



Technical Notes

# Intratumoral continuous facial nerve stimulation for surgical resection of cystic vestibular schwannoma: Technical note

Katsuyoshi Miyashita, Ryouken Kimura, Sho Tamai, Shingo Tanaka, Masashi Kinoshita, Yasuhiko Hayashi, Mitsutoshi Nakada

Department of Neurosurgery, Kanazawa University, Kanazawa, Ishikawa, Japan.

E-mail: \*Katsuyoshi Miyashita - miyashita@med.kanazawa-u.ac.jp; Ryouken Kimura - ryouken@med.kanazawa-u.ac.jp; Sho Tamai - sho.tamai@med.kanazawa-u.ac.jp; Shingo Tanaka - t-shingo@med.kanazawa-u.ac.jp; Masashi Kinoshita - m-kinoshita@med.kanazawa-u.ac.jp; Yasuhiko Hayashi - yahayashi@med.kanazawa-u.ac.jp; Mitsutoshi Nakada - mnakada@med.kanazawa-u.ac.jp



**\*Corresponding author:**

Katsuyoshi Miyashita,  
Department of Neurosurgery,  
Kanazawa University,  
Kanazawa, Ishikawa, Japan.

miyashita@med.kanazawa-u.ac.jp

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## ABSTRACT

**Background:** Cystic vestibular schwannomas (CVSs) account for about 10% of VS. The efficacy of continuous facial nerve stimulation (CFS) was previously reported; however, it is often difficult to place the electrode at the root exit zone (REZ) in the early stage of surgical resection. We proposed a new method of intratumoral CFS (ICFS) by searching for the facial nerve through the cyst wall and leaving the spherically shaped electrode at this point.

**Methods:** The cyst wall was opened, and the ventral side of the tumor wall was stimulated to search for the positive point of facial nerve stimulation and place the spherically shaped electrode for continuous stimulation at this point through the cyst cavity (intensity: 0.2–1.5 mA, frequency: 1 Hz). Safe surgical resection could be performed under ICFS in all three cases.

**Results:** Good preservation of the facial nerve and extent of resection that was estimated preoperatively was achieved in all cases.

**Conclusion:** ICFS is suitable for the preservation of facial nerve function in surgical resection of CVS in cases in which electrode placement at the REZ is difficult.

**Keywords:** Cystic vestibular schwannoma, Intratumoral continuous facial nerve stimulation, Root exit zone

## INTRODUCTION

Most vestibular schwannomas (VSs) are the solid type, and cystic VSs (CVSs) were reported to account for about 10% of VSs.<sup>[7]</sup> Functional preservation of the facial nerve is the most important factor for surgical resection of VS. Preservation of facial nerve function in CVS was inferior to that of solid VS due to the tight adherence to surrounding structures.<sup>[2,5]</sup> Amano *et al.* reported that continuous monitoring of facial nerve electromyogram by continuous facial nerve stimulation (CFS) is useful for VS resection.<sup>[1]</sup> The advantage of this method is the ability to identify changes in facial nerve function in real time. We routinely used this method for VS resection; however, there were some cases in which placing electrodes close to root exit zone (REZ) of the facial nerve were difficult. We present three cases of intratumoral CFS (ICFS) and propose the efficacy of this method for CVS resection.

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## MATERIALS AND METHODS

Three CVS patients underwent surgical resection with ICFS [Table 1]. Surgical tumor resection was performed by the lateral suboccipital approach. Intraoperative facial nerve function was monitored by NIM response (Medtronic, Xomed, Jacksonville, FL, USA) and a CFS system (Nihon Kohden, Tokyo, Japan). CFS was performed by a spherically shaped electrode with a disc-shaped transparent stabilizer (Unique Medical, Tokyo, Japan). The strength of stimulation was adapted from the previous reports, and the frequency of stimulation was 1 Hz.<sup>[1]</sup>

Anesthesia was maintained without muscle relaxants during microsurgery. A craniotomy and U-shaped dural incision were performed. We stimulated the dorsal side of the tumor wall with NIM after tumor exposure and dissected the tumor wall if there was no facial nerve function on the dorsal side. The tumor was resected through the cyst cavity, and NIM was used during tumor resection as required. If there was a positive response point on the ventral side of the tumor wall, a spherically shaped electrode was placed at the positive point. Stimulation strength was as low as possible, and the frequency of stimulation was 1 Hz during tumor resection. We often switched to occasional stimulation by NIM to identify the path of the facial nerve. If the amplitude was decreased, a medical technologist warned the surgeon immediately. We checked the appropriate initial placement of the electrode and paused tumor resection until recovery.

