The effect of Microvascular Decompression for Hemifacial Spasm caused by Vertebrobasilar Dolichoectasia

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This certifies that the Master's Thesis of Jeong Han Kang is approved.

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Jeong Han Kang

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ABSTRACT

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OBJECTIVE: Hemifacial spasm (HFS) consists of unilateral involuntary contractions of facial muscles innervated by the seventh cranial nerve and has some causes. Although the seventh nerve compression is occasionally caused by tumors or bony abnormalities, compression by a blood vessel is most common. Among this vascular compression, HFS caused by vertebrobasilar dolicoectasia (VBD) is very rare and difficult to decompress nerve from vascular compression. Therefore the objective of this study was to investigate the outcome of microvascular decompression (MVD) for HFS caused by VBD.

Materials and Methods: There were 10 patients with HFS caused by VBD between September 1978 and September 2008. We evaluated preoperative magnetic resonance angiography (MRA) and time of flight magnetic resonance image (TOF MRI) using the criteria of VBD. We compared the clinical outcome of MVD for 10patients with overall outcome of our 2058 MVD for HFS. Last, we analyzed complication occurrence of MVD for HFS related with VBD.

RESULTS: The results of MVD for HFS caused by VBD were successful (90.9%). Postoperative complication rate in VBD was 45.5%, greater than in non-VBD (24.7%). Offending vessels in VBD identified on operation view were 4 anterior inferior cerebellar artery (AICA), 1 posterior inferior cerebellar artery (PICA), 1 vertebral artery (VA), and 5 multiple artery. Adverse effects after MVD were found in 4 patients (2 patients with transient facial weakness, 1 patient with transient facial weakness and hearing impairment, and 1 patient with permanent facial palsy). We found that Diameter of VBD was significantly greater in complication than in no complication (p=0.028)

CONCLUSION: Our data shows that MVD may be a good treatment modality for HFS caused

by VBD but we need to be careful not to have adverse effects of MVD. Therefore, it is important to make dolichoectatic artery, from proximal portion to distal, enough detached from surrounding structure to be easily movable. Also we try to obtain much more working space for complete decompression without complication.

Key Word: Microvascular decompression, Hemifacial spasm, Vertebrobasilar dolichoectasia

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I. INTRODUCTION

Hemifacial spasm (HFS) is one of hyperactive cranial nerve dysfunction syndrome characterized by unilateral involuntary contractions of muscles innervated by the affected facial nerve. There are some causes of HFS, such as vessel, tumor, and bony abnormality. Sine Campbell and keedy[1] first described vascular arterial compression of the facial nerve among patients with HFS. The cause of this condition is thought to be mainly neurovascular compression of the facial nerve at its root exit zone from the brainstem[2]. Therefore, microsurgical neurovascular decompression (MVD) is now widely performed as the most logical and curative treatment of hemifacial spasm.

In generally, the offending vessels are anterior inferior cerebellar artery (AICA), posterior inferior cerebellar artery (PICA), vertebral artery (VA), or branch of these main arteries that we usually meet during MVD. But HFS caused by vertebrobasilar dolichoectasia (VBD) is quite rare[3]. Offending vessel related with VBD is difficult to move for MVD due to the character of enlargement and elongation. We have experienced several MVD for HFS resulting from VBD. We compare outcomes of MVD for HFS caused by VBD with non-VBD and analysis complication occurrence in MVD for HFS related with VBD.

II. DEFINITIONS

Vertebrobasilar dolichoectasia (VBD) means enlargement and elongation of the vertebrobasilar artery. To define vertebrobasilar dolichoectasia, we need criteria that define enlargement and elongation of vetebrobasilar artery. Smoker et al.[4-5] reviewed normal high-resolution computed tomographic (CT) scans of 123 patients and defined the diameter, height of the bifurcation, and transverse position of the normal basilar artery. According to smoker's criteria, we use the term elongation if the basilar artery, at any point throughout its course, lies in lateral position to the margin of the clivus or dorsum sellae (position 2, 3. Table 1) or the artery bifurcation lies above the plane of the suprasellar cistern (height 2, 3. Table 2). Enlargement is diagnosed if the diameter of the basilar artery is greater than 4.5 mm. Also, Giang et al.[6] reported MRI diagnosed VBD as well as CT, and it was proved to be superior to CT in delineating the anatomical relationship of the vessels to the neural structures. Although Smoker et al. defined normal basilar artery based on the data from CT, we measured elongation and enlargement on time of flight magnetic resonance image (TOF MRI) and magnetic resonance angiography (MRA).

