ORIGINAL ARTICLE

The outcome of microvascular decompression for hemifacial spasm: a systematic review and meta-analysis

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Abstract

Microvascular decompression (MVD) is the first choice of surgery for hemifacial spasm (HFS). MVD surgery for vertebral artery (VA)-associated HFS is more difficult than for non-VA-associated HFS. There is controversy about the cure rate and complication of MVD for HFS in previous studies. We searched PubMed, Web of Science, and Embase for relevant publications. Based on the search results, we compared the outcomes of MVD for VA-associated HFS and non-VA-associated HFS. At the same time, we analyzed spasm-free rates and the complications and assessed the relationship between VA-associated HFS and gender, left side, and age. For analysis, six studies that included 2952 patients in the VA-associated group and 604 in the non-VA-associated group were selected. The effective rate of MVD was not significantly different between both groups (OR = 1.16, 95% CI 0.81–1.67, $P = 0.42$). Compared to non-VA-associated group, the transient complications (OR = 0.64, 95% CI 0.46–0.89, $P = 0.008$) and permanent complications (OR = 0.28, 95% CI 0.15–0.54, $P = 0.0001$) occurred more frequently in VA-associated group. The rate of hearing loss was significantly higher in VA-associated HFS than non-VA-associated HFS (OR = 0.35, 95% CI 0.19–0.64, $P = 0.0007$); the facial paralysis after operation was not significantly different between both groups (OR = 1.25, 95% CI 0.91–1.72, $P = 0.17$). There were older patients (WMD = 3.67, 95% CI 3.29–4.05, $P < 0.00001$) and more left-sided HFS (OR = 0.23, 95% CI $0.19 - 0.29$, $P < 0.0002$) in the VA-associated HFS group than non-VA-associated HFS group, while the non-VA-associated HFS group was female-dominated (OR = 1.58, 95% CI $1.32 - 1.89$, $P < 0.00001$). Both groups achieved good results in MVD cure rates. In VA-associated HFS, the complication rate of decompression and the rate of hearing loss after operation were higher than in non-VA-associated HFS, but the facial paralysis after operation was similar in both groups, and most complications were transient and disappeared during follow-up. VA-associated HFS is more prevalent in older adults, less prevalent in women, and more predominantly left-sided. More clinical studies are needed to better compare the efficacy and complication of MVD between both groups.

Keywords Meta-analysis · MVD · HFS · Microvascular decompression · Hemifacial spasm

Introduction

Facial spasm is a common neurovascular syndrome that manifests as involuntary twitching of the muscles innervated by the facial nerve [1]. The incidence of hemifacial spasm is 4/10000, which is more common in the fifth year of life and is more prevalent in women [2, 3]. The currently accepted etiology of hemifacial spasm is the long-term neurovascular compression (NVC) at the root exit zone (REZ) of the facial nerve, which leads to abnormal excitation of the facial nerve nucleus or abnormal transmission of nerve fiber telecommunications signals [4–6]. The most common compressions are from the anterior inferior cerebellar artery and the superior cerebellar artery. The compression from VA is less common, and vertebral arteries often indirectly compress nerves together with small branch vessels. The treatment methods include drug therapy, botulinum toxin therapy, and MVD. However, the drug therapy is currently considered less feasible, while botulinum toxin treatment is the first-line therapy. Considering the short duration and high complications of botulinum toxin treatment, microvascular decompression (MVD) is currently the only treatment to cure HFS. The effectiveness of MVD is well known for VA-associated HFS or non-VA-associated HFS. But there are some associated

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risks, and it is not always successful. Compared to non-VA-associated HFS, MVD is more difficult for VA-associated HFS and has a relatively poor clinical outcome [7, 8]. A recent study revealed that there was no significant difference between VA-associated HFS and non-VA-associated HFS [9–11]. In this study, we conducted a meta-analysis to compare the treatment outcomes for VA-associated HFS and non-VA-associated HFS. Provide some useful advice for surgeons using MVD for HFS.

Method

We conducted a search in PubMed, Web of Science, and Embase for relevant publications. The searching time was from the inception of databases to September 2021. Potential studies were also selected by reviewing the citations. The keywords were "hemifacial spasm" and "vertebral artery." In addition, this systematic review was conducted in strict compliance with the principles of PRISMA [12], which was not registered before.

Search strategy and selection criteria

We included studies reporting MVD for VA-associated HFS. The inclusion criteria were (I) reports of at least 20 patients; (II) patients first treated with MVD for HFS; (III) studies published in English; and (IV) studies provide the effective rate of MVD and post-operative complications of in patients with VA-associated HFS and non-VA-associated HFS. The exclusion criteria included (I) not published in English; (II) sample size ≤ 20 patients; (III) lack of comparison groups or lack of baseline data comparison; (IV) overlapping data sets or duplication of articles; and (V) expert opinions, comments, letters, and reviews.

Outcome and quality assessment

The primary objective of this systematic review and meta-analysis were as follows: (i) to compare the success rate of MVD and complication rate in patients with VA-associated HFS and non-VA-associated HFS; (ii) to examine the pre-operative clinical characteristics including age, gender, and side of HFS. The post-operative outcome was classified as "spasm-free" and "uncontrolled spasm." For review, spasm-free was defined as no HFS or good HFS > 90% resolved, while others were defined as uncontrolled spasm. The complication was defined as an early complication, including the onset of new defects and deterioration of pre-operative clinical conditions after the surgical treatment.

The quality assessment was performed using Newcastle–Ottawa Scale (NOS) [13–15]. An assessment checklist was prepared for 2 independent reviewers to determine the quality of studies, with a maximum of 9 stars per study. Studies that received ≥ 6 stars were considered moderate-to-high quality. Afterward, 2 independent reviewers performed data extraction. Any disagreements were resolved by a third reviewer. Publication bias and a funnel plot analysis were performed to detect publication bias when more than 10 studies were included.