## RESULTS

### Case 1

An 84-year-old female who suffered from dizziness was referred to our hospital. Gadolinium (Gd)-contrast-enhanced magnetic resonance (MR) images showed cystic enhanced tumor 40 mm in diameter in the left cerebellopontine angle [CPA; Figure 1a]. We intended to perform a partial resection to minimize operative time and surgical risk because the patient was the elderly. The NIM-positive point was identified at the ventral tumor wall [Figure 1b] and stimulated continuously at 1.5 mA by placing a spherically

shaped electrode [Figure 1c and d]. The tumor was partially resected [Figure 1e], and the path of the facial nerve was identified by stimulating the ventral cyst wall [Figure 1f]. Facial nerve palsy (House–Brackmann Grade II) appeared postoperatively but completely recovered within 3 months.

### Case 2

A 72-year-old male for whom a subtotal resection (STR) for a left CVS was performed 2 years prior. Two years after STR, he suffered from progressive left facial and abducens palsy. Gd-contrast-enhanced MR imaging showed cyst regrowth. We intended to achieve cyst shrinkage and perform postoperative stereotactic radiosurgery. Adhesion of the tumor wall to the surrounding structures was too tight to perform a dissection. The cyst wall was opened, and an electrode was placed at the NIM-positive point of ventral wall. The tumor was resected partially, and the cyst size was reduced [Table 1].

### Case 3

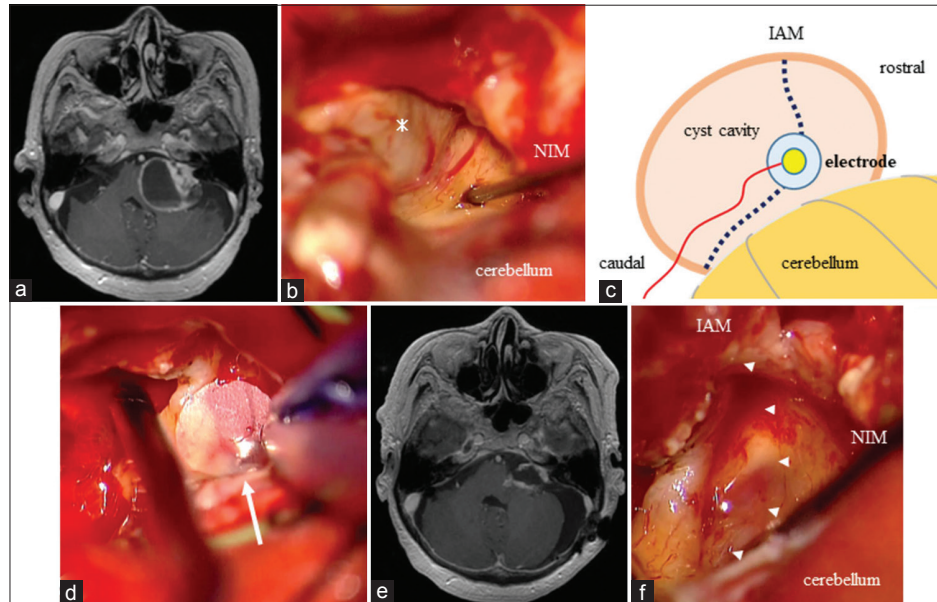
A 63-year-old female who suffered the right hearing disturbance presented at our department. MR images showed a right cystic enhanced lesion, and the brainstem and cerebellum were compressed. The facial nerve was identified through the cyst cavity at the ventrorostral side of the tumor cavity, and an electrode was placed. The electrode was replaced at the REZ of the facial nerve when REZ was visible after mass reduction. STR was achieved without facial nerve palsy [Table 1].

