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Original Article

Microvascular decompression for hemifacial spasm: Complications after 292 procedures without neurophysiological monitoring

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ABSTRACT

Background: Hemifacial spasm (HFS) is characterized by involuntary, progressive, and intermittent spasms in the upper and lower facial muscles. Due to the high success rate, microvascular decompression (MVD) is the treatment of choice, and intraoperative neuromonitoring (INM) is considered useful for achieving safe surgery. Still, most centers do not have this technology.

Methods: We analyzed 294 patients with HFS treated with MVD without INM. We only included patients with a neurovascular etiology while excluding other causes, such as tumors. As part of the postoperative evaluation, we assessed preoperative magnetic resonance imaging and pure-tone audiometry.

Results: The main complication was peripheral facial paralysis in 50 patients, followed by hypoacusis in 22 patients and deafness in 17 patients, associated with a failed surgical outcome ($P = 0.0002$). The anterior inferior cerebellar artery (AICA) was an offending vessel, and the involvement of more than one vessel was significantly associated with the development of facial nerve palsy ($P = 0.01$). AICA was also associated with hearing impairment ($P = 0.04$). Over 90% of immediate complications improve in the follow-up (6 months), and one patient did not show a cure for initial HFS.

Conclusion: MVD is the method with the highest long-term cure rates for treating HFS; however, we must inquire into the multiple factors of the patient and the surgeon to predict surgical outcomes. INM is not a must during MVD for HFS. We recommend its use depending on the availability and mainly on the surgeon's skills, for surgeons.

Keywords: Hemifacial spasm, Intraoperative neurophysiological monitoring, Microvascular decompression, Postoperative complications

INTRODUCTION

Hemifacial spasm (HFS) is a rare condition characterized by involuntary, progressive, and intermittent spasms in the upper and lower facial muscles. It is most often unilateral (bilateral in <1% of cases) and is attributed to an aberrant vascular loop compressing the facial nerve at its emergence into the brainstem.[1,6,23] The initial manifestations appear as short and repetitive clonic

movements in the orbicularis oculi (90% of cases) and, over the years, involve other facial muscles as a typical presentation; patients with atypical presentation begin instead on the lower half of the face.[1,6] The high rate of success and the low rates of late recurrence and morbidity suggest that microvascular decompression (MVD) should remain the treatment of choice for most HFS patients.[4,8,15] In addition, using intraoperative neuromonitoring (INM) is considered to help achieve safe surgery.[2,18] However, most centers still need this technology, or it may not be necessary for the hands of a skilled surgeon. The present retrospective study aims to describe the outcome of MVD performed without INM and associate complications with patients' risk factors.

MATERIALS AND METHODS

We reviewed and analyzed the clinical data and medical files of patients treated with MVD for HFS from May 1992 to December 2018; we made this study in adherence to STROBE guidelines for retrospective observational cohorts. We only included patients with a neurovascular etiology while excluding other causes, such as tumors. As part of the postoperative evaluation, we assessed all patients' preoperative magnetic resonance imaging and pure-tone audiometry (PTA) studies. Our institutional ethics board approved this study.

Population and data collection

Outcome collection included age, sex, history of the previous medications, duration of HFS, previous medical treatments, complications, and the presence or absence of HFS at hospital discharge. HFS outcome was set on the relief of symptoms and classified according to the previously described Revuelta's HFS score criteria.[21] The postoperative complications were collected in a follow-up during the first 6 months after the intervention. They were classified as transient or permanent complications if they persisted after this period. Facial palsy was evaluated using the House-Brackmann scale, and the hearing impairment was evaluated through the preoperative PTA comparison.[7] We employ IBM Statistical Package for the Social Sciences (SPSS) Version 25 (IBM Corp., Armonk, New York, USA) for statistical analysis. We used the Shapiro–Wilk test to determine the normal distribution of the population. In addition, we used Mann–Whitney U tests for nonparametric distribution. For inferential statistics, we used the Chi-square test with $P < 0.05$ to be considered statistically significant.

