Preservation of Facial Nerve Function Repaired by Using Fibrin Glue-Coated Collagen Fleece for a Totally Transected Facial Nerve during Vestibular Schwannoma Surgery

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The vestibular schwannoma (VS) that surrounds the vestibular nerve is a benign tumor originating from Schwann cells. Postoperative facial nerve weakness, however, is reported in 8% to 20% of patients in the immediate postoperative period.¹ The incidence is as high as 25% of patients when delayed postoperative paralysis is considered.¹ The incidence of facial nerve dysfunction after VS resection has significantly decreased with the widespread use of microsurgical techniques. Increasing expectations have paralleled improvements in techniques and technologies, and the introduction of intraoperative facial nerve monitoring.¹²⁻¹³. Despite these advancements, the most troubling postoperative impairment experienced by many patients is facial nerve dysfunction, which affects patients more substantially than physicians might predict.¹⁴⁻¹⁵

Diffusion tensor (DT) imaging of the facial nerve tractography-based fiber tracking is an established imaging technique that allows for the 3-dimensional reconstruction of white matter fibers, such as the pyramidal tract.¹⁶⁻¹⁸. Its feasibility to show the position of cranial nerves in the cerebellopontine angle (CPA) has been demonstrated recently in individual patients with VS.¹⁹. In this report, we describe a successful case that had a good recovery after a nerve repair using glue-coated collagen fleece (Tachocomb®) during VS surgery. We were able to verify the anatomical preservation and functional outcome of the facial nerve with postoperative diffusion tensor (DT) imaging facial nerve tractography, electroneurography (ENoG) and House-Brackmann (HB) grade. DT imaging tractography at the 3rd postoperative day revealed preservation of facial nerve. And facial nerve degeneration ratio was 94.1% at 7th postoperative day ENoG. At postoperative 3 months and 1 year follow-up examination with DT imaging facial nerve tractography and ENoG, good results for facial nerve function were observed.

Key Words: Vestibular schwannoma · Facial nerve injury · Diffusion tensor imaging · Electromyography · Intraoperative monitoring.

INTRODUCTION

The vestibular schwannoma (VS) that surrounds the vestibular nerve is a benign tumor originating from Schwann cells. Postoperative facial nerve weakness, however, is reported in 8% to 20% of patients in the immediate postoperative period.¹ The incidence is as high as 25% of patients when delayed postoperative paralysis is considered.¹ The incidence of facial nerve dysfunction after VS resection has significantly decreased with the widespread use of microsurgical techniques. Increasing expectations have paralleled improvements in techniques and technologies, and the introduction of intraoperative facial nerve monitoring.¹²⁻¹³. Despite these advancements, the most troubling postoperative impairment experienced by many patients is facial nerve dysfunction, which affects patients more substantially than physicians might predict.¹⁴⁻¹⁵

CASE REPORT

A 74-year-old female presented with a 7-year history of right-sided tinnitus and hearing loss without facial paresis in a hospital. A neurological examination of the patient on admission was nonspecific. A VS in the right CPA was seen on a magnetic resonance (MR) image (Fig. 1A). The lesion significantly compressed the brainstem. Preoperative DT imaging facial nerve
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Facial function had improved markedly (HB grade II). No synkinesis was observed by the patient or identified on physical examination.

DISCUSSION

Postoperative facial nerve injury is one of the major compli-

Fig. 1. A : The preoperative axial enhanced T1-weighted magnetic resonance image shows a vestibular schwannoma on the right cerebellopontine angle (arrow). B : The preoperative diffusion tensor imaging of facial nerve tractography shows that the facial nerve was displaced anterior to the tumor mass (red color).

Fig. 2. A : Intraoperative finding shows facial nerve was transected. B : There was a first attempt to connect the injured facial nerve through a primary end-to-end anastomosis by suture, but it failed due to the thin and fragile facial nerve (arrow). C : Two pieces of Tachocomb® were placed to surround the injured facial nerve like sandwich (arrow). And then, fibrin glue was used (arrow) (D).

Fig. 3. A : A postoperative axial enhanced T1-weighted magnetic resonance image shows no residual tumor. B : A postoperative diffusion tensor imaging of facial nerve tractography shows the pathway of the facial nerve which was connected well (3rd postoperative days) (Fig. 3B). And good results for facial nerve function were observed on additional follow-up examination.

