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Original Article

Surgical Outcomes of Intratemporal Facial Nerve Schwannomas According to Facial Nerve Manipulation

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OBJECTIVES: The aim of this study was to evaluate the preoperative and postoperative facial nerve (FN) function in patients with FN schwannoma (FNS) and analyze the duration of preoperative facial palsy according to the preoperative and postoperative facial function.

MATERIALS and METHODS: We retrospectively reviewed the medical records of 29 patients with FNS who underwent surgery. We evaluated the FN function according to the type of FN manipulation and location of the anastomoses in the cable nerve graft, and we also analyzed the duration of facial palsy according to the facial function before and after surgery.

RESULTS: All 4 patients who underwent nerve-stripping surgery had the House–Brackmann (H-B) Grade III, 12 of 21 who underwent a cable nerve graft had the H-B Grade III or better postoperatively, and all 4 who underwent a hypoglossal facial crossover had the H-B Grade IV. Patients who underwent cable nerve grafting were more likely to have better FN function when the proximal anastomosis site was located in the internal auditory canal, geniculate ganglion, tympanic segment of FN, and distal end in the mastoid segment of FN. The duration of preoperative facial palsy was statistically shorter in patients with better postoperative facial function.

CONCLUSION: Surgery can be considered in patients with FNS who have the H-B Grade III or worse. A shorter duration of facial palsy prior to surgery resulted in better postoperative facial function.

KEYWORDS: Facial nerve, intratemporal, schwannoma, reconstruction, surgical outcomes

INTRODUCTION

Facial nerve schwannoma (FNS) is a slow-growing benign tumor that develops from the Schwann cell sheath along the course of the facial nerve (FN) [1]. It accounts for approximately 0.15%-0.8% of all temporal bone tumors [2, 3] and is relatively rare in comparison with vestibular schwannoma, which accounts for 6% of brain tumors [4]. Despite the low incidence, more than 500 cases of FNS have been reported in the past 20 years, and the increasing detection and incidence is likely attributable to the use of advanced imaging modalities [5].

FNS is mainly diagnosed using the temporal bone magnetic resonance imaging (MRI) in patients with a high index of suspicion indicated by symptoms, such as gradual or recurrent FN palsy [6, 7]. Because FNS is usually identified as a contrast-enhanced mass along the FN course on T1-weighted imaging, the diagnosis is not difficult to make, unless the lesion is extremely small [8]. However, it is difficult to distinguish FNS in the internal auditory canal (IAC) from vestibular schwannoma because the clinical and radiological findings are identical to those of vestibular schwannoma. Accordingly, the prevalence of true FNS that is presumed to be vestibular schwannoma is 1%-5% [1, 9]. Previously, Lee et al. [10] reported surgical findings to better differentiate FNS confined to IAC from ves-

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tibular schwannoma. Surgical excision was the treatment of choice for FNS [6, 11]. Many patients with FNS exhibit middle ear symptoms, such as hearing loss or a sense of fullness in the ear, without facial weakness. In such situations, surgical excision, which may induce or exacerbate facial palsy, is discouraged [6, 12]. Although some investigators have reported good results with early intervention in selected patients [13, 14], others have insisted on close observation and scanning until FN palsy reaches the House–Brackmann (H-B) Grade III or worse . Now, the observation with serial MRI scans in the setting of normal to near normal facial function is the best option. Radio surgery is also a reasonable strategy for growing tumors with normal to near normal facial function. Surgery is the procedure of choice for growing tumors with the H-B Grade III facial function or worse.

In the present study, we analyzed the surgical treatment outcomes in patients with FNS.

MATERIALS AND METHODS

We retrospectively reviewed the clinical data of 29 patients with intratemporal FNS who underwent surgical excision at one of three independent tertiary hospitals between 1994 and 2015.

The H-B grading system was used to evaluate the FN function [16]. The preoperative FN function was evaluated at the first visit and compared with the FN function evaluated 1 year postoperatively.

Tumor locations were indicated as Types A and B. Type A included tumors located anywhere from the cerebellopontine angle (CPA) to IAC, and Type B included those from the labyrinthine to the mastoid segments. The tumor size was measured as the longest axis of the tumor on the gadolinium-enhanced, T1-weighted axial or coronal MRI sections. The postoperative FN function was compared among patients who underwent nerve-stripping surgery, cable grafting, and hypoglossal facial crossover. In nerve-stripping surgery, The proximal and distal portions of the tumor were dissected until normal nerve fibers were identified. The tumor is further carefully dissected from the nerve and removed without injury to the neural fascicle. Moreover, we compared the proportion of patients who had the H-B Grade III or better postoperatively according to the location of the proximal and distal ends of the cable nerve graft. The duration of the facial weakness was also analyzed according to the preoperative and postoperative facial function.

