Delayed facial palsy after microvascular decompression for hemifacial spasm: friend or foe?

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OBJECTIVE The authors investigated the incidence, clinical course, and predisposing factors associated with delayed facial palsy (DFP) following microvascular decompression (MVD).

METHODS The authors reviewed the records of 310 patients (311 cases) who were followed after MVD for hemifacial spasm (HFS). Of these patients, 45 (14.5%) developed DFP after MVD. The clinical characteristics and predisposing factors of the patients with HFS were investigated to identify prognostic factors that predicted the development of DFP after MVD. Log-rank tests were used to compare times to symptom disappearance, and a logistic regression analysis was performed to compare clinical characteristics between patients who developed DFP and those who did not.

RESULTS HFS was completely resolved immediately after MVD in 158 cases (50.8%), and HFS eventually disappeared in 289 (92.9%) of the cases. Of the 45 patients with DFP, 17 were men and 28 were women. DFP occurred between postoperative Days 1 and 44 (mean 9.67 days). Finally, 44 patients (97.8%) completely recovered. The average time to recovery was 3.9 months (range 1–24 months). Patients who had experienced an immediate disappearance of HFS experienced a significantly higher occurrence of DFP than those who did not (odds ratio 0.383, 95% confidence interval 0.183–0.802; $p = 0.011$). In addition, preoperative botulinum neurotoxin injections negatively influenced the occurrence of DFP ($p = 0.016$).

CONCLUSIONS In this study, the incidence rate of DFP was slightly higher than previously reported values. Moreover, DFP can occur even when spasms disappear immediately after MVD, but the patients with DFP can fully recover within weeks.

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KEY WORDS delayed facial palsy; hemifacial spasm; microvascular decompression; functional neurosurgery

HEMIFACIAL spasm (HFS) was originally described by Gowers as a condition characterized by the voluntary contraction of muscles in the region innervated by the ipsilateral facial nerve.³⁴ The prevalence of HFS appears to be much higher in some Asian races than in Western races, although precise epidemiological data are not available. Most cases occur unilaterally, and onset begins in the orbicularis oculi muscles. The most common cause of HFS is the compression of the facial nerve by cerebral arteries.^{2,5,9,25,28} Botulinum neurotoxin (Botox) is

commonly used to treat medication-refractory HFS. Another treatment modality that is widely used to treat HFS is microvascular decompression (MVD), which has been shown to completely cure HFS.⁴ However, some complications have been reported in association with the surgical approach, particularly for surgeries performed near the facial and vestibulocochlear nerve complexes.⁶ One such complication is delayed facial palsy (DFP), which is a transient or self-limited and unpredictable condition. Although most cases of postoperative facial palsy have am-

ABBREVIATIONS CI = confidence interval; CISS = constructive interference in steady state; DFP = delayed facial palsy; fEMG = facial electromyography; HB = House-Brackmann; HFS = hemifacial spasm; LSR = lateral spread response; MVD = microvascular decompression; OR = odds ratio; PTA = pure tone audiometry; REZ = root entry zone; SDA = speech discrimination audiometry; SNUH = Seoul National University Hospital; VA = vertebral artery.

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ambiguous causes, intraoperative damage can cause permanent facial palsy. The definition of DFP is a sudden onset of symptoms that usually occurs more than 24 hours after the operation.^{3,12,23,30} DFP is not a rare complication after MVD for HFS. As shown in previous reports, the rate of DFP following MVD is 2.8%–10.4%.^{12,18,19,21,23,30} Nonetheless, few studies have explored DFP after MVD.

The aim of the present study was to investigate the clinical course and incidence of DFP following MVD and to use a literature review to identify predisposing factors associated with this condition.

Methods

Study Population

Three hundred and twelve patients who were followed up after MVD surgery at the Seoul National University Hospital (SNUH) between September 2006 and June 2015 were identified as candidates for this study. All included patients suffered from medically refractory HFS. The exclusion criteria included undergoing a revision surgery. Of the 312 evaluated patients, 310 fulfilled the inclusion criteria. One patient underwent bilateral MVD for bilateral HFS.

