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Fully endoscopic microvascular decompression for hemifacial spasm

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Abstract. With the rapid development of endoscopic technology, fully endoscopic microvascular decompression (MVD) has been widely used in the treatment of hemifacial spasm (HFS), and has achieved good effect. The present study reviewed 5 cases of HFS treated by fully endoscopic MVD. After fully endoscopic MVD, the symptom of facial involuntary twitching was relieved in each of the 5 patients with an effective rate of 100%. Among the cases, 4 had no postoperative complications, such as cranial nerve dysfunction, and cerebellar or brainstem injury, while 1 patient had postoperative aseptic meningitis and recovered after follow-up treatment. In these 5 cases of MVD, endoscopy played an important role in identifying the offending blood vessels, which is of great significance to improve the surgical effect and safety. Furthermore, the postoperative effects showed that endoscopy has certain potential and advantages in MVD. Therefore, fully endoscopic MVD is also a feasible method for the treatment of HFS.

Introduction

Hemifacial spasm (HFS) is a movement disorder characterized by involuntary spasms of the facial muscles, which usually presents as recurrent paroxysmal and involuntary convulsions of the muscles, including the orbicularis oculi muscle, expression muscle, frontalis, platysma and orbicularis oris muscles (1). When the patient is excited or nervous, the condition may become more severe, and patient may even have difficulty in opening their eyes, develop crooked mouth corners or suffer from twitch-like noises in the ears (2-4). The facial muscle spasm usually begins with the orbicularis oculi muscle and eventually involves the ipsilateral facial muscles innervated by the facial nerve; however, most patients only have one side facial muscle spasm, and very few patients have bilateral facial muscle spasm (5,6). The annual incidence rate of HFS is ~11 cases/1,000,000 individuals, with most cases beginning in middle age (7). HFS with severe symptoms will directly affect the quality of life (QOL) of patients, so treatment is needed. The current treatments mainly include botulinum toxin (BT) injection and microvascular decompression (MVD). Lawrence *et al* (8) compared BT injection and MVD, and pointed out that the two methods were effective in the treatment of HFS, but that MVD was more effective in the treatment of vascular HFS. At present, MVD is considered the mainstream surgical choice for the treatment of HFS, and it is mainly performed under the microscope. However, endoscopy has rapidly developed as a technique and has the advantages of high brightness, a clear visual field and flexible operation, so has been widely used in certain surgeries instead of a microscope. Endoscopic MVD can identify offending blood vessels, comprehensively assess whether decompression is sufficient, reduce surgical trauma and complications, and improve the QOL of a patient, which has been recognized and promoted by experts in the field (9-11). The present study report 5 cases of HFS treated by fully endoscopic MVD, including the preoperative symptoms, intraoperative conditions, postoperative efficacy and follow-up, in order to further show that fully endoscopic MVD is a relatively safe, feasible and effective method for the treatment of HFS.

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Patients and methods

Patient summary. The cases of 5 patients with HFS treated by fully endoscopic MVD in the Department of Neurosurgery, Chongqing General Hospital (Chongqing, China) between May and December 2020, were retrospectively reviewed and analyzed. The cases consisted of 1 female and 4 male patients, aged 46-64 years and the mean age was 54 years old, and the history of disease ranged from 2 months to 13 years. The HFS symptoms occurred on the left side in 2 patients, on the right side in 2 patients and on both sides in 1 patient. Before surgery, all patients underwent cranial magnetic resonance imaging (MRI) (Figs. 1A-5A) to exclude tumors or other intracranial diseases, and electrophysiological examination to evaluate their condition. The correct muscle location for surgery was determined according to the anatomy of the patient, clinical research and cranial MRI.

Patients

Patient 1. A 57-year-old male had suffered from left-sided facial twitches for 5 years. His left facial twitch was paroxysmal and could be resolved spontaneously. The patient had been treated with acupuncture and moxibustion, but with little effect. He was admitted to hospital on May 5, 2020. A physical examination showed that the left-sided facial twitches were involuntary, and that hearing and extremity muscle tone were normal.