Surgical procedure

We performed the surgical procedure using a published method as Soriano *et al*. described.[21] MVD was under general anesthesia with the head fixed in a Mayfield cranial clamp. Microasterional craniectomy was performed just below the inferior recess of the ipsilateral transverse sinus. After dural incision and intradural dissection, the cerebellum was retracted to expose the path of the cisternal segment of the facial nerve from the Root Entry/Exit Zone (REZ) to the internal auditory canal. Next, the mastoid air cell was sealed with bone wax. When no evidence of vascular contact was observed in the seventh nerve, subtle compression was used over the REZ of the facial nerve using off-bipolar for <5 s. Surgery was completed without any neurophysiological monitoring.

RESULTS

From May 1992 to September 2022, in the Neurosurgery Department of the National Institute of Neurology and Neurosurgery, we collected 292 patients diagnosed with HFS. A total of 331 MVD were made by microasterional approach without retractors. HFS occurred in 189 (64.7%) women and only 103 (35.3%) men, with a mean age of symptom onset of 43.9 ± 12.5 (range, 11–81) years and a mean evolution of 6.34 ± 4.70 (range, 1–30) years, the mean age was 50.2 ± 12.6 (range, 19–85) years. The left side was the most frequently affected at 55.8%, while the right was 44.2%. About 90.1% had a typical HFS presentation and only 9.9% were atypical [Table 1].

Preoperative findings

In 174 patients (59.6%), the neurological examination was regular; however, in some cases, 14 patients (4.8%), HFS was

Table 1: Demographic and clinical data of HFS patients with MVD

Age at onset, year median (range)	43.9±12.5 (11-81)
Age at surgery, year median (range)	50.25±12.67 (19-85)
Sex, *n* (ratio)	
Female	189 (64.7%)
Male	103 (35.3%)
Evolution (years)	6.34±4.73 (1-30)
Affected side, *n* (ratio)	
Right	129 (44.2%)
Left	163 (55.8%)
Clínal type, *n* (ratio)	
Typical	263 (90.1%)
Atypical	29 (9.9%)
Previous pharmacological treatment, n (ratio)	
None	232 (79.5%)
Botox	46 (15.8%)
Acupuncture	1 (0.3%)
Vitamin	1 (0.3%)
Mixed	12 (4.1%)
Previous surgical treatment, *n* (ratio)	
Yes	3 (1%)
No	289 (99%)
Previous audiometry, *n* (ratio)	
Normal	253 (86.6%)
Abnormal	39 (13.4%)

HFS: hemifacial spasm; MVD: microvascular decompression; *n*: Number.

present together with some other alterations, in with ipsilateral trigeminal neuralgia (painful convulsive tic), and in 28 patients (9.6%) with vestibulocochlear alterations, respectively. The treatment received by 46 patients (15.8%) was botox as monotherapy. Other treatments used were acupuncture and multivitamins (0.3%). All patients underwent a previous magnetic resonance study. Vascular compression was evident in 171 patients (58.6%). A previous PTA was performed within the surgical protocol, where 39 patients (13.4%) showed an abnormal development; the rest were regular [Table 1].

Surgical findings, postoperative complications, and follow-up of patients who underwent MVD for HFS

The main complication was peripheral facial paralysis in 50 patients (17.1%), being of a transitory nature the most common in 41 patients (82%). The second most frequent complication was hypoacusis in 22 patients (7.5%), which remitted in 14 of them (63%). The third most frequent complication was ipsilateral deafness in 17 patients (5.8%), associated with a failed surgical outcome ($P = 0.0002$). Complete remission was obtained in the nine patients who presented vertigo. Of the 12 patients who presented tinnitus, all obtained improvement in the follow-up; nine of them with complete remission. The average follow-up was 82.64 ± 37.9 months (range 1–281). A total of 256 patients (87.7%) were considered "cured," with excellent postoperative and follow-up results. On the other hand, 36 patients (12.3%) were categorized as "failed" defined by partial postoperative development or recurrence. Of these 36 failed patients, 33 achieved a complete cure of HFS after reoperation (29 in the second and four in the third steps), two improved at follow-up, and one definitive failure [Table 2].

VI and VII cranial nerve-related complications

Diplopia and facial palsy

Of the 50 patients who presented with postoperative facial paralysis, 40 (80%) had a satisfactory recovery during the first 6 months of follow-up. The anterior inferior cerebellar artery (AICA) was an offending vessel and the involvement of more than one vessel was significantly associated with the development of diplopia and facial palsy ($P = 0.01$). We did not recognize prognostic factors associated with cranial nerve VI complications [Table 3].