To determine whether DFP frequently occurs in a particular age group, we divided the patient group based on generation (twenties, thirties, forties, fifties, sixties, and >70) and compared the DFP frequency among the divided groups. The following clinical characteristics of patients with HFS were investigated to identify prognostic indicators for the development of DFP after MVD: age, sex, side of spasm, preoperative symptom duration, follow-up duration after MVD, and offending vessels. We categorized patients into 4 groups according to the offending vessel. Cases that presented with the involvement of both the vertebral artery (VA) and small perforating arteries were considered “VA.” “Complex” was defined as the presentation of 2 or more large, dominant, offending vessels with clear proximity to the facial nerve. No vein was observed to compress the root entry zone (REZ) in any case.

Weakness associated with facial palsy was assessed using the House-Brackmann (HB) scale, which assigns patients to 1 of 6 classes. Our definition of postoperative DFP was facial weakness that was scored up to Grade II on the HB scale more than 24 hours after undergoing MVD involving the facial nerve. We evaluated the following clinical characteristics in all patients: age, sex, side of MVD, preoperative symptom duration, follow-up duration after MVD, offending vessel, obesity, postoperative hearing loss, postoperative hearing reduction (including hearing loss), and preoperative Botox injection. Obesity is considered when patients have a body mass index greater than 25 kg/m². We investigated the following prognostic factors in the patients with DFP: age, sex, side of spasm, offending vessels, smoking, alcohol, hypertension, diabetes mellitus, and obesity. Patient characteristics and demographics are described in Table 1.

We divided and analyzed the patients according to 3 additional factors (Teflon felts, lateral spread response [LSR], and Botox injections) to investigate the possible influence of other variables on the incidence of DFP. Tef-

lon felts were counted for all patients who underwent 3D constructive interference in steady state (3D-CISS) at 1 year after MVD. The obtained images were analyzed and recorded using electronic medical records. We inserted at least 3 Teflon felts in every patient, so the number was defined as “3” when the felts were not observed in 3D-CISS except in vessels. Patients with complete LSR recordings were investigated. LSR was subdivided into zygomatic and mandibular branches based on its status to identify correlations between the LSR recordings and the incidence of DFP. Finally, the influence of Botox injections was analyzed to identify possible relations with the development of DFP. The IRB of SNUH approved this study.

Pre- and Postoperative Evaluation Protocol

Preoperative and postoperative evaluations were performed according to a previously described SNUH protocol. All patients were admitted to the SNUH for preoperative evaluations, which included temporal bone CT, internal auditory canal MRI, pure tone audiometry (PTA), and speech discrimination audiometry (SDA). Clinical outcomes were assessed immediately after MVD; at 1, 2, 3, and 6 months postoperatively; and at 1, 2, 3, 5, and 7 years by the surgeon and a specially trained nurse. PTA-SDA was assessed preoperatively and after 6 months, and at 1, 3, 5, 7, and 10 years.

Immediately after MVD, we determined the status of both facial palsy and HFS and included all new cases of facial palsy that occurred within 24 hours after surgery. If DFP occurred during the follow-up period, we rechecked symptom improvement at 2 weeks after treatment for DFP was started. Patients were administered oral prednisolone (1 mg/kg/day), which was gradually tapered off over 2 weeks.³¹ In severe cases of DFP (HB Grade IV), an intravenous infusion of methylprednisolone was administered for 5 days. None of the patients exhibited signs of infection, such as blisters around the lips, when DFP occurred. Serological studies for specific herpes simplex virus antibodies and antiviral drugs were not performed in the patients with DFP who underwent MVD.

Patients were observed postoperatively until spasms and facial palsies completely disappeared. Additionally, the time from HFS re-occurrence after MVD to its complete disappearance was observed and recorded for the analysis.