Analysis

Data synthesis and analysis were performed using Review Manager (RevMan) version 5.3. Risk ratios (95% confidence intervals) were calculated to compare dichotomous outcomes, while standardized mean difference and the corresponding 95% confidence intervals (CI) were used to compare continuous data. When the mean and the standard deviation (SD) were not available, they were calculated based on the reported median and range [16]. The degree of heterogeneity has been reported to be low, medium, and high, with I^2 values of 25%, 50%, and 75%, respectively [17]. Therefore, we used the I^2 value to assess the degree of heterogeneity between studies. $I^2 > 50\%$ suggested high heterogeneity and therefore required a random effects model for analysis, while the fixed effects model was employed when $I^2 < 50\%$. $P < 0.05$ indicates a statistically significant difference.

Results

A total of 884 initial articles were retrieved from PubMed, Embase, and Web of Science. After screening and assessing according to the flow chart (Fig. 1), 6 articles [9–11, 18–20] were finally included. The quality of included studies was assessed by the NOS tool. According to the number of stars, all the studies were considered as moderate-to-high quality.

Clinical characteristics of patients

Six studies provided data on gender with low heterogeneity [9–11, 18–20]. The meta-analysis showed that the women were more common in the non-VA-associated HFS group than in the VA-associated HFS group (OR = 1.58, 95% CI 1.32 − 1.89, $P < 0.02$ $I^2 = 67\%$), as shown in Fig. 2. In addition, the left-side predominance was more prevalent in the VA-associated HFS group than in the non-VA-associated HFS group (OR = 0.23, 95% CI 0.19 − 0.29, $P < 0.0002$, $I^2 = 79\%$), as shown in Fig. 3. Five studies reported data on the average age with low heterogeneity [9, 10, 18–20]. As shown in Fig. 4, the patients in the VA-associated HFS group were older than those in the non-VA-associated group (WMD = 3.67, 95% CI 3.29–4.05, $P < 0.00001$, $I^2 = 81\%$).

Fig. 1 Flow chart for selection process

Total records identified:
pubmed:243
web of science:343
embase:298

471 duplicate was removed

414 records for screening

394 records excluded based on title/abstrate

20 reports assessed for eligibility

14 reports excluded due to:
No related outcome: 11
Not published in English :1
full-text unavilable :2

6 records for analysis

Study or Subgroup	non-VA HFS Events	Total	VA-involved HFS Events	Total	Weight	Odds Ratio M-H, Fixed, 95% CI	Odds Ratio M-H, Fixed, 95% CI
Jiang 2020	519	954	95	198	37.9%	1.29 [0.95, 1.76]	
Lee 2021	1078	1500	150	271	37.8%	2.06 [1.58, 2.68]	
Masuoka 2016	62	78	10	22	1.7%	4.65 [1.71, 12.68]	
Mikami 2013	24	35	10	18	2.2%	1.75 [0.54, 5.64]	
Yang 2017	42	89	16	29	6.7%	0.73 [0.31, 1.69]	
Zhao 2019	162	296	35	66	13.7%	1.07 [0.63, 1.83]	
Total (95% CI)		2952		604	100.0%	1.58 [1.32, 1.89]	
Total events	1887		316				

Heterogeneity: Chi² = 15.29, df = 5 (P = 0.009); I² = 67%
Test for overall effect: Z = 5.05 (P < 0.00001)

0.01 0.1 1 10 100
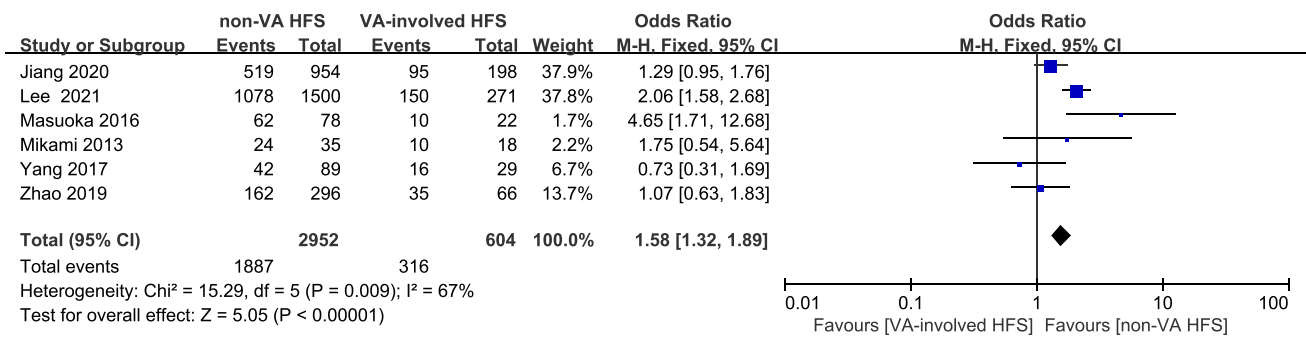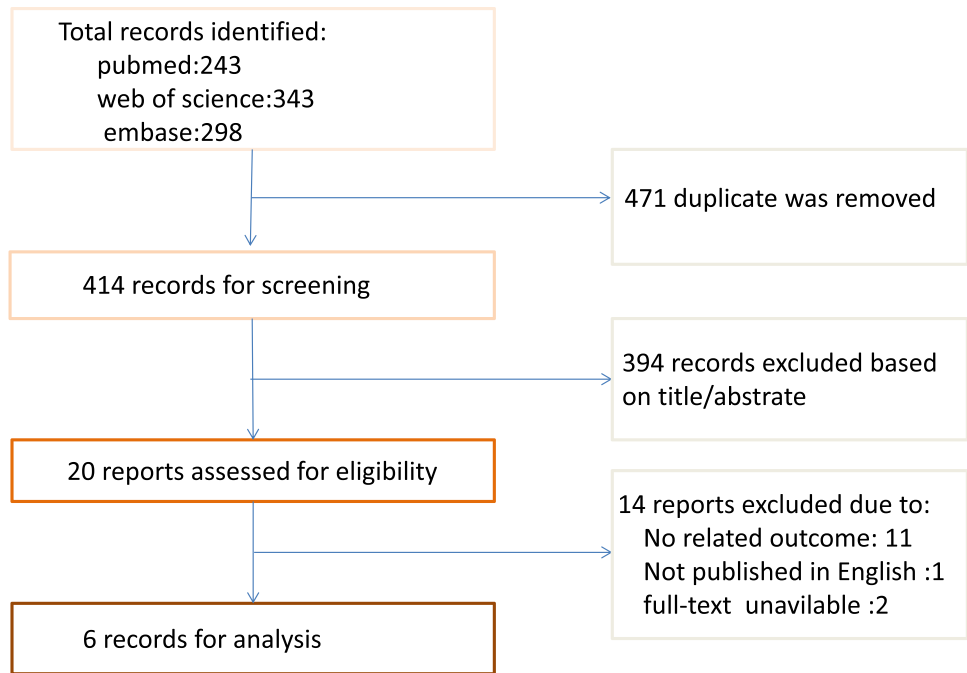Favours [VA-involved HFS] Favours [non-VA HFS]

