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ORIGINAL ARTICLE - FUNCTIONAL NEUROSURGERY - OTHER

Delayed hearing loss after microvascular decompression for hemifacial spasm

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Abstract

Background This study aimed to analyze cases of delayed hearing loss after microvascular decompression (MVD) for hemifacial spasm and identify the characteristic features of these patients.

Methods We retrospectively reviewed the medical records of 3462 patients who underwent MVD for hemifacial spasm between January 1998 and August 2017.

Results Among these, there were 5 cases in which hearing was normal immediately postoperatively but delayed hearing loss occurred. None of the 5 patients reported any hearing disturbance immediately after the operation. However, they developed hearing problems suddenly after some time (median, 22 days; range 10–45 days). On examination, sensorineural hearing loss was confirmed. High-dose corticosteroid treatment was prescribed. Preoperative hearing levels were restored after several months (median duration from the time of the operation, 45 days; range 22–118 days). Interestingly, the inter-peak latency of waves I–III in the brainstem auditory evoked potential (BAEP) was prolonged during the surgery, but recovered within a short time.

Conclusion Delayed hearing loss may occur after MVD for HFS. Prolongation of the inter-peak latency of waves I–III seems to be associated with the occurrence of delayed hearing loss. It is possible that BAEP changes may predict delayed hearing loss, but confirmatory evidence is not available as yet. Analysis of more cases is necessary to determine the utility of BAEP monitoring to predict delayed hearing loss after MVD and to identify its exact cause.

Keywords Microvascular decompression · Hearing loss · Brain stem auditory evoked potentials · Hemifacial spasm

Introduction

Hemifacial spasm (HFS) is one of the common hyperactivity disorders of the cranial nerves caused by vascular compression [1]. Microvascular decompression (MVD) is the only surgical treatment modality that can directly treat the pathogenesis of HFS; it is a relatively low-risk treatment for cranial nerve hyperactivity disorders [2–4]. However, it is associated with a risk of postoperative complications, among which hearing loss is one of the more serious [5, 6]. Various etiologies have been suggested for hearing loss, but the issue needs to be investigated further. Considerable effort has been invested in reducing the incidence of this complication. It has been reported that changes in brainstem auditory evoked potentials (BAEPs) may predict the risk of postoperative hearing loss [7]. Most cases of hearing loss occur during surgery, and the risk can be lowered by BAEP monitoring. However, delayed hearing loss may also occur. In the present study, we report cases of delayed hearing loss after MVD for HFS and present an analysis of the characteristic features of these patients.

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Methods

Patients and data collection and evaluation

We retrospectively reviewed the medical records of 3462 patients who underwent MVD for HFS between January 1998

and August 2017. All surgeries were performed by a single surgeon (Park, K) at Samsung Medical Center in Seoul, Korea. Preoperative evaluation and surgical procedures were the same as described elsewhere [4]. In brief, all patients underwent the following preoperative evaluations: magnetic resonance imaging, magnetic resonance angiography, temporal bone computed tomography (CT), facial nerve conduction study, electromyography, BAEP monitoring, pure tone audiometry (PTA), and speech discrimination score (SDS). A non-contrast brain CT scan was performed 1 day after the MVD procedure. Three days after MVD, follow-up PTA, SDS, and physical examination were performed by the otolaryngologist. Patients visited the outpatient clinic 2 to 4 weeks after discharge for evaluation of the clinical outcomes. Follow-up visits were then scheduled on a case-by-case basis.

Delayed hearing loss was defined as the absence of any abnormality on PTA and SDS on the third postoperative day, followed by occurrence of hearing difficulty after some time.

Surgical procedures and intra-operative monitoring

Retrosigmoid suboccipital craniectomy was performed as described by McLaughlin et al. [8]. Briefly, a small suboccipital craniectomy was performed. After opening the dura mater, the cerebellum was gently retracted to expose the trigeminal or facial nerve. Several Teflon balls and threads were inserted between the affected cranial nerve and the corresponding vessels to relieve compression. If a mastoid air cell was opened, it was meticulously sealed with bone wax, and a muscle patch was placed on the opened surface [9]. During surgery, BAEP monitoring and facial electromyography were performed from the time of general anesthesia administration until dural closure.

The study protocol was reviewed and approved by the Institutional Review Board of Samsung Medical Center (SMC 2014-04-028-001). The requirement for informed consent was waived, as the study used existing clinical data.