Table 1 Criteria for Assignment of Basilar Artery Position

Position	Most Lateral Position Identified throughout Course of Basilar Artery
0	Midline throughout
1 (R or L)	Medial to lateral margin of clivus or dorsum sellae
2 (R or L)	Lateral to lateral margin of clivus or dorsum sellae
3 (R or L)	In cerebellopontine angle cistern

Table 2 Criteria for Assignment of Basilar Artery Height

Height	Plane of Basilar Bifurcation
0	At or below dorsum sellae
1	Within suprasellar cistern (one cut above dorsum)
2	At level of third ventricle floor (one cut above suprasellar cistern)
3	Indenting and elevating floor of third ventricle(two or more cuts above suprasellar cistern)

0.6 mm-thick, TOF MRI

III. PATIENTS AND METHODS

1. Patient population

2,064 MVDs for HFS were performed at Yonsei University Hospital between September 1978 and September 2008. In Six patients, HFS was not resulting from vessel, and they were excluded from this study. Among the remaining 2,058 cases, 2,047 patients (99.5%) had non-VBD vessel, 11cases (0.5%) had VBD vessel. One patient had bilateral HFS and was performed 2- stage MVD. The clinical outcome and image findings of TOF MRI and MRA of these 11 cases were analyzed.

2. TOF MRI and MRA evaluation

We retrospectively evaluated the preoperative available TOF MRI and MRA using the criteria previously described. Enlargement of vertebrobasilar artery was measured on MRA by Picture Archiving Communication System (PACS; GE Medical Systems, Milwaukee, WI) and diagnosed if the diameter of the basilar artery is greater than 4.5 mm. Elongation was evaluated on TOF MRI and diagnosed in the case of position 2, 3 or height 2, 3 (table 1, 2).

3. Clinical assessment and follow-up review

The Clinical data and intra-operative findings of the selected patients retrospectively were reviewed. After MVD, the patients were classified into the following five grades, on the basis of the degree of HFS present: 1) “excellent” if an HFS was absent; 2) “good” if the HFS was more than 90% resolved; 3) “fair” if the HFS was more than 50% resolved; 4) “poor” if the HFS was less than 50% resolved; and 5) “failure” for all remaining results. Also, “excellent” and “good” outcome was considered successful outcome.

4. Statistical Analysis

Comparisons between two groups (non-VBD vs. VBD) were tested for statistical significance whit the Fisher exact test. The complication occurrences of VBD were assessed using Mann-Whitney test. Probability values were 2-tailed, and values of $P < 0.05$ were considered significant. Case no 3 (table 4) was excluded from statistical analysis, considering its offender was not affected by dolichoectatic artery. All Data analyses were performed with PASW statistics version 18.0 (SPSS Inc., Somers, NY, USA).

IV. RESULTS

Clinical characteristics of 2,058 cases with HFS treated by MVD are summarized at Table 3.

Table 3 Clinical characteristics of 2058 cases with hemifacial spasm treated by maicovascualr decompression

		Non-VBD (n=2,047)	**VBD(n=11)**
Age(years)		49.4(20-77)	55.6(43-69)
Sex	Men	508(24.8%)	5(45.5%)
	Women	1,539(75.2%)	6(54.5%)
Symptom duration (years)		7(1-40)	5(1-20)
Postoperative follow-up (months)		17(6-226)	21.5(4-76)
Offending vessel	AICA	806(39.4%)	4(36.3%)
	PICA	850(41.5%)	1(9.1%)
	VA	131(6.4%)	1(9.1%)
	Multiple	256(12.5%)	5(45.5%)
	venous	4(0.2%)	0

The diameter, height, and transverse position of basilar arteries of VBD cases are presented in table 4. The mean diameter of the basilar arteries was 5.05mm (range, 4.61-5.93 mm). Offending vessels identified on operation view were 4 AICA, 1PICA, 1 VA, and 5 multiple artery. A patient with right offending VA (case no 4, figure 1) had left side facial spasm. In all cases except one, VA or basilar artery (BA, case no 2, figure 2) affected neurovascular

compression of facial nerve directly or over offending vessel. One case (case no 3, figure 3) had only AICA offending vessel that was not related with VA or BA compression. This patient had bilateral HFS that needed 2-stage MVD.