Fig. 2 The meta-analysis showing the women were more common in the non-VA-associated HFS group than in the VA-associated HFS group (OR = 1.58, 95% CI 1.32 − 1.89, $P < 0.02$ $I^2 = 67\%$)

Study or Subgroup	non-VA HFS Events	Total	VA-involved HFS Events	Total	Weight	Odds Ratio M-H, Fixed, 95% CI	Odds Ratio M-H, Fixed, 95% CI
Jiang 2020	497	954	145	198	27.8%	0.40 [0.28, 0.56]	
Lee 2021	683	1500	234	271	52.1%	0.13 [0.09, 0.19]	
Masuoka 2016	39	78	18	22	3.4%	0.22 [0.07, 0.72]	
Mikami 2013	15	35	17	18	3.1%	0.04 [0.01, 0.37]	
Yang 2017	41	89	19	29	3.7%	0.45 [0.19, 1.08]	
Zhao 2019	153	296	52	66	9.9%	0.29 [0.15, 0.54]	
Total (95% CI)		2952		604	100.0%	0.23 [0.19, 0.29]	
Total events	1428		485				

Heterogeneity: Chi² = 23.93, df = 5 (P = 0.0002); I² = 79%
Test for overall effect: Z = 13.40 (P < 0.00001)

0.01 0.1 1 10 100
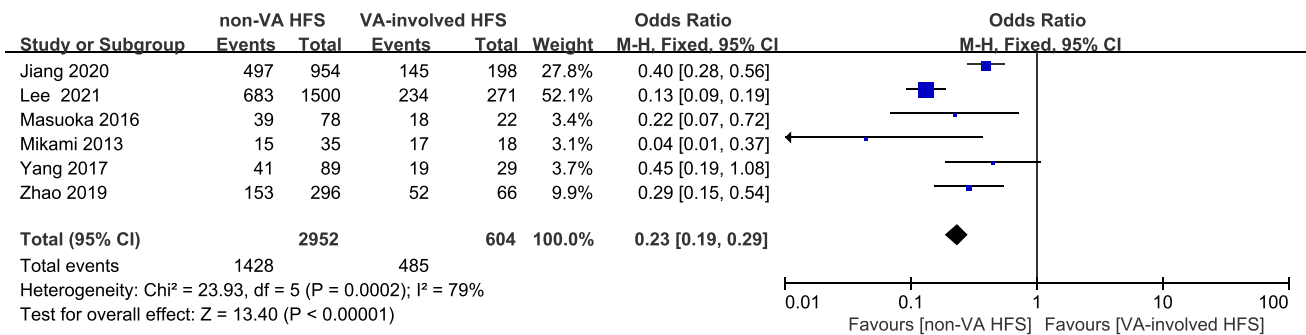Favours [non-VA HFS] Favours [VA-involved HFS]

Fig. 3 The left-side predominance was more prevalent in the VA-associated HFS group than in the non-VA-associated HFS group (OR = 0.23, 95% CI 0.19 − 0.29, $P < 0.0002$, $I^2 = 79\%$)

Post-operative recovery outcomes complication

All six studies mentioned surgical outcomes with low heterogeneity. The difference was not statistically significant in comparison of the spasm-free between two groups (OR = 1.16, 95% CI 0.81–1.67, $P = 0.42$, $I^2 = 0\%$), as shown in Fig. 5. Overall complications and permanent complications were reported in 6 [9–11, 18–20] and 4 studies [9, 10, 18, 19], respectively. Compared with the non-VA-associated HFS group, the following outcomes are more frequent in the VA-associated HFS group: the transient complications (OR = 0.64, 95% CI 0.46–0.89, $P = 0.008$, $I^2 = 28\%$, Fig. 6) and permanent complications (OR = 0.28, 95% CI 0.15–0.54, $P = 0.0001$, $I^2 = 0\%$, Fig. 7). Although facial paralysis after

operation was not significantly different between both groups (OR = 1.25, 95% CI 0.91–1.72, $P = 0.17$, $I^2 = 12\%$, Fig. 8), hearing loss was more frequent in VA-associated HFS than non-VA-associated group (OR = 0.35, 95% CI 0.19–0.64, $P = 0.0007$, $I^2 = 0\%$, Fig. 9).