This retrospective study protocol was approved by the institutional review boards of three individual institutes.

Table 1. Patient Characteristics (n=29)

Characteristics	Number
Age, years (range)	42.5 (16-71)
Sex	
Male	10
Female	19
Chief complaint	
Facial palsy	22
Vertigo	3
Others (hearing disturbance, ear fullness, otorrhea, headache)	4
Facial nerve palsy duration until visit, months (range)	20.3 (0.4-241)
Average size of the tumor, mm (range)	23 (10-50)
Total follow-up period, months (range)	80.1 (5.3-214.6)

RESULTS

We studied 29 patients (10 males and 19 females), with a mean age at diagnosis of 42.7 years. The most common main complaint was FN palsy in 22 patients, followed by vertigo in 3, hearing difficulty in 1, ear fullness in 1, otorrhea in 1, and headache in 1. The average duration of facial palsy at the time of surgery was 20.3 months (Table 1). Facial palsy was observed in 25 patients, whereas facial weakness was not observed in 4. When the involved segments were classified into Types A and B as described above, 11 patients were classified as having Type B, whereas 8 had Type A tumor. The average tumor size was 2.3 (range, 1.0-4.3) cm. The mean follow-up period was 76 (range, 8-210) months.

The type of surgical approach, FN manipulation, duration of facial palsy prior to surgery, and pre- and postoperative FN functions are described in Table 2. For the postoperative FN function, all 4 patients who underwent nerve-stripping surgery had the H-B Grade III (100%), 12 of 21 (57.1%) who underwent cable nerve grafting had the H-B Grade III or better, and all 4 who underwent hypoglossal facial crossover had the H-B Grade IV (Table 2).

The duration of preoperative facial palsy was analyzed according to the preoperative and postoperative FN function (Table 3). The mean duration of facial palsy was not statistically different between better and worse preoperative facial function. However, patients with better postoperative facial function had shorter duration of facial palsy, which was statistically significant.

Pre- and postoperative FN functions are depicted for each patient according to the FN manipulation in Figure 1 and according to the location of the proximal and distal ends of the cable nerve graft in patients who underwent cable nerve grafting in Figures 2 and 3, respectively. The proportion of patients with the postoperative H-B Grade III or better was higher in patients with the proximal end of the cable graft in IAC (70%), geniculate ganglion (GG; 50%), and tympanic segment of FN (66.7%) than in patients with the proximal end in CPA (0%; Fig. 2). The H-B Grade III or better was postoperatively achieved in 5 of 6 patients (62.5%) with the distal end of the cable nerve graft in the mastoid segment of FN, and in 6 of 12 (50%) with the distal end in the stylomastoid foramen (Figure 3). The intratemporal area, including the tympanic and mastoid segments of the FN, showed better postoperative FN function. The proportion of patients with the H-B Grade III or better and the distal end of the cable nerve graft in the intratemporal area was 66.7% (6 of 9) compared with 50% of patients with the distal end in the stylomastoid foramen (Figure 3).

DISCUSSION

FNS is a benign tumor that originates from the Schwann cell sheath along the course of FN. Although the GG and labyrinthine segments are the sites most commonly affected by FNS, IAC, and CPA are also common locations [17]. The presence of skip lesions and multiple-segment involvement, which are frequently observed in FNS, can lead to difficulties in specifying the involved segment [1, 7, 15].

Table 2. Types of Surgery and Preoperative and Postoperative Facial Nerve Function

