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

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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].

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

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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 intratemporal FNS who underwent surgical excision at one of three independent tertiary hospitals between 1994 and 2015.

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 weakness 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 \[1,7,16\].

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) |
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 Manipulation (Mo) | 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    |

*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
Facial palsy is known to be the most frequent symptom in patients with FNS 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) 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]

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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.

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