Surgical Procedure

All surgical procedures were performed via a previously described lateral retrosigmoid suboccipital approach.^{1,14,29,32} First, intraoperative brainstem auditory-evoked potentials, facial electromyography (fEMG), and LSR were recorded prior to surgery. A lazy-S skin incision was made medially behind the ear along the hairline. A bone flap approximately 3 cm in diameter was removed using a high-speed drill. An incision was made in the dura mater along the inferoposterior margin of the sigmoid sinus, and the CSF was then drained enough to relax the cerebellum. Using an operating microscope, we gently dissected the arachnoid membrane to expose the REZ, relaxed the brain, and minimized traction on cranial nerve VIII. We designed Teflon felts (Impra Inc., a subsidiary

TABLE 1. Demographic and clinical characteristics of the patient groups

Variable	Total	DFP		p Value
		Yes (%)	No (%)	
Sex (M/F)	102/208	17/28	85/181	0.442
Side of MVD (rt/lt/both)	173/136/1	18/27/0	118/146/1	0.554
Age at op (yrs)				0.448
Mean $\pm$ SD	55.62 $\pm$ 10.86	56.76 $\pm$ 11.61	55.42 $\pm$ 10.74	
Range	24–80	32–80	24–79	
Preop symptom duration (mos)				0.563
Mean $\pm$ SD	61.10 $\pm$ 52.51	65.29 $\pm$ 56.80	60.39 $\pm$ 51.84	
Range	3–360	3–252	3–360	
Spasm immediately after MVD				0.007
Disappearance	158	33 (20.9)	125 (79.1)	
Improvement	143	12 (8.4)	131 (91.6)	
No improvement	9	0	9 (100.0)	
Aggravation	1	0	1 (100)	
Spasm at final follow-up				0.765
Disappearance	289	44 (15.2)	245 (84.8)	
Improvement	17	1 (5.9)	16 (94.1)	
No improvement	2	0	2 (100.0)	
Aggravation	3	0	3 (100.0)	
Offending arteries				0.161
AICA	206	27 (13.1)	179 (86.9)	
PICA	31	7 (22.6)	24 (77.4)	
VA	38	3 (7.9)	35 (92.1)	
Complex	36	8 (22.2)	28 (77.8)	
Obesity				0.954
Yes	137	20 (14.6)	117 (85.4)	
No	174	25 (14.4)	149 (85.6)	
Postop hearing loss				0.203
Yes	11	3 (27.3)	8 (72.7)	
No	300	42 (14.0)	258 (86.0)	
Postop hearing reduction*				0.027
Yes	31	9 (29.0)	22 (71.0)	
No	280	36 (12.9)	244 (87.1)	
Preop Botox injection				0.065
Yes	99	9 (9.1)	90 (90.9)	
No	212	36 (17.0)	176 (83.0)	

AICA = anterior inferior cerebellar artery; PICA = posterior inferior cerebellar artery.

Bold type indicates statistical significance.

* Included postoperative hearing loss.

of C. R. Bard, Inc.) with a narrow and long shape and inserted them between the REZ and the offending artery to subsequently identify the offending vessel loop.¹⁷ After thorough irrigation, the dura mater was closed with a watertight seal.

Statistical Analysis

All analyses were performed using SPSS (version 21.0, IBM Corp.). The results were expressed as a percentage and the mean $\pm$ standard deviation. The Student t-test, Fisher's exact probability test, and chi-square test were

used for the statistical analyses. Moreover, a logistic regression analysis was used to identify prognostic factors for DFP in patients who underwent MVD using the factors shown in Tables 1 and 2. A correlation analysis was performed to test for associations with HB grades using the Spearman rank correlation coefficient. Kaplan-Meier survival curves are presented for the time to symptom disappearance after MVD. The log-rank test was used to compare the time to symptom disappearance between the 2 study groups. A statistical threshold of $p < 0.05$ (2-tailed) was used to determine significance.

Results

Overall Clinical Outcomes

HFS completely resolved immediately after MVD in 158 cases (50.8%). HFS had completely disappeared at the last follow-up after MVD in 289 cases (92.9%). No immediate postoperative facial palsy was observed, but 45 patients (14.5%) developed DFP after MVD.

The age distribution for patients with DFP was: 0% of the patients were in their twenties (0/7), 22.2% were in their thirties (4/18), 14.3% were in their forties (8/56), 14.7% were in their fifties (16/109), 10.5% were in their sixties (10/95), and 26.9% were older than 70 years (7/26). There was no significant difference in prevalence according to age (Fig. 1).

The average preoperative symptom duration was 65 months, and the median was 60 months (range 3–252 months). Of the 45 patients affected, 17 were men, and 28 were women. Twenty-seven patients had spasms on the left side, and 18 patients had spasms on the right side. The mean duration of the follow-up period was 27 months (range 2–84 months).