VIII cranial nerve-related complications

Hearing decrease, deafness, and vertigo

To describe the auditory function, we used the American Academy of Otolaryngology-Head and Neck Surgery classification, published in 1995.[5] We made preoperative and postoperative

Table 2: Prognostic factors associated with postoperative CN VI, VII complications in patients underwent MVD for HFS.

Prognostic factors	Diplopia *n* (%)	*P*	Facial palsy *n* (%)	*P*
Age (years)	39+18.38	0.20	50.6+12.74	0.82
Sex		0.66		0.14
Male	1 (1)		13 (12.6)	
Female	1 (0.5)		37 (19.6)	
Spasm side		1.00		0.77
Right	1 (0.8)		23 (17.8)	
Left	1 (0.6)		27 (16.6)	
Atypical spasms	0 (0.0)	1.00	4 (13.8)	0.79
Botulinum toxin	0 (0.0)	1.00	10 (16.7)	0.91
Previous surgery	0 (0.0)	1.00	0 (0.0)	1.00
Abnormal audiometry	1 (2.6)	0.25	20 (7.9)	0.26
Type of approach		1.00		1.00
Janetta	2 (0.7)		47 (17.2)	
Other	0 (0.0)		3 (16.7)	
Vessel in MRI	2 (0.7)	1.00	47 (16.8)	0.47
None	0 (0.0)	1.00	3 (23.1)	0.47
SUCA	0 (0.0)	1.00	3 (23.1)	0.47
AICA	2 (0.9)	1.00	29 (13.7)	0.02
PICA	0 (0.0)	1.00	4 (20.0)	0.75
Basilar	0 (0.0)	1.00	0 (0.0)	0.01
More than one	0 (0.0)	1.00	11 (55)	0.00
Type of material				
Dacron	0 (0.0)	1.00	2 (13.3)	1.00
Silastic	2 (0.8)	1.00	42 (15.8)	0.09

CN: cranial nerve; MVD: microvascular decompression; HFS: hemifacial spasm; MRI: Magnetic Resonance Imaging; SUCA: superior cerebellar artery; AICA: anteroinferior cerebellar artery; PICA: posteriorinferior cerebellar artery; *n*: Number; *P*: *P*-value.

PTA in all patients. Twenty-two patients (7.5%) were detected with transient hearing loss, and 17 fully recovered within the first 6 months. In total, 17 patients (5.8%) were deaf. We defined significant deafness as an increase of more than 15 dB of the mean PTA threshold (0.5, 1, and 2 K) according to bone conduction. AICA was the main offending vessel associated significantly with hearing impairment ($P = 0.04$) [Table 4]. Vertigo appeared in nine patients (3.1%), and the significant association with its occurrence was in patients with previous surgery ($P = 0.02$) and with last abnormal audiometry ($P = 0.02$), as well as the involvement of more than one offending vessel ($P = 0.01$).

Others

Cerebrospinal fluid (CSF) leakage and wound infection

As complications, CSF leakage occurred in seven patients (2.3%) and wound infection in 6 patients (2.1%); all cases resolved within 2 weeks. The presence of a CSF leak was associated with a history of atypical spasm preoperatively ($P = 0.03$), as was the involvement of the AICA as the offending vessel ($P = 0.01$). In addition, the risk of postoperative wound infection increased when the offending vessels were more than one ($P = 0.04$) (odds ratio = 7.4, 1.2–13.4) [Table 5].

Table 3: Surgical findings, postoperative complications, and follow-up of patients who underwent MVD for HFS.

Aggressor vessels	
None	13 (4.5%)
SUCA	13 (4.5%)
AICA	211 (72.3%)
PICA	20 (6.8%)
Basilar	15 (5.1%)
2 o more vessels	20 (6.8%)
Material	
Dacron	10 (3.4%)
Silastic	15 (5.1%)
Teflon	267 (91.4%)
Referral	
Excellent	244 (83.6%)
Good	12 (4.1%)
Partial	35 (12%)
Relapse	1 (0.3%)
Cured	
Yes	256 (87.7%)
No	36 (12.3%)
Complications	
None	143 (49.0%)
Fistula	8 (2.7%)
Infection	6 (2.1%)
FNP	50 (17.1%)
Hearing loss	22 (7.5%)
Vertigo	9 (3.1%)
Deafness	17 (5.8%)
Diplopia	2 (0.7%)
Surgical reintervention	
1st	33 (11.3%)
2nd	5 (1.7%)
Follow-up (months)	82,64±37,9 (range 1-281)

MVD: microvascular decompression; HFS: hemifacial spasm; SUCA: Superior cerebellar artery; AICA: anteroinferior cerebellar artery; PICA: posteriorinferior cerebellar artery; FNP: facial nerve palsy.