The patient was referred for intensive physiotherapy treatment, including participation in a facial nerve training program and periodical clinical examinations. One year later, the patient underwent a follow-up examination at our outpatient department. Follow-up DT imaging facial nerve tractography had no interval change as compared with the immediate postoperative study. A follow-up ENoG revealed that the facial nerve degeneration ratio had not changed compared to an immediate postoperative ENoG. The patient's
ciations of a VS resection surgery. There is a disruption of the fac-
cial nerve in an estimated 2% to 10% of VS resections\(^2\). Satis-
factory facial nerve function has important implications for a pa-
ient’s quality of life after VS surgery.

The reliable preoperative visualization of the facial nerve loca-
tion in relation to the VS would allow surgeons to plan tumor 
removal accordingly and may increase the safety of surgery\(^6\). 
Recent MR imaging modalities, such as diffusion-weighted im-
ageing and DT imaging tractography, have allowed mapping of 
the cranial nerves in healthy individuals\(^{11,12}\). DT imaging tractog-
yraphy is a novel modality of MR imaging analysis that measures 
the diffusion direction of water molecules by combining multi-
ple diffusion-weighted image scans taken from multiple gradi-
ent directions. The diffusion of water molecules is thought to be 
anisotropic inside white matter tracts\(^{12,13}\) and therefore maxi-
mal along the direction of the fiber tracts\(^{12}\). A 3D vector field 
(tensor) is assigned to each voxel. This information is then used 
to reconstruct and represent pictorially the white matter tracts 
within specific regions of interest. DT imaging tractography re-
construction was considered successful if a continuous tract of 
fibers was seen to extend from the internal acoustic meatus to 
the brainstem along the tumor capsule\(^7\). Taoka et al.\(^{20}\) applied 
these DT imaging tractography techniques to patients with VSs, 
and the authors reported that they were able to identify the lo-
cation of the facial nerve in a subset of patients. We therefore 
consider the technique of DT imaging tractography to be a pow-
erful tool for preoperatively predicting the course of the dis-
placed facial nerve in VS. This information may increase the 
safety of surgery by enabling preservation of facial nerve func-
tion\(^21\).

With recent progress in surgical techniques for resection sur-
gery of VS resulting in diminished morbidity and mortality, the 
expectation for the preservation of facial nerve function after 
surgery has increased\(^1\). Nerve preservation is the most obvious 
course in achieving satisfactory function, but nerve reconstruc-
tion and nerve reanimation may also be necessary to achieve 
acceptable results\(^4,\). 

Occasionally, the facial nerve can be transected during tumor 
resection. Immediate repair of an intentionally or unintention-
ally transected facial nerve is recommended to restore function. 
Different technical solutions are available in the case of facial 
nerve interruption, but it has been determined that, when feasi-
ble, end-to-end reapproximation represents the best option. In 
cases with longer nerve defects, not favorable for tensionless 
end-to-end anastomosis, a facial nerve interposition graft is in-
dicated for bridging the defect. But the proximal facial nerve 
end was alive and the function of nerve signal transmission 
was partially preserved by end-to-end attachment using glue-
coated collagen fleece although facial nerve was totally transect-
ed during the operation.

Electromyography may assist in prognosticating a functional 
return, determining neural conduction across the site of injury 
and following reinnervation in the recovery period. In a patient 
with Bell's palsy, a facial nerve degeneration ratio of less than 
98% in ENoG is reported to have a good recovery\(^5\). Therefore, 
we expected that she would have good prognosis of facial nerve 
function because the facial nerve degeneration ratio was 94.1% 
in postoperative ENoG.

The patient was referred to intensive physiotherapy treatment. 
At postoperative 1 year follow-up a DT imaging facial nerve 
tractography and follow-up ENoG had not interval change as 
compared with the immediate postoperative study. However, the 
patient’s facial function had improved to HB grade II.

**CONCLUSION**

The present case shows that end-to-end reapproximation 
methods could produce good results for the treatment of the 
injured facial nerve during tumor resection. This procedure 
also has a likelihood of functional improvement of repaired fa-
cial nerve. Therefore, we think that the facial nerve repair tech-
nique using glue-coated collagen fleece is a possible alternative 
method to primary end-to-end anastomosis. This process can 
be easily and quickly done and may have promising results with 
low morbidity. The authors report for the first time that ana-
tomical preservation of the repaired facial nerve by postope-
ative DT imaging tractography, with the prediction of improve-
ment of facial nerve function through postoperative ENoG.
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References