.

Statement

The patient has consented to submission of this case report to the journal, including the photographs.

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