Results

During follow-up, 5 cases were observed in which there was no hearing abnormality on the third postoperative day, but hearing difficulty developed later. These cases were reviewed and analyzed in detail.

In all five cases, the operation had been uneventful. However, interestingly, a prolongation of the inter-peak latency of waves I–III was observed during BAEP monitoring intraoperatively. (median, 0.6 ms; range, 0.4–0.96 ms). However, the inter-peak latency returned to normal before the completion of the operation. At that time, this was assumed to be a nonspecific finding. The patients did not report any hearing difficulties immediately postoperatively. In addition, PTA and SDS performed 3 days after surgery showed the same results as those before surgery. However, a few weeks later, from the time of the operation (median, 22 days; range 10–45 days), the patients suddenly complained of hearing difficulty. On examination, sensorineural hearing loss (SNHL) was confirmed. High-dose corticosteroid treatment with methylprednisolone was prescribed. Several months later from the time of the operation (median, 45 days; range 22–118 days), preoperative hearing levels were restored.

The detailed clinical course of each patient is presented in Table 1. The detailed PTA/SDS and intra-operative BAEP monitoring results are provided in the supplementary figures.

Case illustration

Case no. 5 (Fig. 1)

A 50-year-old woman presented to our clinic with a 6-year history of left-sided HFS. Preoperatively, her hearing was within the normal range. During the surgery, the decompression went well without any problems. The anterior inferior cerebellar artery and its perforators were compressing the facial nerve at the stem side. The nerve was decompressed with Teflon-felt threads. During surgery, there were noticeable changes in BAEP indicating prolongation of the inter-peak latency of waves I–III. There was a prolongation of 0.96 ms, from 2.47 to 3.43 ms. The changes in the inter-peak latency disappeared by the end of the surgery but the initial waveform was not completely restored. After surgery, the patient did not report any particular hearing difficulties. PTA and SDS tests performed 3 days after the surgery yielded normal results, similar to those before the operation. On postoperative day 21, the patient developed sudden grade 3 facial nerve palsy, and significant hearing difficulty developed on postoperative day 22. The patient visited the emergency room and was diagnosed with SNHL and prescribed methylprednisolone. Her facial palsy improved after 1 week, and SNHL improved 1 week after that. PTA and SDS tests performed 4 months after the operation yielded normal results, indicating recovery to the preoperative status. The preoperative HFS disappeared after surgery. At the time of the most recent check-up, only a very minimal spasm, which occurred intermittently once or twice, remained.

Discussion

The incidence of hearing loss after MVD is reported to be approximately 1–3% [4, 16]. Most cases occur immediately after surgery, and the etiology is still not clear. The possible causes of hearing loss after MVD have been reported to be the stretching of the 8th cranial nerve during cerebellar retraction,

Table 1 Summary of cases presenting with delayed hearing loss after microvascular decompression

References	Cases	Dx	Sex	Age	Affected side	Preoperative hearing status	Intra op BAEP findings	Immediate postop haring status (within a week)	The time the hearing loss occurred (postoperative days)	Management	Auditory outcome
Present study	Case 1	HFS	F	43	L	NL	Prolongation of wave I–III inter-peak latency	No specific findings	37 days	MPD	Fully recovered in POD#78
	Case 2	HFS	F	57	R	NL	Prolongation of wave I–III inter-peak latency	No specific findings	45 days	MPD	Fully recovered in POD#54
	Case 3	HFS	F	56	L	Mild HL	Prolongation of wave I–III inter-peak latency	No specific findings	18 days	MPD	Nearly recovered in POD#22
	Case 4	HFS	M	39	L	NL	Prolongation of wave I–III inter-peak latency	No specific findings	10 days	MPD	Fully recovered in POD#41
	Case 5	HFS	F	50	L	NL	Prolongation of wave I–III inter-peak latency	No specific findings	22 days	MPD	Fully recovered in POD#118
Onoda et al. [10]	Case 1	HFS	F	59	L	NL	Not documented	No specific findings	7 days	Steroid	Recovered after 2 months
	Case 2	HFS	M	39	R	NL	Not documented	No specific findings	7 days	Steroid	Recovered after 2 months
Kuchta et al. [11]	Case 1	TN	F	36	L	NL	Latency shift of peak V	Slight hearing impairment in POD#3	3 days	Not documented	Not recovered in 6 days
Fuse and Moller [12]	Case 1	HFS & TN	F	52	L	Mild HL	Not documented	No specific findings	3 years	Explorative operation	Not recovered after second operation
McDonnell et al. [13]	Case 1	TN	F	40	R	NL	Not documented	Unremarkable	3 weeks	Not documented	Not recovered in 2 years
	Case 2	HFS	M	65	L	Mild HL	Not documented	Hearing difficulty in POD#3	3 days	Not documented	Not recovered in 6 months
Schwartz and Gennarelli [14]	Case 1	TN	F	38	R	NL	Latency shift of peak V	Mild hearing difficulty in POD#2	2 days	Not documented	Not documented
Jung et al. [15]	case 1	HFS	Not documented					Mild discomfort	Not documented		Not recovered in 1 month
	case 2	HFS	Not documented					Mild discomfort	Not documented		Not recovered in 1 month