## DISCUSSION

The goal of VS surgical resection is maximal tumor resection and simultaneous preservation of facial nerve function. To preserve facial nerve function, two types of stimulation are used: occasional and continuous. When we use occasional facial nerve monitoring, it is difficult to recognize the facial nerve injury during the stimulation interval. CFS can monitor facial nerve injury immediately because the stimulation interval is just 1 s (1 Hz). The previous reports showed that the preservation ratio of facial nerve function was 98.6% with 98.2% tumor resection rate when using CFS.<sup>[1]</sup> We routinely

**Table 1:** Summary of patient characteristics in this study.

Case	Age/Sex	Laterality	Diameter (mm)	Reason for using intratumoral continuous facial nerve stimulation	Stimulation intensity (mA)	Outcome of facial nerve function
1	84/F	Left	40	Intended near-total resection considering age	1.5	Good (transient palsy)
2	72/M	Left	30	Electrode placement difficulty due to tight adhesion of tumor to surroundings	0.2	Good
3	63/F	Right	35	Electrode placement difficulty at early stage of resection due to large tumor size	0.2	Good



**Figure 1:** Axial T1-weighted postcontrast magnetic resonance (MR) images and intraoperative scenes of case 1. Pre- (a) and post-operative (b) axial T1-weighted MR images showing subtotal cystic vestibular schwannomas resection with marked shrinkage. (c) Schematic of intratumoral continuous facial nerve stimulation (ICFS). Placement of the spherically shaped electrode at the ventral tumor wall through the tumor cavity at the positive point by occasional stimulation. Dotted line is the path of the facial nerve. (d) Positive point of ventral tumor wall stimulation by NIM through the cyst cavity (asterisk) after opening the cyst wall. (e) Positioning the spherically shaped electrode for ICFS (white arrow) at the positive point from c. (f) Estimated route of facial nerve, which responded positively to stimulation through the tumor wall (arrowheads). IAM: Internal auditory meatus.

use the NIM response and CFS system for VS resection. An electrode needs to be placed at the REZ for CFS; however, there are various reasons of difficulty to place the electrode at the REZ. CVSs have large cyst cavities, and it is easy to put the electrode on the tumor wall. That is why ICFS would be suitable for CVS if it is demonstrated that ICFS could achieve stable facial nerve monitoring.

A suitable intensity for electrical stimulation of the facial nerve was reported. It is desirable that the intensity for exposed facial nerve stimulation is as low as possible (generally 0.1–0.2 mA).<sup>[4]</sup> On the tumor surface, CPA, and temporal bone, higher stimulation intensity is used (0.1–3.0 mA).<sup>[4,6]</sup> In case 1, we selected 1.5 mA for stimulation considering thickness of the tumor wall; however, postoperative transient facial nerve palsy appeared. It was reported that when using an intensity of about 0.5–0.6 mA, current spread is dispersed within a maximum of 2 cm from electrode.<sup>[8]</sup> Based on this finding, we must select the lowest intensity for ICFS to prevent facial nerve injury proportional to the amount of exposed facial nerve.

In a previous report of CVS, good facial nerve outcomes were achieved in 82% of STR or near-total resection patients, as compared with 73% of gross total resection patients.<sup>[7]</sup> Piccirillo *et al.* divided CVS into central and peripheral types based on cyst location; favorable facial nerve outcomes were observed in 91% of patients.<sup>[3]</sup> Central and thick-walled

tumors can be removed in almost all cases; however, they recommended STR leaving portions of the cyst walls on the facial nerve if the tumor is peripheral thin-walled type and the cyst was located medially or anteriorly with adherence to surrounding structures. Our three cases were peripheral thin-walled types, and the cysts were located medially or anteriorly. In each case, good preservation of facial nerve function was achieved using ICFS.

## CONCLUSION

We presented the first report of ICFS for surgical resection of CVS. ICFS is suitable for surgical resection of CVS, in which leaving the electrode near the REZ is difficult.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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