Discussion

This systematic review and meta-analysis summarized the outcome of MVD for VA-associated HFS and non-VA-associated HFS. Consistent with the previous studies, the results of this study show that MVD is an effective treatment for HFS. Besides, VA-associated HFS are predominantly
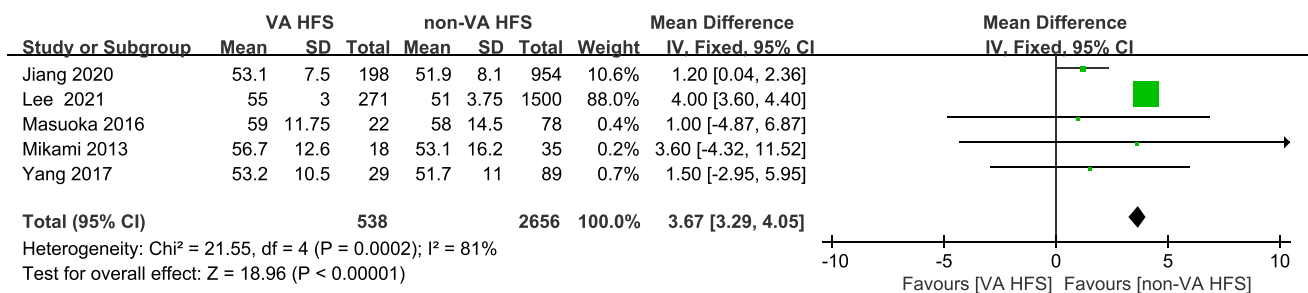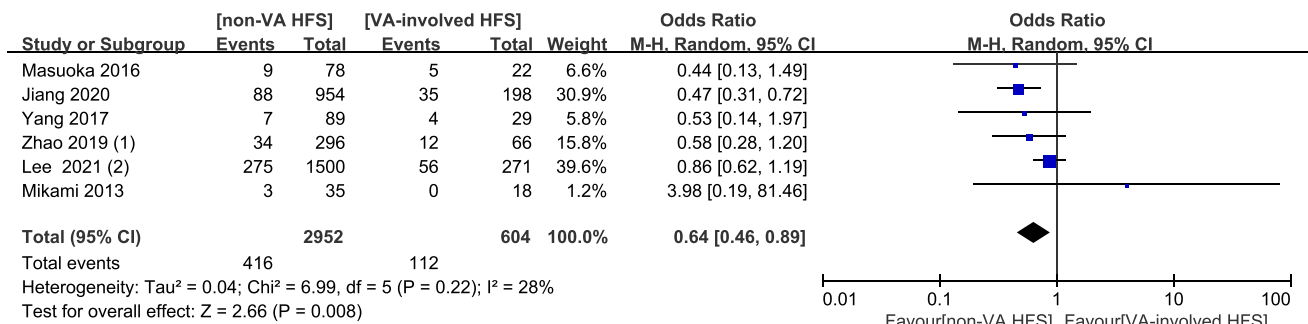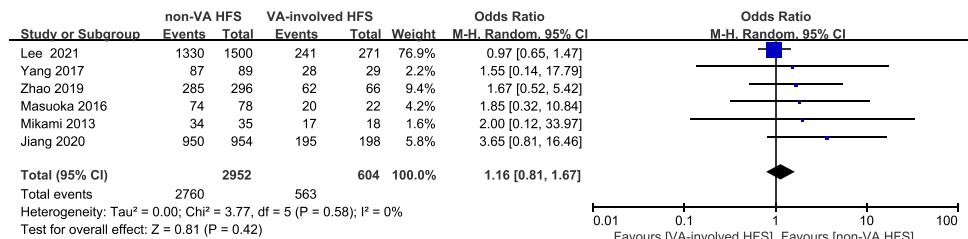
Fig. 4 The patients in the VA-associated HFS group were older than those in the non-VA-associated group (WMD = 3.67, 95% CI 3.29–4.05, $P < 0.00001$, $I^2 = 81\%$)

Fig. 5 The difference was not statistically significant in comparison of the spasm-free between two groups (OR = 1.16, 95% CI 0.81–1.67, $P = 0.42$, $I^2 = 0\%$)

Fig. 6 Compared with the non-VA-associated HFS group, the transient complications are more frequent in the VA-associated HFS group (OR = 0.64, 95% CI 0.46–0.89, $P = 0.008$, $I^2 = 28\%$)
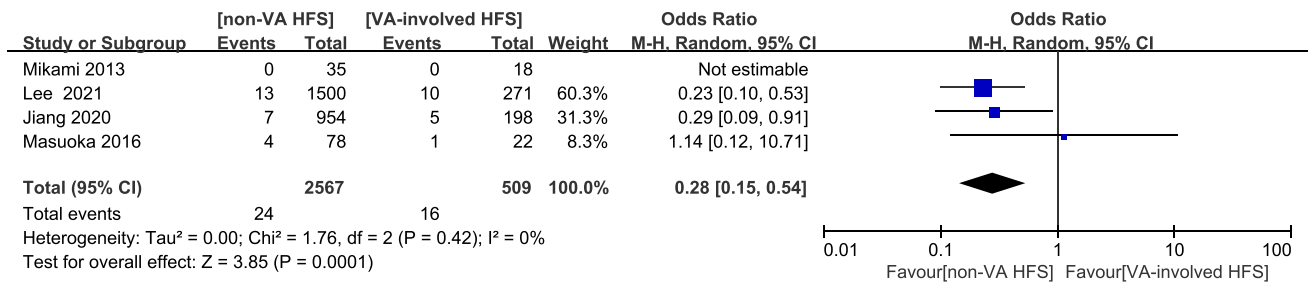
Study or Subgroup	[non-VA HFS] Events	Total	[VA-involved HFS] Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Mikami 2013	0	35	0	18		Not estimable
Lee 2021	13	1500	10	271	60.3%	0.23 [0.10, 0.53]
Jiang 2020	7	954	5	198	31.3%	0.29 [0.09, 0.91]
Masuoka 2016	4	78	1	22	8.3%	1.14 [0.12, 10.71]
Total (95% CI)		2567		509	100.0%	0.28 [0.15, 0.54]
Total events	24		16			

Heterogeneity: Tau² = 0.00; Chi² = 1.76, df = 2 (P = 0.42); I² = 0%
Test for overall effect: Z = 3.85 (P = 0.0001)

Odds Ratio M-H, Random, 95% CI
0.01   0.1   1   10   100
Favour[non-VA HFS]   Favour[VA-involved HFS]