As shown in Table 1, the spasm state immediately after MVD and postoperative hearing reduction ($p < 0.05$) were the only variables with a statistically significant association with the incidence of DFP between patients who did and did not develop DFP after MVD. Of the 9 DFP cases with postoperative hearing reduction, 6 (66.7%) displayed DFP the day after surgery. Finally, we observed that only one-third of the patients had received a Botox injection prior to MVD, and no statistical correlation was observed between the occurrence of DFP and Botox injections.

The onset of DFP occurred on average on postoperative Day 9.67 ± 10.05 (range 1–44 days; Fig. 2A). The time to complete remission of palsy averaged 3.90 ± 4.63 months (range 1–24 months), when the value was calculated after patients with residual facial palsy at the last follow-up were excluded (Fig. 2B). Twenty-six patients (57.8%) were HB Grade II, 12 (26.7%) were Grade III, and 7 (15.6%) were Grade IV (Fig. 2C). Final outcomes were measured in terms of the complete recovery of DFP (HB Grade I). DFP was resolved completely in 40 patients (88.9%). All patients who were HB Grade IV recovered completely, while 23 (88.5%) and 9 (75%) patients who were Grade II and Grade III, respectively, had completely recovered at the final examination. A total of 44 patients (97.8%) completely recovered. Unfortunately, of the cases with DFP, 4 had residual weakness, and 1 displayed no improvement in symptoms at the end of follow-up. We confirmed that 4 patients with residual weakness exhibited a complete recovery, whereas when evaluated through telephone interviews, 1 patient reported continued symptoms. Therefore, we excluded these patients from the calculation of time to complete remission of palsy because we could not determine their exact recovery time points.

Figure 3 shows that there was a significant difference in HFS disappearance between patients who underwent MVD with and without DFP: patients with DFP had a higher probability of symptom disappearance after MVD ($p = 0.005$, log-rank test).

A logistic regression analysis revealed that the disap-

pearance of spasms immediately after MVD was the only prognostic factor that predicted the occurrence of DFP. The odds ratio (OR) for improvement in spasms was 0.383 (95% confidence interval [CI] 0.183–0.802). The risk of DFP occurring in the group that showed improvement in spasms was 0.383-fold lower than the risk of DFP in the group in which spasms disappeared (Table 2). The onset of DFP after MVD was significantly correlated ($p < 0.05$) with the HB grade ($r = 0.321$), but the recovery time from the onset of DFP was not ($p > 0.05$; Table 3).

As shown in Table 4, 156 patients underwent 3D-CISS

TABLE 2. Logistic regression results for DFP

Variable	Cases	OR	95% CI	p Value
Age		1.011	0.976–1.048	0.532
Sex				
M	102	1		
F	209	0.760	0.318–1.819	0.538
Side of MVD				
Rt	137	1		
Lt	174	1.121	0.547–0.296	0.755
Offending vessel				
AICA	206	1		
PICA	31	1.953	0.714–5.337	0.192
VA	38	0.498	0.133–1.870	0.302
Complex	36	1.692	0.632–4.532	0.295
Spasm immediately after MVD				
Disappearance	158	1		
Improvement	143	0.383	0.183–0.802	0.011
No improvement	9	0.000		0.999
Aggravation	1	0.000		1.000
Postop hearing state				
Normal	280	1		
Decreased	20	2.585	0.783–8.535	0.119
Lost	11	1.658	0.371–7.415	0.508
Preop symptom period		1.002	0.996–1.009	0.475
Smoking				
No	278	1		
Yes	33	0.516	0.130–2.055	0.348
Alcohol				
No	222	1		
Yes	89	1.188	0.517–2.730	0.684
Hypertension				
No	235	1		
Yes	76	0.820	0.341–1.970	0.657
Diabetes mellitus				
No	299	1		
Yes	12	0.420	0.039–4.534	0.475
Obesity				
No	174	1		
Yes	137	0.874	0.426–1.791	0.713

Bold type indicates statistical significance.