Patient 2. A 46-year-old female had experienced right-sided facial twitches for 13 years. The initial clinical manifestation of the patient was twitching of the right eyelid, and later the clinical symptoms gradually became the whole right facial twitching. The patient had been treated with BT injection four times, and after each treatment, the symptoms were relieved for several months before relapsing again. She was admitted to hospital on May 25, 2020.

Patient 3. A 54-year-old male had experienced involuntary bilateral lateral twitching for 2 months. His bilateral facial twitches were paroxysmal, and these clinical manifestations aggravated when he was tense and disappeared when he slept. The patient was admitted to the hospital on May 7, 2020 and November 23, 2020. He received no treatment prior to his first admission to the hospital.

Patient 4. A 50-year-old male had suffered from left-sided facial twitches for 6 years. The patient had received acupuncture and moxibustion therapy with poor results. The patient had also received BT injections several times, and after each treatment, the symptoms were only relieved for a few months before the condition relapsed again. He was admitted to hospital on July 1, 2020.

Patient 5. A 64-year-old male had experienced right-sided facial twitches for 2 years. His left facial twitch was paroxysmal and could be resolved spontaneously. The patient was admitted to hospital on July 1, 2020. He had not received any treatment prior to his admission to the hospital.

MVD treatment. All operations were performed via the suboccipito-retrosigmoid approach under full endoscopy. The patients were placed in an upside-down position on the surgical site, with the head drooping 15˚ and rotating 10˚ to the opposite side. The neck was slightly forward, the mandible was ~2 transverse fingers from the sternum, and the mastoid on the surgical side was roughly parallel to the operating table and in the highest position. The head was fixed and slightly turned to the surgical site, in order to help the cerebellum leave the petrous bone due to its own gravity, without the use of a brain plate. A straight incision parallel to the inner edge of the hairline or a transverse incision through the root of the mastoid was performed, at a length of 4-6 cm. The upper and the outer edges of the bone window were located under the transverse sinus and exposed the edge of the sigmoid sinus. Usually, the diameter of the bone window is only 2-3 cm. In order to prevent damage to the venous sinus, drill a hole farthest from the venous sinus, then grind the skull, and gradually expand the bone window to the transverse sinus and sigmoid sinus. In order to make the bone window as close to the sigmoid sinus as possible, the mastoid air chamber can be opened if necessary, but it must be blocked with bone wax in time. After suspending and cutting the dura mater, the arachnoid membrane was cut to slowly release cerebrospinal fluid, so that the cerebellar hemisphere collapsed naturally and formed enough space for surgery. Next, under the neuroendoscope, the arachnoid surrounding the trigeminal nerve, the acoustic-facial bundle and the lower cranial nerves was completely cleared and dissected, and the neurovascular conflict area was identified. The offending blood vessels in contact with the facial nerve roots were separated and shifted, and decompressed using a Teflon pad. Meanwhile, a small piece of Teflon pad cotton was placed parallel to the root outlet zone (REZ) along the nerve to prevent blood vessels from compressing the REZ. Arteries with severe atherosclerosis should be avoided during the operation, so as not to distort arteries and cause blood flow obstruction. Next, under the neuroendoscope, checks were performed to confirm that no offending blood vessels were missed, that decompression was sufficient, and that the size and location of the Teflon pads were appropriate. Finally, the dura mater was sutured and the skull defect was repaired with titanium plates and screws, and sutured closed layer by layer.