Fig. 7 Compared with the non-VA-associated HFS group, permanent complications are more frequent in the VA-associated HFS group (OR = 0.28, 95% CI 0.15–0.54, $P = 0.0001$, $I^2 = 0$%)
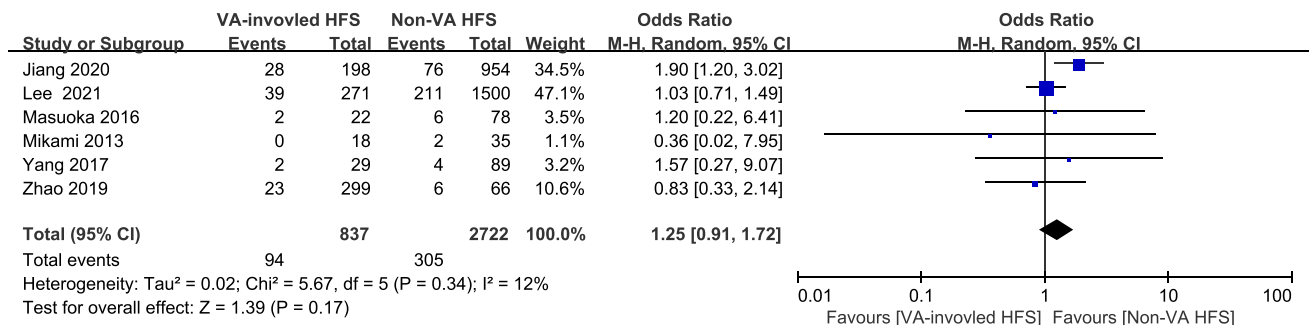
Study or Subgroup	VA-invovled HFS Events	Total	Non-VA HFS Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Jiang 2020	28	198	76	954	34.5%	1.90 [1.20, 3.02]
Lee 2021	39	271	211	1500	47.1%	1.03 [0.71, 1.49]
Masuoka 2016	2	22	6	78	3.5%	1.20 [0.22, 6.41]
Mikami 2013	0	18	2	35	1.1%	0.36 [0.02, 7.95]
Yang 2017	2	29	4	89	3.2%	1.57 [0.27, 9.07]
Zhao 2019	23	299	6	66	10.6%	0.83 [0.33, 2.14]
Total (95% CI)		837		2722	100.0%	1.25 [0.91, 1.72]
Total events	94		305			

Heterogeneity: Tau² = 0.02; Chi² = 5.67, df = 5 (P = 0.34); I² = 12%
Test for overall effect: Z = 1.39 (P = 0.17)

Odds Ratio M-H, Random, 95% CI
0.01   0.1   1   10   100
Favours [VA-invovled HFS]   Favours [Non-VA HFS]

Fig. 8 Facial paralysis after operation was not significantly different between both groups (OR = 1.25, 95% CI 0.91–1.72, $P = 0.17$, $I^2 = 12$%)

Study or Subgroup	Experimental Events	Total	Control Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Jiang 2020	7	954	4	198	23.6%	0.36 [0.10, 1.24]
Lee 2021	13	1500	10	271	51.9%	0.23 [0.10, 0.53]
Masuoka 2016	1	78	0	22	3.5%	0.87 [0.03, 22.12]
Mikami 2013	0	35	0	18		Not estimable
Yang 2017	2	89	1	29	6.1%	0.64 [0.06, 7.37]
Zhao 2019	9	296	2	66	14.9%	1.00 [0.21, 4.76]
Total (95% CI)		2952		604	100.0%	0.35 [0.19, 0.64]
Total events	32		17			

Heterogeneity: Tau² = 0.00; Chi² = 3.38, df = 4 (P = 0.50); I² = 0%
Test for overall effect: Z = 3.39 (P = 0.0007)

Odds Ratio M-H, Random, 95% CI
0.01   0.1   1   10   100
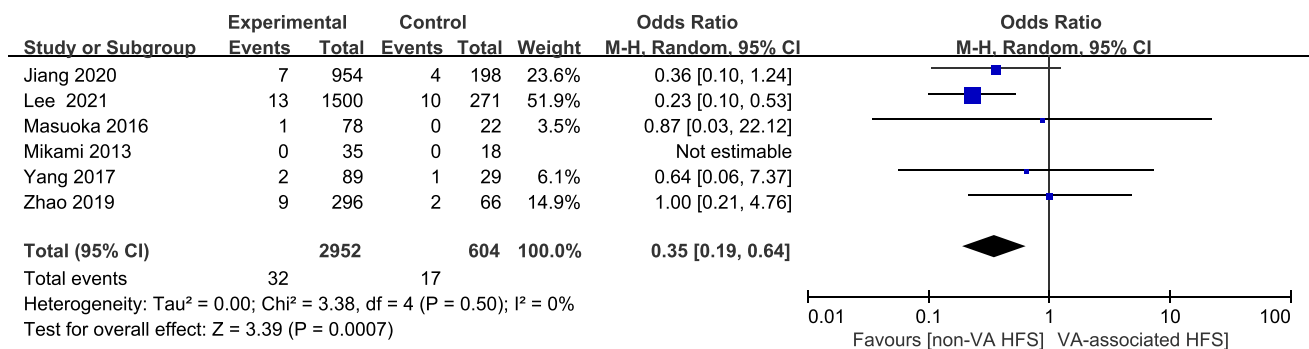Favours [non-VA HFS]   VA-associated HFS]

Fig. 9 Hearing loss was more frequent in VA-associated HFS than non-VA-associated group (OR = 0.35, 95% CI 0.19–0.64, $P = 0.0007$, $I^2 = 0$%)

left-sided with older patient age, while women are more prevalent in non-VA-associated HFS patients. However, MVD for VA-associated HFS may pose a higher surgical risk for post-operative complications, including transient complications and permanent complications.

Age

In previous studies, patients with HFS were more common in their fifth decade of life. The age of VA-associated HFS patients was similar to that of non-VA-associated HFS patients [9, 10]. However, patients with VA-associated HFS are older than those with non-VA-associated HFS in this

analysis. The number of samples may be an important influencing factor. In addition, the incidence characteristics of populations in different regions may be a potential influencing factor. In this meta-analysis, the patient age in the VA-associated HFS group is significantly higher than the non-VA-associated HFS group in the Asian population. At the same time, there is no significant difference in age in the European and American populations. This phenomenon also may be associated with the mechanisms of HFS. Neurovascular compression is a relatively well-recognized etiology. After long-term compression of blood vessels, abnormal nerve conduction or high excitability of the facial nerve nucleus leads to involuntary twitching of facial muscles.

Similarly, hypertension is a risk factor for HFS [21]. As age increases, the incidence of hypertension is higher, and blood vessels become less elastic due to atherosclerosis. Also, the vessel wall of the VA is thicker than that of the branch vessels. The VA is more tolerant to atherosclerosis and hypertension, which may be associated with higher age of onset in the VA-associated HFS group.

Left-sided predominance

As shown in Fig. 3, the left-sided HFS was more common in the VA-associated HFS group (RR = 0.60, 95% CI 0.57−0.64, $P < 0.00001$). This phenomenon was also reported in other studies, and the following reasons were proposed [22]. Left-sided VA originates directly from the aortic arch and is larger than right-sided [23, 24]. In addition, the hemodynamics of the left-sided VA is larger than that of the right-sided VA [25].