DISCUSSION

MVD is a functional surgery that has proven to be a definitive treatment for HFS. Surgical planning should be individualized by considering predictive variables and the potential risks in each patient. Although, in our experience, good to excellent surgical outcomes are obtained without INM, there is global advocacy in the use of INM, all measuring the clinical benefit according to the reduction in the number of cramps postoperatively. Although severe from a functional perspective, its complications are reported in <10% of all cases, with a mortality of 0.1% reported in the literature.[6,23]

We must take into account that all surgeries were made by skilled neurosurgeons in MVD, and, therefore, variability in surgical outcomes secondary to surgeon competence can be ruled out in this series. Wei *et al*. performed an analysis of MVD without INM and they concluded that monitoring does not appear to provide significant benefit with respect to the outcome.[22] However, in their study, as in ours, all of the surgeries were performed by a surgeon with unusually extensive experience with the procedure, and this may have contributed to the good postoperative outcome.

Neurophysiological monitoring

The INM objective during MVD for HFS is to prevent intraoperative injury to neural structures such as the vestibulocochlear nerve, which is directly adjacent to the facial nerve; INM can additionally assess and optimize vascular decompression and identify the offending vessel to improve the accuracy of the decompression procedure.[16,20] Even this, in 2008, Dannenbaum *et al*. published a series of patients who underwent MVD for HFS without neurophysiological monitoring and obtained surgical outcomes and complication rates that are comparable to those of previously published series that routinely used monitoring,[6] and now, our study aims to analyze the complications associated with risk factors in this same population. We address the most common complications, classifying them according to the cranial nerves affected (VI, VII, and VIII), CSF leakage, and wound infection, looking for associations based on the prognostic factors that have been identified.

VI cranial nerve cranial nerve-related complications

Trochlear nerve affection is rarely reported,[2,3,19] and no significant association was found in our study. Furthermore,

Table 4: Prognostic factors associated with postoperative CN VIII complications in patients underwent MVD for HFS.

Prognostic factors	Hearing decrease *n* (%)	*P*	Deafness *n* (%)	*P*	Vertigo *n* (%)	*P*
Age (years)	53.80.+12.4	0.16	55.3 + 9.9	0.08	49.1+	0.78
Sex		0.91		0.60		0.90
Male	8 (7.8)		7 (6.8)		3 (2.9)	
Female	14 (7.4)		10 (5.3)		6 (3.2)	
Spasm side		0.09		0.45		0.50
Right	6 (4.7)		9 (7.0)		3 (2.3)	
Left	16 (9.8)		8 (4.9)		6 (3.7)	
Atypical spasms	3 (10.3)	0.46	3 (10.3)	0.23	0 (0.0)	0.60
Botulinum toxin	5 (8.3)	0.78	5 (8.3)	0.35	2 (3.3)	0.90
Previous surgery	0 (0.0)	1.00	0 (0.0)	1.00	1 (33.3)	0.02
Abnormal audiometry	2 (5.1)	0.75	4 (10.3)	0.25	4 (10.3)	0.02
Type of approach		0.63		1.00		0.44
Janetta	20 (7.3)		16 (5.8)		8 (2.9)	
Other	2 (11.1)		1 (5.6)		1 (5.6)	
Vessel in MRI						
None	2 (15.4)	0.25	0 (0.0)	1.00	0 (0.0)	1.00
SUCA	0 (0.0)	0.6	1 (7.7)	0.54	0 (0.0)	1.00
AICA	20 (9.5%)	0.04	10 (4.7)	0.21	5 (2.4)	0.26
PICA	0 (0.0)	0.38	1 (5.0)	1.00	0 (0.0)	1.00
Basilar	0 (0.0)	0.61	3 (20)	0.04	1 (6.7)	0.38
More than one	0 (0.0)	0.38	2 (10)	0.32	3 (15)	0.01
Type of material						
Dacron	0 (0.0)	0.61	1 (6.7)	0.60	0 (0.0)	1.00
Silastic	22 (8.3)	0.23	14 (5.3)	0.18	8 (3.0)	0.57