Table 4 Summary of eleven cases of hemifacial spasm caused by vertebrobasilar dolichoectasia

Case	Age(y)	Symptom	symptom	Intra-OP	TOF-MRI and MRA			result	complication
no.	/sex	duration(y)	side	Offender	Diameter(mm)	Height	Position		
1*	51/F	1	Left	VA, PICA	5.93	3	1	Excellent	FP, HI
2	48/M	2	Right	AICA(BA)#	5.34	2	2	Excellent	FP
3*	57/F	2	Right	AICA	5.93	3	1	Excellent	
4	69/M	5	Left	Right VA	4.90	2	2	good	P-FP
5	60/M	20	Left	AICA(VA)#	4.91	3	1	Excellent	
6	43/M	2	Left	VA,PICA	4.95	2	2	Excellent	FP
7	56/F	4	Right	AICA(VA)*	4.62	0	2	fair	
8	62/F	6	Left	VA,PICA	4.61	0	2	Excellent	
9	61/M	5	Left	PICA(VA)*	4.98	0	2	Excellent	
10	59/F	5	Left	VA,PICA	4.65	3	2	Excellent	
11	46/F	4	Left	VA,PICA	4.75	1	2	Excellent	

*: one patient who had bilateral HFS and underwent MVD twice. ( )#: over offender vessel, not direct contact. FP: facial palsy.

P-FP: permanent facial palsy. HL: hearing impairment

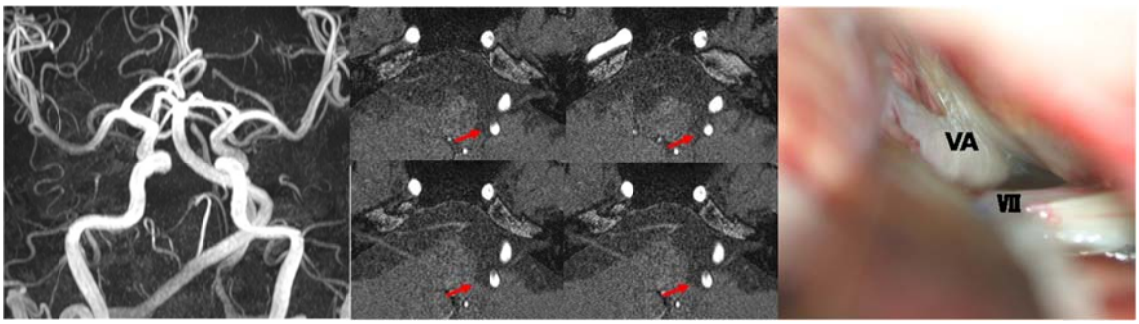

Figure 1 Preoperative MRI and photograph taken during surgery of a patient with right VA offender. The patient was 69 year old man with a left side facial spasm for 5 years. Preoperative MRI showed that right side VA compressed left facial nerve at the REZ (*red arrows*). Photograph was taken before neurovascular decompression. Surgical outcome was 'good' with permanent facial palsy. *VA basilar artery, VII facial nerve*

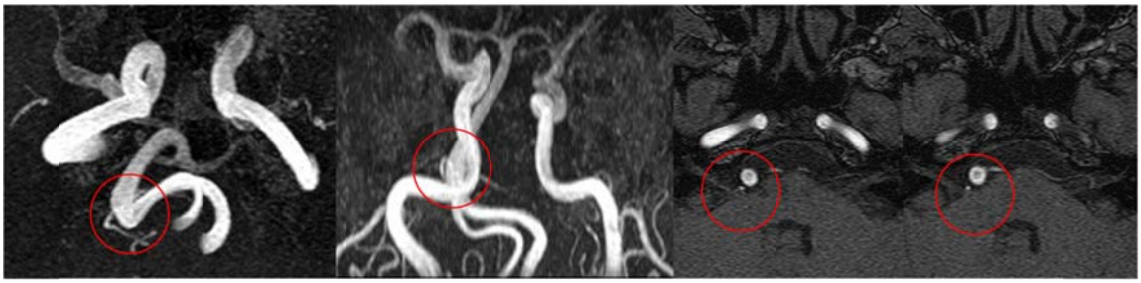

Figure 2 Preoperative MRI of a patient with AICA offender and BA over AICA. The patient was 48 year old man with right side facial spasm for 2 years. Preoperative MRI showed that AICA compressed facial nerve and BA was over AICA offender (*red circle*) at the REZ. During MVD, we made an effort to make BA move freely. After surgery, HFS completely resolved but transient facial palsy occurred.