Female predominance

There are more female patients in the non-VA-associated HFS group, while the number of male and female patients is almost the same in the VA-associated HFS group. It is well known that neurovascular syndrome tends to develop more severely with insomnia, tired, and bad mood. Studies showed that women experience more sleep problems during sex hormones fluctuation, such as puberty and menopause [26]. Most patients also develop HFS around 50, which coincides with menopause. Therefore, fluctuations in female hormones can cause sleep or mood disorders and increase the incidence of HFS. However, the VA diameter is smaller in middle-aged women than in men, and the wide tortuous VA is a high-risk factor for VA-associated HFS [25, 27]. Considering the fluctuation of female hormones and the VA diameter, female patients are more common in the non-VA-associated HFS group. In the VA-associated HFS group, the number of men and women is similar. In order to clarify the relationship between gender and HFS, more prospective randomized studies should be conducted in the future.

The outcome of MVD and complication

Although MVD is effective in treating HFS, surgery is still difficult to provide adequate decompression of nerves and vessels, especially for VA-associated HFS. The key procedure of MVD is to accurately identify the relationship between the responsible vessels and the facial nerve and fully separate them. In most cases, the VA compresses the nerve indirectly combined with small branches [28]. In addition, the branches may supply the brainstem, blocking the surgical view and making separation more difficult. However, this meta-analysis showed no significant

difference in the success rate of MVD between the VA-associated HFS group and the non-VA-associated HFS group. This similar success rate maybe attributed to the surgical improvements, especially for VA-associated HFS. Although three of six included studies did not described the difference of surgical procedures in detail, the rest mentioned that the surgical techniques for VA-associated HFS were different and some special techniques were applied, for example, enlarged, building a bridge for VA, and sling retraction technique [10, 19, 29]. Some reports had reported that the new techniques had improved the outcome and complications, while a study has reported that the new techniques did not affect the outcome of MVD and complication [30–32]. This result may also benefit from many extraordinary technical, such as adequate preoperative imaging evaluation, neuroendoscopy, and preoperative electrophysiological monitoring [33, 34]. For example, neuroendoscopy significantly increases the surgical view, allowing surgeons to more directly observe the relationship between responsible vessels and peripheral nerves without extended craniotomy [35–37]. Furthermore, intraoperative electrophysiological monitoring can help the surgeon determine the responsible vessel and decide when to end the operation. Electrophysiological monitoring also contributes to understanding the nature of HFS [38–40]. Some new surgical techniques have also increased the success rate of surgery, such as the biomedical glue sling technique, the "bird-lime" technique, the wedge technique, and the cornerstone technique [30, 32, 41–43]. Unlike the previous results, transient post-operative complications remain higher in the VA-associated HFS group than the non-VA-associated HFS group in our meta-analysis [19, 20]. The following reasons can be considered: in most previous single-center studies, the number of cases was relatively small, the definitions of complications were different, and the specific surgical protocols and techniques in each study were different. Considering the vast majority of transient complications resolve completely within 1 year after surgery and the incidence of permanent complications is very low, MVD may still be an effective surgical method for VA-associated HFS. It is worth lighting that hearing loss is more frequent in VA-associated HFS than non-VA-associated HFS and has a statistical difference. The risk of surgery is still very high, especially for VA-associated HFS. The surgical procedures for VA-associated HFS should be pruned according to different conditions. Indeed, some studies have reported that new surgical techniques increased the success rate of surgery and reduced the complication of operation. The surgeon should also keep in mind that slight abnormal operations may turn transient complications into permanent complications, and decompression surgery for VA-associated HFS should be more cautious. It is a pity that

Table 1 The characteristics of studies and outcome variables for inclusion in meta-analysis

First author	Type of study	Study period	Group	Patients number	Gender (M/F)	Age (years)	HFS on left side	Cure sample	Overall complication number	Permanent complication number	Follow-up
Zhao (2019)	Retrospective	January 2013 to January 2014	Not VA	296	134/162	NA	153	285	34	NA	36 months on average
			VA	66	31/35	NA	52	62	12	NA	
Yang (2017)	Retrospective	February 2010 to February 2015	Not VA	89	47/42	51.7±11.0	41	87	7	NA	More than 1 year
			VA	29	13/16	53.2±10.5	19	28	4	NA	
Mikami (2013)	Retrospective	January 2003 to January 2011	Not VA	35	11/24	53.1±16.2	15	34	3	0	More than 1 year
			VA	18	8/10	56.7±12.6	17	17	0	0	
Masuoka (2016)	Retrospective	April 2008 to April 2015	Not VA	78	16/62	58±14.5 (21–79)	39	74	9	4	More than 1 year
			VA	22	12/10	59±11.75 (28–75)	18	20	5	1	
Lee (2021)	Retrospective	January 2008 to March 2015	Not VA	1500	422/1078	51±3.75 (43–58)	683	1330	285	13	22.8 months (7.8–42.0)
			VA	271	121/150	55±3 (48–60)	234	241	62	10	
Jiang (2020)	Retrospective	January 2014 to December 2017	Not VA	954	435/519	51.9±8.1 (21–75)	497	950	88	7	mean 42.6 months(16 to 65 months)
			VA	198	103/95	53.1±7.5 (30–72)	145	195	55	5	

VA vertebral artery, *NA* not available

all the primary studies in this meta-analysis did not calculate the adjusted odds ratio to exclude the confounders. Therefore, a large of clinical studies are needed future.

Conclusion

Non-VA-associated HFS occurs predominantly in women, while there is no difference in the number of male and female patients with VA-associated HFS. In addition, VA-associated HFS occurs primarily in the elderly and on the left side of VA. The results show that MVD is an effective treatment for HFS caused by small vascular compression and VA-associated HFS. Considering the high rate of complications in VA-associated HFS, MVD is more difficult and carries a higher risk. Surgeons should be more careful to achieve excellent surgical outcomes. In the future, more clinical studies are needed to better compare the efficacy and complication of MVD between VA-associated HFS and non-VA-associated HFS. Moreover, more clinical researches of MVD for hemifacial spasms should be analyzed by stratification future.