Results

Overall results. Figs. 1-5 show the relevant images of cases 1-5, respectively, including the preoperative MRI and intraoperative images. From the intraoperative images, the offending blood vessels are clearly visible in all 5 cases, including 3 cases in which the anterior inferior cerebellar artery was affected (Figs. 1, 3 and 5), 2 cases in which the posterior inferior cerebellar artery was affected (Figs. 2 and 4) and 1 case where the small arteries were affected (Fig. 3). Notably, the offending blood vessels were found on both sides of the left and right face of the same patient, with the left side affected by the small arteries and the right side by the inferior cerebellar artery. (Fig. 3). Generally, the criteria for judging the curative effect of HFS after surgery are divided into four levels using a postoperative efficacy classification based on previous literature and clinical symptoms (12): i) Excellent: The symptoms of HFS completely disappear. ii) Good: The symptoms of HFS basically disappear and can only be induced occasionally when the patient is emotionally intense or during certain facial movements. In addition, when the symptoms have basically disappeared and the patient feels subjectively satisfied. iii) Fair: The symptoms of HFS are relieved but still frequent, and the patient feels subjectively dissatisfied. iv) Poor: The symptoms of HFS did not change and even worsened. According to the aforementioned classification, the surgical efficacy of the 5 cases was evaluated, from which 2 cases were graded as excellent and 3 cases were graded as good, with an effective rate of 100%. This showed that fully endoscopic MVD was a safe and effective method for the treatment of HFS. In addition, 4 cases had no postoperative complications, while only 1 patient experience postoperative aseptic meningitis, but fully recovered after follow-up treatment.

Individual patient results

Patient 1. The symptoms of left-sided HFS were significantly improved after fully endoscopic MVD, but twitching around

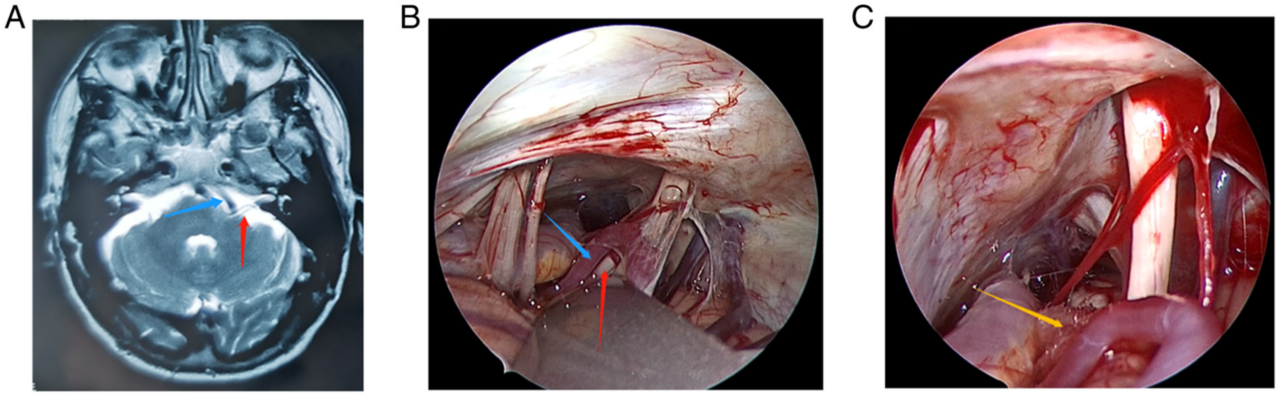

Figure 1. Patient 1. (A) Preoperative head magnetic resonance imaging of the patient. (B) The anterior inferior cerebellar artery and compressed cranial nerves were clearly visible under the endoscopic view. (C) The Teflon pad was placed between the root exit zone of cranial nerve 7 and the anterior inferior cerebellar artery under the endoscopic view. Red arrows indicate the compressed cranial nerve vessels, blue arrows indicate the anterior inferior cerebellar artery and the yellow arrow indicates the Teflon pad.