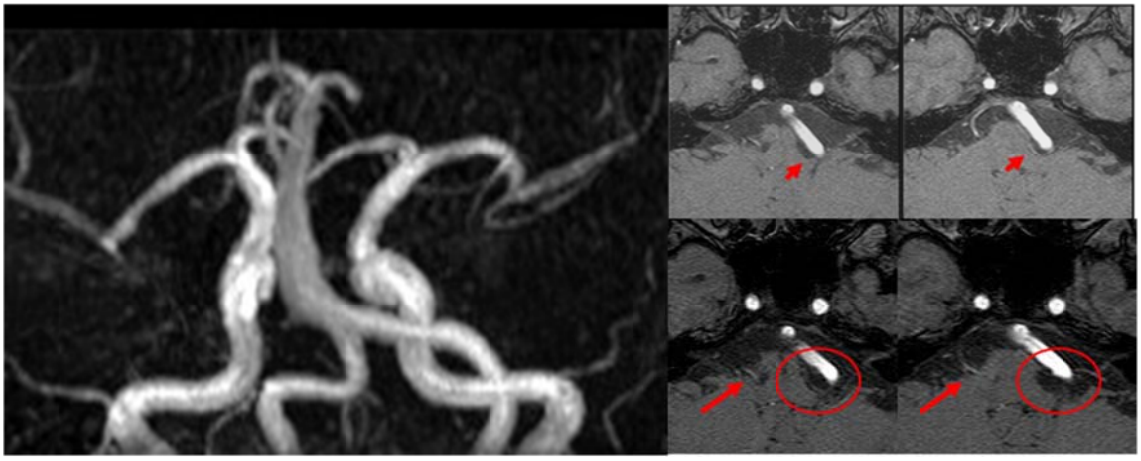

Figure 3 Preoperative and postoperative MRI of a patient with bilateral HFS. The patient was 50s woman with bilateral HFS. Left side facial spasm resulting from VA and PICA occurred one year before first MVD. Preoperative MRI showed that dolichoectatic VA and PICA compressed left facial nerve at the REZ (*short red arrow*). After MVD, left HFS completely resolved but transient facial palsy and hearing impairment occurred. Right side HFS occurred 4 years after left MVD. We obtained postoperative MRI showing that only AICA compressed facial nerve (*long red arrow*) and that complete decompression of left facial nerve was done (*red circle*). After right MVD, right HFS completely disappeared without any complication. In the right HFS, VBD did not affect the offender.

Levels of successful outcome were 93.1% in non-VBD and 90.9% in VBD, which was not statistically significant (p=0.779, table 5). Postoperative complications related to facial nerve and cochlear nerve in non-VBD was noted in 24.7% (permanent 2.4%) including facial palsy

18.5% (permanent 0.9%) and hearing impairment 6.1% (permanent 1.5%). However, this postoperative complication rate in VBD was 45.5%, greater than in non-VBD (24.7%). There were transient facial palsy in three cases (27.2%), transient hearing impairment in one case (9.1%), and one permanent facial palsy (9.1%). There was no statistical difference in overall complication rate (p=0.154) but permanent facial palsy was significantly more frequent in VBD (p=0.006).

Table 5 Surgical outcome and complications after microvasuclar decompression for hemifacial spasm in 2058 cases

		Non-VBD (n=2047)	VBD(n=11)	P value
outcome	**Successful**	**1905(93.1%)**	**10(90.9%)**	**0.779**
	Excellent	1791(87.5%)	9(81.8%)	
	Good	114(5.6%)	1(9.1%)	
	Fair	88(4.3%)	1(9.1%)	
	poor	25(1.2%)	0	
	Failure	29(1.4%)	0	
complication	**7^{th} and 8^{th} nerve**	**506(24.7%)**	**5(45.5%)**	**0.154**
	Transient FP	361(17.6%)	3(27.2%)	0.404
	Permanent FP	19(0.9%)	1(9.1%)	0.006
	Transient HL	95(4.6%)	1(9.1%)	0.485
	Permanent HL	31(1.5%)	0	0.681

FP: facial palsy. HL: hearing impairment

There are 5 complications in VBD. Table 6 shows the results of the analysis of complication occurrence in VBD. Age was higher in no complication but number of males was greater in complication .This difference was not statistically significant. Diameter of VBD was significantly greater in complication than in no complication (p=0.028). There was no statistically difference in height and position of VBD between complication and no complication.

