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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Recently, the increasing rates of facial nerve preservation after vestibular schwannoma (VS) surgery have been achieved. However, the management of a partially or completely damaged facial nerve remains an important issue. The authors report a patient who was had a good recovery after a facial nerve reconstruction using fibrin glue-coated collagen fleece for a totally transected facial nerve during VS surgery. And, we verified 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. The incidence is as high as 25% of patients when delayed postoperative paralysis is considered. 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. 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.

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. Its feasibility to show the position of cranial nerves in the cerebellopontine angle (CPA) has been demonstrated recently in individual patients with VS. In this report, we describe a successful case that had a preservation of the facial nerve function 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 DT imaging facial nerve tractography, electroneurography (ENoG) and House-Brackmann (HB) grade.

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...
tractography was performed to visualize the course of the facial nerve which is displaced anteriorly by VS (Fig. 1B).

We performed a tumor resection through the retromastoid approach with intraoperative neuro-monitoring as brainstem auditory evoked potential (BAEP), electromyography (EMG) and nerve conduction study (NCS). The internal decompression of the tumor and careful dissection of surrounding neural tissue including the facial nerve were performed under intraoperative monitoring. In this process, the facial nerve was cut. During surgery, we found that the facial nerve was thin and fragile because of severe indentation by the tumor mass (Fig. 2A). First, we tried to do a primary end to end anastomosis but failed due to a thin and weak facial nerve (Fig. 2B). Glue-coated collagen fleece was then used to connect the facial nerve (Fig. 2C, D).

The patient presented, in the immediate postoperative period, with a significant facial palsy. Complete right eye closure was not possible. A shape of the mouth was asymmetrical with maximal effort (HB grade V). Postoperative MR images showed no residual tumor (Fig 3A). We checked postoperative DT imaging tractography for anatomical preservation of facial nerve and ENoG for prediction of functional outcome of repaired facial nerve. In postoperative ENoG (7th postoperative days), the facial nerve degeneration ratio was 94.1%. In addition, a postoperative DT imaging facial nerve tractography visualized 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 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-
cations of a VS resection surgery. There is a disruption of the fa-
cial nerve in an estimated 2% to 10% of VS resections12. Satis-
factory facial nerve function has important implications for a pa-
patient'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 surgery6.
Recent MR imaging modalities, such as diffusion-weighted im-
aging and DT imaging tractography, have allowed mapping of
the cranial nerves in healthy individuals13. DT imaging tractog-
raphy 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 tracts14,15 and therefore max-
imal along the direction of the fiber tracts16. 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 capsule17. Taoka et al.18 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-
tion19.

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 increased20. 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 results21.

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
stump at the brainstem is either too short or impossible to iden-
tify, an intracranial cable nerve interposition grafting cannot be
accomplished. In these situations, other reconstructive tech-
niques, such as hypoglossal-facial nerve anastomosis, neu-
muscular free flaps, and cross-face nerve grafting, are effective
alternatives.

Bacciu et al.22 reported a study that compared the facial nerve
outcomes of patients who underwent facial nerve cable grafting
by using fibrin glue with those of patients who underwent facial
nerve cable grafting by using microsuture. Above study, the func-
tional results after facial nerve cable grafting by using fibrin glue
exclusively were equivalent to those obtained with microsuture.
Several advantages of a sutureless anastomosis such as less for-

eign body reaction, less trauma to the nerve from the suture,
limitation of scar in the anastomosis, have been recognized.
Also, the major advantages of the method of facial nerve graft-
ing using fibrin glue are the simplicity, safety, and speed of this
technique.

Our case is similar to the above study. We obtained good re-
results without microsuture. We used only the end-to-end reap-
proximation method without cable graft. Furthermore, we could
confirm anatomical preservation of the repaired facial nerve by
postoperative DT imaging tractography, and could predict the
excellent functional outcome of the repaired facial nerve by
postoperative ENoG. The degeneration ratio was 94.1% in post-
operative ENoG. Moreover, the postoperative DT imaging fa-
cial nerve tractography MR imaging demonstrated that the fa-
cial nerve was well preserved. We speculated that the fiber of
nerve end was alive and the function of nerve signal transmission
was partially preservation 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 recovery23. 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-
tative DT imaging tractography, with the prediction of improve-
ment of facial nerve function through postoperative ENoG.
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