FIG. 1. Graph of the occurrence of DFP in each generation, which corresponded to 14.5% of all cases. No significant difference was observed in the prevalence of DFP according to age. The values within the black bars indicate the percentage of patients with DFP in each generation.

sequences 1 year after MVD. Of these patients, 29 experienced DFP and 127 did not. Although a significant difference in the number of Teflon felts was not observed between the two groups, the patients with DFP had a higher median number of Teflon felts than the other group. In addition, complete LSR recordings were obtained for 110 patients who were included in this study. As shown in the table, 17 experienced DFP, and 93 did not. The comparisons of each outcome with the results of LSR monitoring indicated that there were no significant differences between the groups. The patients who had received more than 2 Botox injections prior to MVD experienced significantly less DFP than those who had not received a Botox injection or who received 1 Botox injection prior to surgery ($p = 0.016$).

Discussion

The incidences of DFP after MVD have been described

by several authors.^{12,18,19,21,23,30} Hongo et al.¹⁵ first noted this phenomenon in 1985 and reported that all affected patients exhibited a complete recovery within several weeks.

Table 5 shows the results of comparisons between the clinical results from our study and those from previous reports. The incidence of DFP following MVD was somewhat higher in our study (14.5%) than in previous studies (2.8%–10.4%).^{12,18,19,21,23,30} Other results described in these studies were similar to our findings. For example, the median range of the onset time after MVD was 7–12 days, and all patients experienced nearly complete recovery from DFP. Furthermore, consistent with a previous study,²³ we found no correlations between DFP and predictive variables, such as age, sex, and offending vessels. The current study also demonstrates that the immediate disappearance of HFS after MVD is one of the most important prognostic indicators of the onset of DFP.

The continuous outflow of CSF can cause a thin and long Teflon felt to temporarily move within a neurovas-

FIG. 2. Graphs showing the onset time for DFP (A; mean 9.67 days, range 1–44 days); the time to complete recovery from DFP (B; mean 3.9 months, range 1–24 months); and the HB scale grade for DFP (C).

FIG. 3. Kaplan-Meier survival curves depicting the probability of symptom disappearance within months after MVD for HFS in patients with or without DFP. Patients with DFP had a higher probability of symptom disappearance after MVD than those without DFP ($p = 0.005$).

cular region, and this could result in the unwanted stimulation of the nerve. The higher rate of DFP observed in our institution might result from such events. Additionally, although many different shapes and sizes of Teflon felts are preferred by surgeons, we cannot completely rule out the possibility that the number of felts contributes to the occurrence of DFP.

The term “lateral spread response (LSR)” is used to define the hyperexcitability of the facial motor nucleus induced by the compression of blood vessels or ephaptic transmission between facial nerve fibers, which is caused by various factors such as demyelination. Thus, LSR is widely used to predict adequate nerve decompression in addition to outcomes in MVD for HFS.¹³ However, in this study, the usefulness of LSR monitoring in predicting the occurrence of DFP was limited because there was no significant correlation between the incidence of DFP and LSR status (Table 4). Kim et al. also reported that the role of fEMG as a predictive factor for DFP is uncertain.¹⁹

Facial nerves are known to be more sensitive to external stimuli, they are influenced by electrical changes caused by decompression, which results in a higher frequency of DFP. DFP is speculated to occur less frequently once facial nerves have become insensitive to electrical changes because of various kinds of immune responses induced by Botox injections, such as antiinflammatory reactions. Moreover, multiple injections, rather than a single injection, have been reported to induce greater changes in the immune system,^{20,26} supporting our observation that the number of cases of DFP is lower in patients who received multiple Botox injections than in patients who only received a single injection.

According to our study, only one-third of the patients had previously received Botox injections; however, another study by Wang et al.³³ reported that two-thirds of

TABLE 3. Correlations between HB grade and time factors

Time Factor	HB Grade correlation
Postop onset of DFP (days)	0.321*
HB grade	1
Recovery time from onset of DFP (mos)	0.148

* Correlation significant at $p < 0.05$.

the patients had received Botox injections prior to MVD to treat HFS. Although Botox injections are regarded as a first line of treatment for medically refractory HFS in Western countries, they are not generally favored in South Korea, where acupuncture is traditionally highly preferred as a treatment for HFS. Thus, patients who had previously received acupuncture tended to choose MVD over Botox injections, which were commonly perceived as a similar treatment option to acupuncture because they both involve needle injection. For this reason, the patients probably preferred MVD because they experienced little or no improvements from acupuncture treatment.