Table 6 Analysis of complication occurrence in microvascular decompression for hemifacial spasm related with vertebrobasilar dolichoectasia

	Complication (n=5)	No complication (n=6)	P value
Age (yr)	52.4(43-69)	57.8(46-62)	0.271
Males (%)	60	33.4	0.399
Diameter (mm)	5.41(4.90-5.93)	4.75(4.61-4.98)	0.028
Height			0.182
0	0	3	
1	0	1	
2	3	0	
3	2	2	
Position			0.409
1	2	1	
2	3	5	

V. DISCUSSION

Vertebrobasilar dolichoectasia is a rare arteriopathy characterized by elongation and enlargement of the vertebrobasilar artery with subsequent thrombosis, micro-embolization, and brainstem compression, with or without aneurysm formation[7-15]. This arteriopathy is known to cause variable neurologic deficits, including combined brainstem and cranial nerve syndromes[7,9,13,16-18], cervicomedullary junction compression[9-11,13,19,20] transient or permanent motor deficits[9,10,12,14,19,21], cerebellar dysfunction[10],central sleep apnea[22], hydrocephalus, ischemic stroke[14,20], and subarachnoid hemorrhage[23-25]. Vertebrobasilar dolichoectasia is a potential severe condition that may cause severe disability due to ischemic or compressive dysfunction in the posterior fossa[26-27]. Vertebrobasilar dolichoectasia itself may cause hemodynamic changes leading to thrombosis and microemboliztion[26]. Furthermore, manipulation of dolichoectatic artery during procedure also may result in these hemodynamic changes. Therefore, an effort should be made to minimize the manipulation of dolichoectatic

artery in order to prevent ischemic dysfunction in the posterior fossa. In our study, 10 patients all had hemifacial spasm caused by vertebrobasilar dolichoectasia without any other neurologic deficits and fortunately any ischemic dysfunction did not occur after microsurgical neurovascular decompression.

Hemifacial spasm caused by vertebrobasilar dolichoectasia has been reported previously[3,16,27-30]. In these cases, vascular compression of the facial nerve at the root entry zone was considered cause of hemifacial spasm. There was another cause of hemifacial spasm related with dolichoectatic artery. Chakravarty A.[31] reported hemifacial spasm resulting from pontine compression by a large fusiform dolichoectatic basilar artery without any compression of the facial nerve at the REZ. In all our cases, we identified offending artery compressing the facial nerve at the REZ. There were VA direct compression of the facial nerve in six cases, including right VA compression of left facial nerve (figure 1), VA or BA (figure 2) over offending vessel in four cases, and only AICA offending vessel that was not related with dolichoectatic artery (figure 3) in one case. Actually, the patient (case no 1 and 3, figure 3) who had only PICA offending vessel in right side, underwent microsurgical neurovascular decompression for hemifacial spasm in left side first. Left side offending vessels were VA and PICA. Even though the patient had veterbrobasilar dolichoectasia, microsurgical neurovascular decompression for right side was similar to other usual decompression. Dolichoectatic artery as offending vessel or over offending vessel makes surgical procedure difficult for us to perform completely without any complication. In the case of hemifacial spasm resulting from dolichoectatic artery, it is mandatory step for neurovascular decompression to make dolichoectatic artery detached from surrounding structure enough to move easily.

The prevalence of vertebrobasilar dolichoectasia is 0.5% of all HFS patients in this study. Even though VBD is very rare arteriopathy, there is the problem of selection and referral bias in

this result. Male to female ratio in VBD is greater than non-VBD (1: 1.2 vs. 1: 3). Multiple offending vessels are more frequent in VBD than in non-VBD (45.5% vs. 12.5%). We achieved 90.9% success rate in VBD, similar to 93.2% success rate in non-VBD (p=0.779**)**. However, one patient (case no 1) developed transient facial weakness and hearing impairment, two (case no 2, 6) transient facial weakness, and one (case no 4) permanent facial weakness. Although there was no statistically significant difference between VBD and non-VBD (p=0.154), postoperative complication rate (45.5%) in VBD was higher than non-VBD (24.7%). It is Manipulation of dolichoectatic artery attached to surrounding structure and excessive traction of cerebellar flocculus to obtain surgical view that might play a role in increasing complication rate. We analyze complication occurrence in VBD (table 6). The height and position of VBD may not contribute to the occurrence of complication. As in case no 3, Increase of complication rate might result from VA or BA affecting offending vessel rather than degree of height and position of VBD. Actually, in all cases of VBD we analyzed, VA or BA affected offender directly or over offending vessel. Only diameter of the VBD is significantly associated with the occurrence of complication (p=0.028). As mentioned above, all cases of VBD had VA or BA as offending vessel or over offending vessel, thus the diameter of the VBD could affect occurrence of complication.