Limitation

This meta-analysis has several limitations. First, the number of included studies was limited, and some outcomes of interest were not reported in each study. Second, there was a high degree of heterogeneity in the results of some studies between the two groups. Third, the surgical procedures for both groups are not unified. Fourth, we cannot perform an analysis of confounders because the primary studies all did not mention the adjusted odds ratio. Those heterogeneities were associated with the variability in defining or measurement standards. Despite these limitations, the present meta-analysis results provided a more comprehensive understanding of MVD for treating VA-associated HFS. MVD for VA-associated HFS and non-VA-associated HFS is a successful strategy, and the risk of complications is higher in the VA-associated HFS group (Table 1).

Data availability The original data used in the study are all included in the article; further inquiries can be directed to the corresponding author.

Code availability Not applicable.

Declarations

Ethics approval Not applicable.

Consent for publication Not applicable.

Informed consent Informed consents were required from all participants.

Competing interests The authors declare no competing interests.

References

1. Sindou M, Mercier P (2018) Microvascular decompression for hemifacial spasm: outcome on spasm and complications. A review. Neuro-Chirurgie 64:106–116. https://doi.org/10.1016/j.neuchi.2018.01.001
2. Auger RG, Whisnant JP (1990) Hemifacial spasm in Rochester and Olmsted County, Minnesota, 1960 to 1984. Arch Neurol 47:1233–1234. https://doi.org/10.1001/archneur.1990.00530110095023
3. Tan NC, Chan LL, Tan EK (2002) Hemifacial spasm and involuntary facial movements. QJM 95:493–500. https://doi.org/10.1093/qjmed/95.8.493
4. Dou NN, Zhong J, Zhou QM, Zhu J, Wang YN, Xia L, Yang XS, Ying TT, Zheng XS, Li ST (2015) The mechanism of hemifacial spasm: a new understanding of the offending artery. Neurol Res 37:184–188. https://doi.org/10.1179/1743132814Y.0000000424
5. Green KE, Rastall D, Eggenberger E (2017) Treatment of blepharospasm/hemifacial spasm. Curr Treat Options Neurol 19:41. https://doi.org/10.1007/s11940-017-0475-0
6. Ryu H, Yamamoto S, Sugiyama K, Uemura K, Miyamoto T (1998) Hemifacial spasm caused by vascular compression of the distal portion of the facial nerve. Report of seven cases. J Neurosurg 88:605–609. https://doi.org/10.3171/jns.1998.88.3.0605
7. Kim JP, Park BJ, Choi SK, Rhee BA, Lim YJ (2008) Microvascular decompression for hemifacial spasm associated with vertebrobasilar artery. J Korean Neurosurg Soc 44:131–135. https://doi.org/10.3340/jkns.2008.44.3.131
8. Nagahiro S, Takada A, Matsukado Y, Ushio Y (1991) Microvascular decompression for hemifacial spasm. Patterns of vascular compression in unsuccessfully operated patients. J Neurosurg 75:388–392. https://doi.org/10.3171/jns.1991.75.3.0388
9. Lee S, Han J, Park SK, Lee JA, Joo BE, Park K (2021) Involvement of the vertebral artery in hemifacial spasm: clinical features and surgical strategy. Sci Rep 11:4915. https://doi.org/10.1038/s41598-021-84347-x
10. Mikami T, Minamida Y, Akiyama Y, Wanibuchi M, Sugino T, Houkin K, Mikuni N: (2013) Microvascular decompression for hemifacial spasm associated with the vertebral artery. Neurosurg Rev 36:303–308; discussion 308–309. https://doi.org/10.1007/s10143-012-0425-y
11. Zhao H, Tang Y, Zhang X, Zhu J, Yuan Y, Zhou P, Li S (2019) Long-term outcomes of microvascular decompression in the treatment of hemifacial spasm based on different offending

vessels. J Neurol Surg A Cent Eur Neurosurg 80:285–290. https://doi.org/10.1055/s-0039-1685199

12. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 6:e1000097. https://doi.org/10.1371/journal.pmed.1000097

13. Sohani ZN, Meyre D, de Souza RJ, Joseph PG, Gandhi M, Dennis BB, Norman G, Anand SS (2015) Assessing the quality of published genetic association studies in meta-analyses: the quality of genetic studies (Q-Genie) tool. BMC Genet 16:50. https://doi.org/10.1186/s12863-015-0211-2

14. Thelin GM, Wgner RH (1961) Sedimentation of plasma antihemophilic factor. Arch Biochem Biophys 95:70–76. https://doi.org/10.1016/0003-9861(61)90110-2

15. Thirumala PD, Altibi AM, Chang R, Saca EE, Iyengar P, Reddy R, Anetakis K, Crammond DJ, Balzer JR, Sekula RF (2020) The Utility of intraoperative lateral spread recording in microvascular decompression for hemifacial spasm: a systematic review and meta-analysis. Neurosurgery 87:E473–E484. https://doi.org/10.1093/neuros/nyaa069

16. Wan X, Wang W, Liu J, Tong T (2014) Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. BMC Med Res Methodol 14:135. https://doi.org/10.1186/1471-2288-14-135

17. Higgins JP, Thompson SG (2002) Quantifying heterogeneity in a meta-analysis. Stat Med 21:1539–1558. https://doi.org/10.1002/sim.1186

18. Liu J, Zhu C, Liu R, Liu B, Zhou J, Fan C, Jiao F, Wang D, Wu G, Jiang Y (2020) Clinical analysis of patients with ipsilateral coexistence of hemifacial spasm and trigeminal neuralgia. World Neurosurg 138:e652–e658. https://doi.org/10.1016/j.wneu.2020.03.040

19. Masuoka J, Matsushima T, Nakahara Y, Inoue K, Yoshioka F, Kawashima M, Abe T (2017) Outcome of microvascular decompression for hemifacial spasm associated with the vertebral artery. Neurosurg Rev 40:267–273. https://doi.org/10.1007/s10143-016-0759-y

20. Yang DB, Wang ZM (2017) Microvascular decompression for hemifacial spasm associated with the vertebral artery. Acta Neurol Belg 117:713–717. https://doi.org/10.1007/s13760-017-0766-y

21. Ioli P, Vera J, Femminini R, Gonorazky SE (2004) Arterial hypertension as a risk factor for hemifacial spasm due to vascular compression. Rev Neurol 39:198–199. https://doi.org/10.33588/rn.3902.2003534