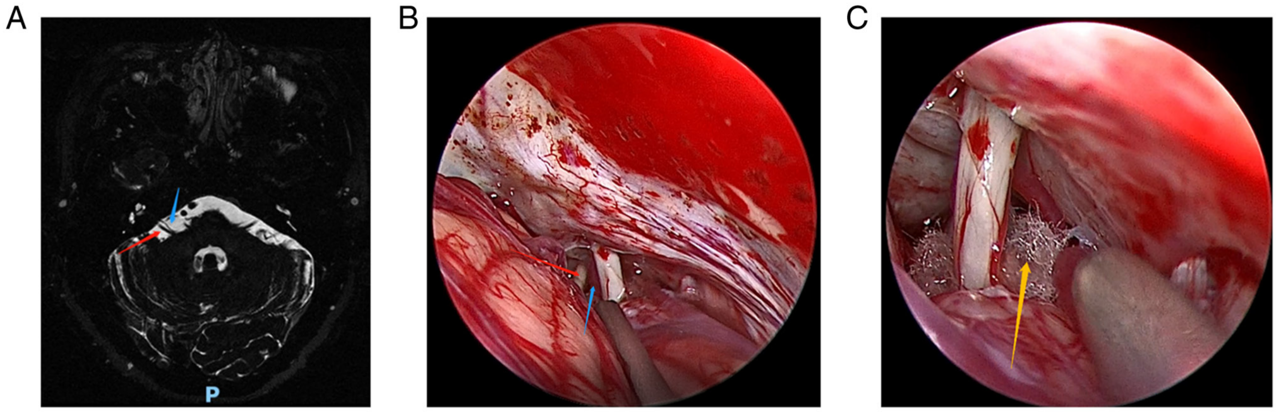

Figure 2. Patient 2. (A) Preoperative head magnetic resonance imaging of the patient. (B) The posterior inferior cerebellar artery and compressed cranial nerves were clearly visible under the endoscopic view. (C) The Teflon pad was placed between the root exit zone of cranial nerve 7 and the posterior inferior cerebellar artery under the endoscopic view. Red arrows indicate the compressed cranial nerve vessels, blue arrows indicate the posterior inferior cerebellar artery and the yellow arrow indicates the Teflon pad.

the eyes occasionally occurred. The patient also suffered from aseptic meningitis after the surgery, but recovered well after lumbar puncture and drainage. After 12 months of follow-up, the clinical symptoms disappeared without recurrence and complications. The offending blood vessel was identified as the anterior inferior cerebellar artery during the operation, and the postoperative curative effect was evaluated as good.

Patient 2. The symptoms of HFS basically disappeared after fully endoscopic MVD, and there was no recurrence during 12 months of follow-up. The offending blood vessel was identified as the posterior inferior cerebellar artery during the operation, and the postoperative curative effect was evaluated as good.

Patient 3. After the first fully endoscopic MVD, the right-sided facial symptoms were completely relieved, but the left facial symptoms were only slightly improved. At 5 months post-surgery, the patient underwent a second fully endoscopic MVD and the left-sided facial symptoms were also completely relieved. After 12 months of follow-up, there was no recurrence on either side of the face. In the two operations, the responsible blood vessels were identified as the anterior inferior cerebellar artery on the right side and the small artery on the left side. The postoperative curative effect was evaluated as excellent.

Patient 4. The patient underwent fully endoscopic MVD and the symptoms on the left side of the face were significantly improved. There was no recurrence during a follow-up period of 12 months. The offending blood vessel was identified as the posterior inferior cerebellar artery during the operation, and the postoperative curative effect was evaluated as good.

Patient 5. The patient underwent fully endoscopic MVD and the symptoms were completely relieved. After 12 months of follow-up, there was no recurrence. The offending blood vessel was identified as the anterior inferior cerebellar artery during the operation, and the postoperative curative effect was evaluated as excellent.

Discussion

HFS is a common clinical cranial nerve disease that manifests as paroxysmal involuntary facial muscle twitching.