VI. CONCLUSION

The cause of hemifacial spasm is thought to be mainly neurovascular compression of the facial nerve at its root exit zone from the brainstem. In a few cases, vertebrobasilar dolichoectasia affects hemifacial spasm. In this study, there is no statistically significant difference in surgical outcomes between VBD and non-VBD. Therefore, we would recommend microsurgical neurovascular decompression as treatment for hemifacial spasm caused by vertebrobasilar

dolichoectasia. Furthermore, to reduce postoperative complication, we need to make dolichoectatic artery, from proximal portion to distal, sufficiently free from the surrounding structure before neurovascular decompression. Also we should make an effort to obtain enough working space to retract cerebellum with less damage of normal structure.

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< ABSTRACT (IN KOREAN)>

추골뇌저동맥 신연확장증에 의한 반측성 안면 경련 환자에서 미세혈관감압술의 효과

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강정한

목적: 반측성 안면 경련은 얼굴 신경이 분포하는 근육에 몇 가지 원인에 의해 불수의적 경련이 나타나는 질환이다. 이러한 원인에는 종양 또는 두개골의 이상 등에 의한 경우도 있지만 혈관이 얼굴 신경을 압박하는 경우가 대부분이다. 그러나 혈관에 의한 반측성 안면 경련 중 특히 추골뇌저동맥 신연확장증에 의한 경우는 매우 드물며 이러한 경우 미세혈관감압술을 시행하는 것은 어렵다. 따라서 우리가 경험한 추골뇌저동맥 신연확장증에 의해 발생한 반측성 안면 경련에 대한 미세혈관감압술의 결과를 분석하고자 한다.

대상 및 방법: 1978년 9월부터 2008년 9월 사이에 추골뇌저동맥 신연확장증에 의한 반측성 안면 경련 환자 10명에 대해 미세혈관감압술을 시행하였다. 수술 전 자기공명영상을 바탕으로 추골뇌저동맥 신연확장의 진단을 확인하였다. 모든 환자에서 수술 이전에 반측성 안면 경련의 원인이 되는 혈관을 자기공명영상을 통하여 확인하였다. 추골뇌저동맥 신연확장과 관련한 반측성 안면 경련 환자에서 시행한 미세혈관감압술의 결과를 전체 미세혈관감압술의 결과와 비교하고 추골뇌저동맥 신연확장과 관련한 반측성 안면 경련 환자에서 수술 후 합병증 발생을 분석하였다.

결과: 추골뇌저동맥 신연확장증에 의한 반측성 안면 경련 환자의 미세감압술에서 90.9% 성공률을 얻었다. 수술 후 합병증의 발생은 추골뇌저동맥 신연확장증에 의한 반측성 안면 경련 환자의 수술에서 45.5%였으며 이는 다른 반측성 안면 경련 환자의 수술에서 발생한 합병증의 발생(24.7%) 보다 많았다. 수술 시 확인한 반측성 안면 경련의 원인이 되는 혈관은 전하소뇌동맥이 네 명의 환자에서, 뒤하소뇌동맥이 한 명의 환자에서, 추골 동맥이 한 환자에서

그리고 두 개 이상의 혈관이 원인인 경우가 다섯 명의 환자에서 확인되었다. 수술 후 합병증으로는 한 환자에서 일과성의 안면마비와 청신경 마비가, 두 환자에서 안면 마비가, 그리고 한 환자에서 영구적 안면 마비가 발생하였다. 이러한 합병증의 발생과 추골뇌저동맥 신연확장증의 직경과는 통계적으로 유의했다(p=0.028).

결론: 추골뇌저동맥 신연확장증에 의한 반측성 안면 경련의 경우 일반적인 경우와 비슷한 미세혈관감압술 치료 결과를 얻었다. 그러나 길고 확장된 혈관으로 인하여 수술 후의 합병증 발생률이 높아질 가능성이 있어 이에 대한 주의가 필요할 것으로 생각된다. 신연확장된 혈관을 주위 구조로부터 충분히 박리하고 미세감압술을 시행하는 공간을 넓게 확보하여 미세감압술을 시행하는 것이 바람직할 것으로 생각된다.

핵심 되는 말: 미세혈관감압술, 반측성 안면 경련, 추골뇌저동맥 신연확장증