CN: cranial nerve; MVD: microvascular decompression; HFS: hemifacial spasm; MRI: magnetic resonance imaging; MRI: Magnetic Resonance Imaging; SUCA: superior cerebellar artery; AICA: anteroinferior cerebellar artery; PICA: posterior inferior cerebellar artery; *n*: Number; *P*: *P*-value.

Table 5: Other prognostic factors associated with postoperative complications in patients underwent MVD for HFS.

Prognostic factors	CSF leakage *n* (%)	*P*	Wound infection *n* (%)	*P*
Age (years)	51.5+16.6	0.77	59+11.1	0.08
Sex		1.00		0.92
Male	3 (2.9)		2 (1.9)	
Female	5 (2.5)		4 (2.1)	
Spasm side		0.47		0.69
Right	2 (1.6)		2 (1.6)	
Left	6 (3.7)		4 (2.5)	
Atypical spasms	3 (10.3)	0.03	1 (3.4)	0.46
Botulinum toxin	2 (3.3)	0.67	1 (1.7)	1.00
Previous surgery	0 (0.0)	1.00	0 (0.0)	1.00
Abnormal audiometry	0 (0.0)	0.60	1 (2.6)	0.58
Type of approach		0.81		1.00
Janetta	6 (2.2)		6 (2.2)	
Other	2 (11.1)		0 (0.0)	
Vessel in MRI				
None	0 (0.0)	1.00	0 (0.0)	1.00
SUCA	0 (0.0)	1.00	0 (0.0)	1.00
AICA	1 (0.5)	0.01	1 (0.5)	0.00
PICA	1 (5.0)	0.43	0 (0.0)	1.00
Basilar	6 (40)	0.00	3 (20)	0.00
More than one	0 (0.0)	1.00	2 (10)	0.04
Type of material				
Dacron	1 (9.1)	0.26	0 (0.0)	1.00
Silastic	0 (0.0)	1.00	1 (6.7)	0.27
Teflon	7 (2.6)	0.53	5 (1.9)	0.43

MVD: microvascular decompression; HFS: hemifacial spasm; CSF: Cerebrospinal fluid; MRI: magnetic resonance imaging; SUCA: superior cerebellar artery; AICA: anteroinferior cerebellar artery; PICA: posterior inferior cerebellar artery; *n*: Number; *P*: *P*-value.

Table 6: Result of multivariate analysis

Prognostic Factors	Facial palsy			Hearing decrease			Vertigo		
	P	OR	CI	*P*	OR	CI	*P*	OR	CI
Previous Surgery	1.00	0.82	0.78-0.87	0.16	0.92	0.89-0.95	0.02	7.56	1.44-12.42
Abnormal Audiometry	0.26	0.51	0.17-1.51	0.75	0.63	0.14-2.80	0.02	5.66	1.45-12.21
Vessel in MRI	0.47	0.67	0.17-2.59	0.25	0.42	0.08-2.04	1.00	1.03	1.01-1.05
Vessel									
None	0.47	1.48	0.39-5.58	0.25	2.35	0.48-11.36	1.00	0.96	0.94-0.98
SUCA	0.47	1.48	0.39-5.58	0.6	0.92	0.89-0.95	1.00	0.96	0.94-0.98
AICA	0.01	0.45	0.24-0.85	0.04	4.13	1.01-18.11	0.27	0.46	0.12-1.78
Basilar	0.08	0.81	0.77-0.86	0.61	0.92	0.88-0.95	0.38	2.4	0.28-20.56
More than one	0.01	7.3	2.84-18.76	0.38	0.91	0.88-0.95	0.01	7.82	1.79-24.02
Type of Material									
Dacron	0.03	6.46	1.89-22.10	1.00	0.92	0.89-0.95	0.29	3.4	0.38-29.96

Abbreviations: MRI: magnetic resonance imaging; SUCA: superior cerebellar artery; AICA: anteroinferior cerebellar artery; *P*: *P*-value; OR: Odds ratio; CI: Confidence interval.

in our series of patients, only one reported diplopia, which spontaneously resolved itself 3 months after surgery.