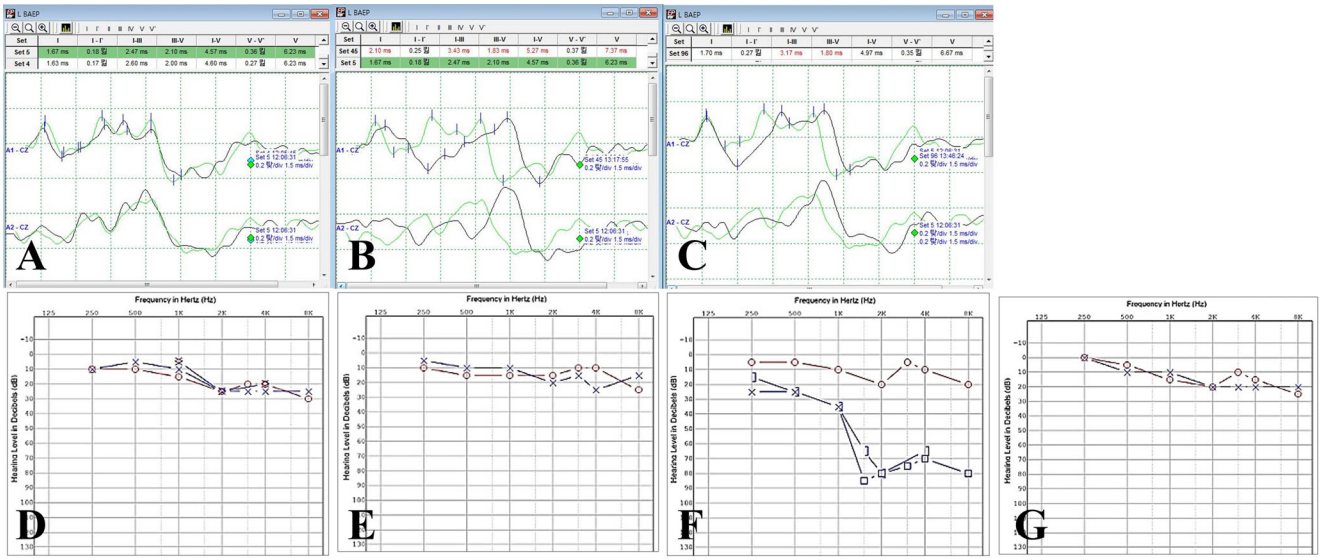

Fig. 1 Case illustration (case no. 5). A 50-year-old woman underwent MVD for HFS. **a** During the operation, initially, brainstem auditory evoked potential (BAEP) showed no unusual findings. **b** Intraoperatively, sudden prolongation of the inter-peak latency of waves I–III was observed. There was a prolongation of 0.96 ms, from 2.47 to 3.43 ms. **c** BAEP findings improved to some extent before the end of the surgery. **d** Preoperatively, pure tone audiometry and speech discrimination tests yielded normal results. **e** On postoperative day 3, the patient had normal hearing test results and was discharged from the hospital. **f** On postoperative day 22, the patient complained of hearing difficulty and tests confirmed high-frequency sensorineural hearing loss. Corticosteroid treatment was prescribed. **g** Four months after the operation, hearing function had improved to the preoperative level