22. Kim JP, Chung JC, Chang WS, Chung SS, Chang JW (2012) Outcomes of surgical treatment for hemifacial spasm associated with the vertebral artery: severity of compression, indentation, and color change. Acta Neurochir 154:501–508. https://doi.org/10.1007/s00701-011-1247-3

23. Omotoso BR, Harrichandparsad R, Satyapal KS, Moodley IG, Lazarus L (2021) Radiological anatomy of the intracranial vertebral artery in a select South African cohort of patients. Sci Rep 11:12138. https://doi.org/10.1038/s41598-021-91744-9

24. Vishal, Kumar H, Medical JJJoEo, Sciences D: (2016) Histological Variations in Various Segments of Vertebral Artery 5

25. Jeng JS, Yip PK (2004) Evaluation of vertebral artery hypoplasia and asymmetry by color-coded duplex ultrasonography. Ultrasound Med Biol 30:605–609. https://doi.org/10.1016/j.ultrasmedbio.2004.03.004

26. Morssinkhof MWL, van Wylick DW, Priester-Vink S, van der Werf YD, den Heijer M, van den Heuvel OA, Broekman BFP (2020) Associations between sex hormones, sleep problems and depression: a systematic review. Neurosci Biobehav R 118:669–680. https://doi.org/10.1016/j.neubiorev.2020.08.006

27. Chen SR (2018) Neurological imaging for hemifacial spasm. Int Ophthalmol Clin 58:97–109. https://doi.org/10.1097/IIO.0000000000000212

28. Mercier P, Sindou M (2018) The conflicting vessels in hemifacial spasm: literature review and anatomical-surgical implications. Neurochirurgie 64:94–100. https://doi.org/10.1016/j.neuchi.2018.01.004

29. Jiang C, Liang W, Wang J, Dai Y, Jin W, Sun X, Xu W (2020) Microvascular decompression for hemifacial spasm associated with distinct offending vessels: a retrospective clinical study. Clin Neurol Neurosurg 194:105876. https://doi.org/10.1016/j.clineuro.2020.105876

30. Kim JY, Jung S, Song TW, Kim IY, Moon KS, Jung TY, Jang WY (2019) The cornerstone technique of microvascular decompression for hemifacial spasm with vertebral artery offender. World Neurosurg 126:e94–e100. https://doi.org/10.1016/j.wneu.2019.01.199

31. Xue F, Shen Z, Wang Y, Kwok SC, Yin J (2021) Microvascular decompression for hemifacial spasm involving the vertebral artery: a modified effective technique using a gelatin sponge with a FuAiLe medical adhesive. CNS Neurosci Ther 27:857–861. https://doi.org/10.1111/cns.13662

32. Zhang X, Zhao H, Zhu J, Tang Y, Ying T, Yuan Y, Li S (2017) Outcome of biomedical glue sling technique in microvascular decompression for hemifacial spasm involving the vertebral artery. World Neurosurg 104:186–191. https://doi.org/10.1016/j.wneu.2017.04.048

33. Xu ZH, Tang YS, Yan YH (2018) Clinical analysis on hemifacial spasm treated by microvascular decompression. Chinese J Contemp Neurol Neurosurg 18:754–757. https://doi.org/10.3969/j.issn.1672-6731.2018.10.012

34. Zhao Z, Chai S, Xiao D, Zhou Y, Gan J, Jiang X, Zhao H (2021) Microscopic versus endoscopic microvascular decompression for the treatment of hemifacial spasm in China: a meta-analysis and systematic review. J Clin Neurosci 91:23–31. https://doi.org/10.1016/j.jocn.2021.06.034

35. Feng BH, Zhong WX, Li ST, Wang XH (2020) Fully endoscopic microvascular decompression of the hemifacial spasm: our experience. Acta Neurochir 162:1081–1087. https://doi.org/10.1007/s00701-020-04245-5

36. Flanders TM, Blue R, Roberts S, McShane BJ, Wilent B, Tambi V, Petrov D, Lee JYK (2018) Fully endoscopic microvascular decompression for hemifacial spasm. J Neurosurg 131:813–819. https://doi.org/10.3171/2018.4.JNS172631

37. Matmusaev M, Kumar RS, Yamada Y, Nagatani T, Kawase T, Tanaka R, Kyosuke M, Kato Y (2020) Endoscopic microvascular decompression for hemifacial spasm. Asian J Neurosurg 15:833–838. https://doi.org/10.4103/ajns.AJNS_152_20

38. Huang BR, Chang CN, Hsu JC (2009) Intraoperative electrophysiological monitoring in microvascular decompression for hemifacial spasm. J Clin Neurosci 16:209–213. https://doi.org/10.1016/j.jocn.2008.04.016

39. Sindou M, Mercier P (2018) Microvascular decompression for hemifacial spasm : surgical techniques and intraoperative monitoring. Neurochirurgie 64:133–143. https://doi.org/10.1016/j.neuchi.2018.04.003

40. Zhu W, Sun C, Zhang Y, Xu J, Wu S (2020) AMR monitoring in microvascular decompression for hemifacial spasm: 115 cases report. J Clin Neurosci 73:187–194. https://doi.org/10.1016/j.jocn.2019.10.008

41. Nonaka Y, Hayashi N, Matsumae M, Fukushima T (2019) Wedge-technique for transposition of the vertebral artery in microvascular decompression for hemifacial spasm: technical nuances and surgical outcomes. Acta Neurochir 161:1435–1442. https://doi.org/10.1007/s00701-018-03793-1

42. Otani N, Toyooka T, Takeuchi S, Tomiyama A, Wada K, Mori K (2018) Novel technical variations and increased adhesive strength in the "birdlime" transposition technique for microvascular decompression. World Neurosurg 116:e460–e468. https://doi.org/10.1016/j.wneu.2018.05.006

43. Zhang X, Kang X, Jiang Q, Zhao H, Tang Y, Zhu J, Zhou P, Yuan Y, Li S (2018) Efficacy of biomedical glue sling technique versus traditional technique for microvascular decompression for hemifacial spasm with refractory hypertension. World Neurosurg 110:E473–E478. https://doi.org/10.1016/j.wneu.2017.11.022