VII cranial nerve-related complications

Facial palsy is one of the most frequent neurological complications of HFS. It can be classified as immediate or delayed and has been reported by Huh *et al*. to have a statistically significant association regarding onset and severity, being the more rapid and severe facial palsies.[9,17] Such palsies remain for longer periods. Permanent facial palsy is a rare occurrence.[11,19] In this study, 50 (15%) patients with an identified offending vessel presented immediate facial palsy in the first 24 h after surgery, of which 40 (80%) of these had a full recovery in the following 6 months, and 9 patients (3%) presented permanent facial palsy. From all the patients that developed this complication in our study, those who gave AICA as the offending vessel (29 patients), those with more than one offending vessel (11 patients), and those in whom Dacron was used (six patients), were found to be associated with postoperative immediate facial palsy with a tendency to recover, regardless of the degree of affection or duration of the palsy.

VIII cranial nerve-related complications

Along with facial palsy, auditory impairment is one of the most frequent neurological complications of MVD. The estimated occurrence reported in the previous studies varies from 1.9 to 20%, with reports varying in the degrees of affection and functional status evaluations due to the lack of consensus in the presurgical evaluation. Although permanent deficits are rarely presented and are associated with older age, the literature suggests an underestimation of hearing loss secondary to MVD due to a lack of consensus regarding diagnostic criteria for this complication after surgery and the absence of an appropriate pre- and postoperative auditory evaluation.[10,12,14,19] Our analysis classified hearing loss and deafness/non-useful hearing by audiometry as separate complications. We implemented audiometry as a pre-and post-surgical control, finding the presence of hearing loss in 21 patients (7%), of which 15 had full hearing function recovery at 6 months follow-up, and eight patients had no functional hearing in the same period. We found a statistically significant association between the presence of AICA as an offending vessel with hearing loss, which usually presented itself as a transient phenomenon. The association was not found with deafness. Vertigo is a relatively common complication attributed to the affection of the VIII CN. It has not been a matter of great attention, with its frequency ranging from 2.7% to 11% in various series. It has been reported superficially, with most cases being described as a transient deficit that may present with auditory affection (tinnitus or hearing loss).[6,10] Bartindale reported an incidence of 5.73% with no significant risk association.[3] In our experience, vertigo was a transitory phenomenon in 13 (4%) patients, with whom we found various associations. Regarding the presurgical personal history of the patient, postoperative vertigo was associated with abnormal audiometry in four patients and the presence of previous surgery in one patient. We found that more than one offending vessel is related to postoperative vertigo, regardless of the preoperative history [Table 6].

Other complications

CSF leakage is reported in the literature as one of the most common complications following MVD, though possibly overestimated because it is a complication that tends to reduce its incidence as the learning curve stabilizes and that can often be misdiagnosed.[2,12,13,19] In our series, the incidence was 2.3%, of which all patients were treated successfully with an external lumbar drain, presenting resolution after the 5th day. A significant association was found with the basilar

artery as the offending vessel in 40% of our patients with CSF leak and AICA as the offending vessel (P = 0.01). We found that the risk factors associated with CSF leak were the presence of the basilar artery as an offending vessel or multiple offending vessels.

CONCLUSION

MVD is the method with the highest long-term cure rates for treating HFS. However, we must inquire into the multiple factors of the patient and the surgeon to predict surgical outcomes. INM is not a must during MVD for HFS; for surgeons with less experience, INM could be helpful until they reach an optimal level in their learning curve, although it is known that INM is not available in all neurosurgical centers, we recommend its use whenever possible but its use should not be a rule of thumb. This procedure should adapt to socioeconomic circumstances. We think that MVD should not be delayed in centers that do not have intraoperative neuromonitoring with brainstem auditory evoked potentials, but the increased risk of PA should be taken into account when the patient undergoes surgical reintervention, where it could be more useful. Presenting normal audiometry and left-sided HFS are of better prognosis.

Declaration of patient consent

Patients' consent not required as patients' identities were not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The author(s) confirms that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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