In our study, a high HB grade was correlated with a late onset of DFP, but the recovery time from the onset of DFP was not related to the HB grade. Although almost all patients with DFP in our cohort recovered over time, 5 patients were left with residual facial paresis for a certain period of time after MVD. However, all but 1 patient reported that they were free of facial palsy at the last follow-up, which was performed via telephone interview. These cases were evaluated only to determine short-term recovery patterns: if the follow-up period had been extended to cover 1 year, more detailed information could have been obtained regarding their recovery status.

Treatment for DFP is aimed at facilitating a functional recovery. Some authors have reported that a combined treatment consisting of a corticosteroid and an antiviral agent is more effective for treating severe facial palsy than a corticosteroid alone.²² In our study, we did not perform antiviral marker tests or administer antiviral agents; nevertheless, most patients completely recovered from DFP. These results are similar to the results from a previous study showing that there is no significant difference in the recovery period between treatments.¹⁰ Figure 3 shows that the patients with DFP experienced significantly better clinical courses of recovery. Based on this result, it can be assumed that the occurrence of DFP is correlated with good outcomes in MVD.

Although DFP has been reported in various studies, its specific mechanisms remain elusive. Furthermore, DFP can develop even after a successful surgery. Many factors have been proposed as probable causes of DFP, including REZ injury to cranial nerve VII caused by a Teflon felt, delayed facial nerve edema, and a microcirculation disorder resulting from vasospasm,^{16,23,30} viral infection has also been implicated.^{8,27}

We propose the following mechanisms to explain the occurrence of DFP. First, a cranial nerve, such as cranial nerve VII, does not histologically have an epineurium. The absence of an epineurium means that there is no neural support for the facial nerve by a firm perineurium, and the facial nerve is therefore enveloped only by a single or double layer of flattened sheath cells without a continu-

TABLE 4. Number of Teflon felts and probability values for LSR monitoring and Botox injections in the two groups with and without DFP

Variable	Total	DFP		p Value
		Yes	No	
Teflon felts				
No. of patients	156	29	127	
Mean no. of Teflon felts ± SD (median)	4.59 ± 1.028 (4.5)	4.76 ± 1.023 (5)	4.55 ± 1.029 (4)	0.328
LSR (%)				0.571
Remained	39	5 (12.8)	34 (87.2)	
Disappeared	71	12 (16.9)	59 (83.1)	
LSR remained (%)				>0.999
Zygomatic branch	10	1 (10.0)	9 (90.0)	
Mandibular branch	8	1 (12.5)	7 (87.5)	
Both branches	21	3 (14.3)	18 (85.7)	
None	71	12 (16.9)	59 (83.1)	
Botox injection (%)				0.016
None or 1	249	42 (16.9)	207 (83.1)	
≥2	62	3 (4.8)	59 (95.2)	

Bold type indicates statistical significance.

ous basal lamina. Manipulations or stimulations of cranial nerve VII are therefore not mechanically buffered by the surrounding supportive tissues.²⁴ Second, the transition zone, a dome-shaped region of the REZ that differentiates between central myelination (by oligodendrocytes) and peripheral myelination (by Schwann cells), is known as the weakest point during manipulation (Fig. 4).^{11,24} The REZ is generally known to consist of central myelin and the transition zone to the cranial nerve. The transition zone from the REZ to cranial nerve VII is located in the immediate vicinity of the brainstem, and thus DFP may be triggered by the manipulation of the nerve during surgery. While the transition zone from the REZ to cranial nerve VIII is located at the internal acoustic meatus, it does not experience as much manipulation as cranial nerve VII during MVD.⁷ It is likely, however, based on our results, that such a manipulation triggers not only DFP but also hearing impairment because of the intimate contact between cranial nerves VII and VIII in the cerebellopontine angle (Table 1). Finally, the gradual development of postoperative edema that progresses into the operative field has been reported to cause DFP at the location where the cranial nerves overrun the body canals.²⁴ While the symptoms of DFP are not present

immediately after MVD, they manifest within 1–7 days. Steroid therapy has been shown to be effective in resolving edema in addition to treating cases of DFP that may have been caused by edema. Accordingly, most of the patients in our study completely recovered from facial weakness after steroid therapy.