Case No.	Location	Extent of Removal	Surgical Approach	FN Manipulation	Duration of FNP Until FN Manipul ation (Mo)	H-B Grade	
						Preop	Postop
1	Aa	Subtotal	MF	Stripping	none	I	III
2	A	Subtotal	MF	Stripping	7	III	III
3	A	Subtotal	MF	Stripping	none	I	III
4	A	Total	TM	Cable graft with SN	3	III	III
5	A	Total	TL	Cable graft with SN	7	IV	IV
6	A	Total	TL	Cable graft with SN	11	III	III
7	A	Total	TL	Cable graft with SN	0	II	IV
8	A	Total	TL	Cable graft with GAN	2	V	III
9	B	Subtotal	TM	Stripping surgery	none	I	III
10	B	Total	TM	Cable graft with SN	14	II	III
11	B	Total	TM	Cable graft with SN	1	IV	II
12	B	Total	TM	Cable graft with SN	14	II	III
13	B	Total	TM	Cable graft with SN	10	II	IV
14	B	Total	TM	Hypoglossal facial crossover	42	V	IV
15	B	Total	TM	Hypoglossal facial crossover	42	V	IV
16	B	Total	TL	Cable graft with SN	241	V	IV
17	B	Total	ITF	Cable graft with SN	21	IV	V
18	B	Total	ITF	Hypoglossal facial crossover	61	III	IV
19	B	Total	SP	Cable graft with SN	0	III	III
20	A+B	Total	TL	Cable graft with SN	59	V	IV
21	A+B	Total	TL	Cable graft with SN	7	IV	III
22	A+B	Total	TL	Cable graft with SN	3	V	III
23	A+B	Total	TL	Cable graft with SN	none	I	III
24	A+B	Total	TL	Cable graft with SN	4	III	IV
25	A+B	Total	TL	Hypoglossal facial crossover	32	IV	IV
26	A+B	Total	MF	Cable graft with SN	1	VI	III
27	A+B	Total	TM	Cable graft with SN	2	IV	V
28	A+B	Total	TL	Cable graft with SN	4	IV	IV
29	A+B	Total	TL	Cable graft with SN	2	III	III

[a]This patient was preoperatively diagnosed with vestibular schwannoma, but tumors were found to have originated from the FN during the middle fossa approach.
FN: facial nerve; FNP: facial nerve palsy; GAN: greater auricular nerve; H–B: House–Brackmann; ITF: infratemporal fossa approach; MF: middle fossa approach; SN: sural nerve; SP: subtotal petrosectomy; preop: preoperative; postop: postoperative; TL: translabyrinthine approach; TM: transmastoid approach

Table 3. Mean Duration of Facial Palsy According to Preoperative and Postoperative Facial Function

Facial Function	No. of Cases	Mean Duration of FNP (Months)
Preop H-B Grade ≤ III	11	11.5±5.2
Preop H-B Grade > III	14	33.1±16.8
Postop H-B Grade ≤ III	12	5.4±1.5*
Postop H-B Grade > III	13	40.4±17.8*

FNP: facial nerve palsy; H–B: House–Brackmann; preop: preoperative; postop: postoperative
*: $p<0.05$

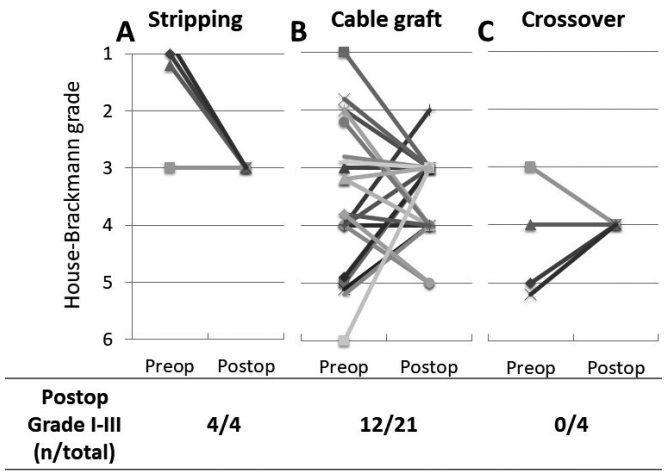

Figure 1. a-c. Pre- and postoperative facial nerve functions according to the type of facial nerve manipulation. (a) Nerve-stripping surgery, (b) cable nerve graft, and (c) hypoglossal facial crossover. Preop: preoperative; postop: postoperative

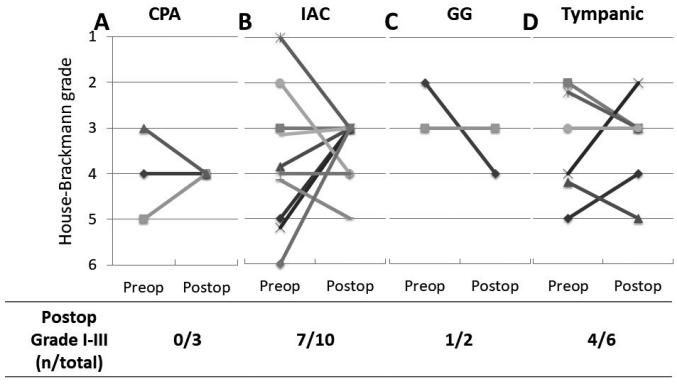

Figure 2. Pre- and postoperative facial nerve functions according to the proximal location of the facial nerve anastomosis in patients after cable nerve grafting.
CPA: cerebropontine angle; GG: geniculate ganglion; IAC: internal auditory canal; preop: preoperative; postop: postoperative; tympanic: tympanic segment of facial nerve