direct mechanical trauma to the 8th cranial nerve by manipulation or coagulation, or secondary ischemic change caused by injury to the labyrinthine artery or anterior inferior cerebellar artery during manipulation [6, 17, 18]. All five patients included in this study had HFS. Among patients who underwent MVD with trigeminal neuralgia (TN) during the same period, no patients with delayed hearing loss were reported. Although hearing loss is more common in HFS than TN, it is not known whether delayed hearing loss occurs only in HFS [4]. In previous studies, delayed hearing loss has also been reported in some patients with TN. A previous study reported that hearing loss after MVD for HFS could be classified into four different categories based on the deterioration in hearing observed in PTA and SDS performed 3 days after surgery [18]. However, the delayed hearing loss observed in the patients included in the present study cannot be classified into any of the four categories. It has been suggested previously that the distance of retraction during surgery can be a predictor of hearing loss [19]. Further, it has also been reported that intradural compression due to overinfusion of saline may lead to postoperative hearing loss [20]. However, these causes seem unrelated to delayed hearing loss.

We have previously analyzed the hearing loss after MVD in HFS patients [4]. Five patients with delayed hearing loss identified in this study were not included in the study at that time. At that time, we defined the definition of hearing loss as abnormal within 7 days after surgery. One case was included in the analysis at the time, but was excluded from the analysis because it did not fall under this criterion.

Although cases of delayed hearing loss have been reported in the past, their rarity makes it difficult to identify the exact cause [10–15]. The two cases reported by Onoda et al. [10] are very similar to our cases. Although no BAEP findings were available, their patients complained of hearing abnormalities on postoperative day 7. They were treated with corticosteroids and the symptoms showed improvement after 2 months [21]. In other reported cases, no improvement in symptoms was observed at the time of the last follow-up.

There have been many reports of delayed facial palsy after MVD for HFS. The incidence is reported to be 2.8–10.4% [15, 22–25]. It is not a rare complication. It has also been reported after MVD for TN [26, 27]. The etiology of delayed facial palsy is still unknown, but in most cases, the clinical course has been benign. We have also encountered and reported one case of delayed unilateral soft palate palsy that developed 5 days after MVD [28]. As in the case illustrated above (case no. 5), it seems that delayed hearing loss and facial palsy may occur simultaneously. This suggests that these two conditions may have a similar etiology. However, there is still a lack of clear evidence regarding this. Previous studies have suggested that viral infection may be the cause of delayed facial palsy [25, 29, 30]. Unfortunately, no viral serologic tests were performed in the 5 cases reported in this article. There were no clinical findings indicative of viral infection, such as oral vesicles, at that time. More data would be required to investigate the role of viral infection in delayed hearing loss.

In the present study, all cases of delayed hearing loss showed prolongation of the inter-peak latency of waves I–

III. This indicates that the cause of the hearing loss was originated between the proximal part of the 8th cranial nerve and the pons. Previously, Polo et al. [31] reported a delay in latency of peak V as a warning value. Recently, based on our experiences, we have reported BAEP changes during surgery to be a critical warning sign [7]. Loss of wave V and latency prolongation of 1 ms with a decrease in amplitude of > 50% in BAEP were considered a warning sign predictive of postoperative hearing loss. However, as of now, it is difficult to pinpoint the clinical significance of prolonged inter-peak latency of waves I–III. A more specific and comprehensive analysis and study of changes in BAEP is warranted.

Limitations

Delayed hearing loss is very rare complication after MVD for HFS. Therefore, it is difficult to determine the exact incidence rate and to characterize the delayed hearing loss. The authors have not yet identified the incidence of prolonged inter-peak latency of waves I–III. Therefore, it is difficult to conclude that this is a characteristic feature of delayed hearing loss.

Conclusion

Hearing loss after MVD for HFS is a very serious complication. In particular, delayed hearing loss may occur after MVD. In some of these cases, high-dose corticosteroid treatment may be considered. Prolongation of the inter-peak latency of waves I–III seems to be associated with the occurrence of delayed hearing loss. Hence, it is possible that BAEP changes may predict delayed hearing loss, but this issue requires further investigation. Analysis of more cases will be necessary to identify the exact cause of delayed hearing loss and to determine whether BAEP monitoring can be used to predict delayed hearing loss after MVD for HFS.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee (Institutional Review Board of Samsung Medical Center/SMC 2014-04-028-001) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The requirement for informed consent was waived, as the study used existing clinical data.

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