Furukawa et al.⁸ described DFP after MVD for HFS that was caused by the reactivation of a virus, which may also underlie Bell's palsy. Because serological tests to detect viral antibodies were not performed in this study, we cannot exclude the potential involvement of a reactivated virus in the development of DFP. Likewise, the exact pathophysiology of DFP still remains controversial, although many studies have been and are being performed to fully elucidate its mechanism. Further studies are certainly needed to fully clarify the cause of DFP.

The occurrence of DFP after MVD has been reported in many studies. However, there have been no reports that demonstrated the possibility that DFP could be used as a prognostic indicator for patients with HFS. Therefore, through this study, we provide a new understanding on the occurrence of DFP after MVD in patients with HFS.

This study has several limitations. The first limita-

TABLE 5. Summary of previously reported results for DFP after MVD for HFS

Authors & Year	Cases (%)	Mean Yrs of Age (range)	Days of DFP Onset After MVD (range)	Time to Complete Recovery (range)
Kuroki et al., 1991	6 (7.5)	53.5 (41–77)	8 (7–10)	2.8 mos (1.5–6 mos)
Lovely et al., 1998	28 (2.8)	51.8 (28–79)	12 (7–16)	6.5 wks (1–28 wks)
Kim et al., 1999	12 (8.3)	53 (45–60)	8.2 (6–11)	6.3 mos (1–12 mos)
Furukawa et al., 2003	1	56	7	9 mos
Rhee et al., 2006	21 (5.4)	46.7 (33–62)	12.1 (7–23)	5.7 wks (25 days–17 wks)
Han et al., 2012	100 (7.4)	48 (25–65)	11.2 (2–23)	9.2 wks (16–270 days)
Kim et al., 2012	9 (10.4)	49.7 (26–63)	9.2 (3–14)	5.4 wks (22–57 days)
Present study	45 (14.5)	56.8 (32–80)	9.67 (1–44)	3.9 mos (1–24 mos)

FIG. 4. Drawing showing the components of cranial nerve VII root: 1) the central myelin portion of the root, 2) the transition zone (green lines), and 3) the peripheral myelinated portion of the root. The REZ of cranial nerve VIII is located at the internal acoustic meatus (IAM). Illustration by Jae Meen Lee. Copyright Sun Ha Paek. Published with permission.

tion is the variation in follow-up periods across patients. There were also some cases in which clinical evaluations were incomplete because of the retrospective nature of our study. The second limitation is that our study did not include a separate group of patients with DFP who received a treatment other than steroids. Finally, the number of Teflon felts was not counted in every patient, and LSR monitoring results were not obtained for every case. The influence of these limitations on the principal conclusions of this report can be significant and should not be minimized. However, to our knowledge, a possible role of DFP after MVD in regards to clinical outcome of patients with HFS has not been examined. Although further work is needed to investigate the potential impact of the above-mentioned limitations on the occurrence of DFP, our study provides clinically meaningful insights into the possible role of DFP after MVD as a prognostic indicator for outcome in patients with HFS. Finally, our study did not investigate the possible effects and correlations between Asian medications and/or treatment modalities (such as acupuncture, which is widely used to treat HFS in South Korea) and the incidence of DFP. This topic is worthy of further investigation to illuminate possible influences of Oriental medications on patients with DFP.

Conclusions

In this study, the incidence of DFP was slightly higher than previously reported values. Moreover, DFP may occur even when spasms disappear immediately after MVD, but the patients in this study exhibited a complete recovery within weeks. Surgeons should be aware that DFP may oc-

cur even when a hemifacial spasm disappears immediately after MVD. Moreover, significantly better results were observed in the patients with DFP than in those without DFP in terms of the overall disappearance of hemifacial spasms.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Conception and design: Paek, Lee, SM Kim, Jeon, HJ Kim, DG Kim. Acquisition of data: Lee, Choi. Analysis and interpretation of data: all authors. Drafting the article: Paek, Lee. Critically revising the article: Lee, SM Kim. Reviewed submitted version of manuscript: Lee, Jeon, HJ Kim, DG Kim. Statistical analysis: Lee. Administrative/technical/material support: Choi. Study supervision: Park, SM Kim, HJ Kim, DG Kim.

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