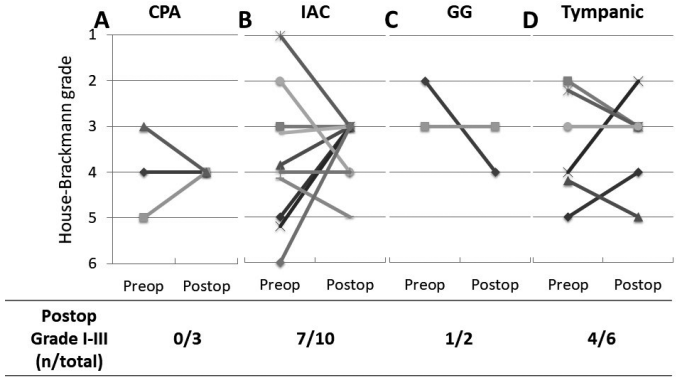

Figure 3. Pre- and postoperative facial nerve functions according to the distal location of the facial nerve anastomosis in patients after cable nerve grafting.
Mastoid: mastoid segment of facial nerve; preop: preoperative; postop: postoperative; SMF: stylomastoid foramen; tympanic: tympanic segment of facial nerve

Facial palsy is known to be the most frequent symptom in patients with FNS [18] and was the most frequent symptom in 22 of our 29 patients (75.8%).

The management of FNS varies and includes observation with serial MRI scans, FN decompression, stereotactic radiation, nerve-stripping surgery, and surgical resection, followed by cable nerve grafting with a donor nerve and hypoglossal facial crossover. The treatment of FNS should be chosen according to the preoperative FN function, tumor size increase, and tumor location [15].

Currently, observation protocols are considered acceptable for patients with FNS who lack central nervous system complications and have good facial function [15]. Observation or watchful waiting is possible for patients with H-B Grades I or II. Some investigators have reported successful nerve preservation surgery in patients with H-B Grades I or II [13, 14]. However, surgeries generally are not accepted in patients with normal facial function because of the risk of FN palsy exacerbation postoperatively. Our study included four cases (Cases 1, 3, 9, and 23) with the H-B Grade I, all of whom postoperatively exhibited the H-B Grade III.

In our study, 4 patients (Cases 1-3 and 9) underwent nerve-stripping surgery, 1 (Case 106 2) maintained the preoperative FN function of the H-B Grade III, and 3 (Cases 1, 3, and 9) 107 postoperatively showed the FN function of the H-B Grade III. Total lesion removal with FN reconstruction is the preferred classic procedure for patients with severe facial palsy or a large tumor [1, 12]. The H-B Grade III occurred in 52.4% of patients and the H-B Grade IV in 33.3% after cable nerve grafting. Wilkinson et al. [15] and McMonagle et al. [6] showed that 84%-85% of patients after cable nerve graft demonstrated the H-B Grade III or IV, which is consistent with our data. Other researchers have reported that 70% of patients had the H-B Grade III or IV after cable nerve grafting [7]. All 4 of our patients who underwent a hypoglossal facial crossover had the H-B Grade IV compared with 67% of patients overall [6]. All 8 patients who underwent hemihypoglossal FN anastomosis had the H-B Grade III, and this result coincides with the previous report [19].

In our study, the H-B Grade III was postoperatively achieved in 100% of the patients after nerve-stripping surgery, the H-B Grade III or IV in 85.6% after cable nerve grafting, and the H-B Grade IV in 100% after hypoglossal facial crossover.

CONCLUSION

Surgery can be considered for patients with FNS who have the H-B Grade III or worse. Nerve-stripping surgery resulted in better postoperative FN function than cable nerve grafting and hypoglossal facial crossover in our patients. The postoperative FN function was better in patients with the proximal end of the cable graft in IAC, GG, and tympanic segments of FN than in those with the proximal end in CPA. Patients with the distal end of the cable graft in the tympanic or mastoid segments of FN tended to show better postoperative FN results than those with the distal end in the stylomastoid foramen. Patients with better postoperative facial function showed a shorter duration of facial palsy prior to surgery.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committees of Asan Medical Center (2015-0244), Seoul

National University Hospital (1807-018-956) and Seoul National University Bundang Hospital (B-1611/369-107).

Informed Consent: Informed consent is not necessary due to the retrospective nature of this study.

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