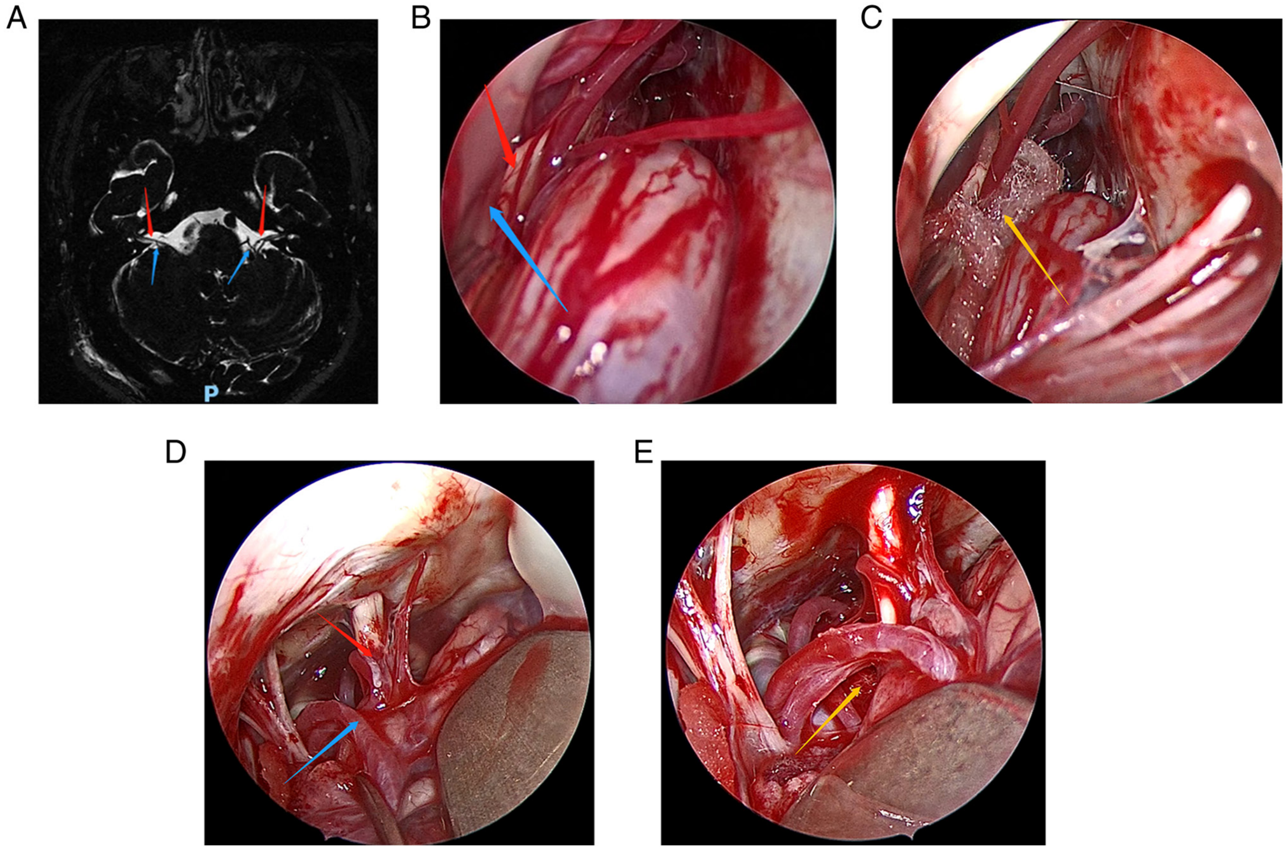

Figure 3. Patient 3. (A) Preoperative head magnetic resonance imaging of the patient. (B) In the first operation, the anterior inferior cerebellar artery and compressed cranial nerves were clearly visible under the endoscopic view. (C) The Teflon pad was placed between the root exit zone of cranial nerve 7 and the anterior inferior cerebellar artery under the endoscopic view in the first operation. (D and E) They are the images observed under the endoscope during the second operation, the offending blood vessel is the small artery. Red arrows indicate the compressed cranial nerve vessels, blue arrows indicate the offending blood vessels and yellow arrows indicate the Teflon pad.

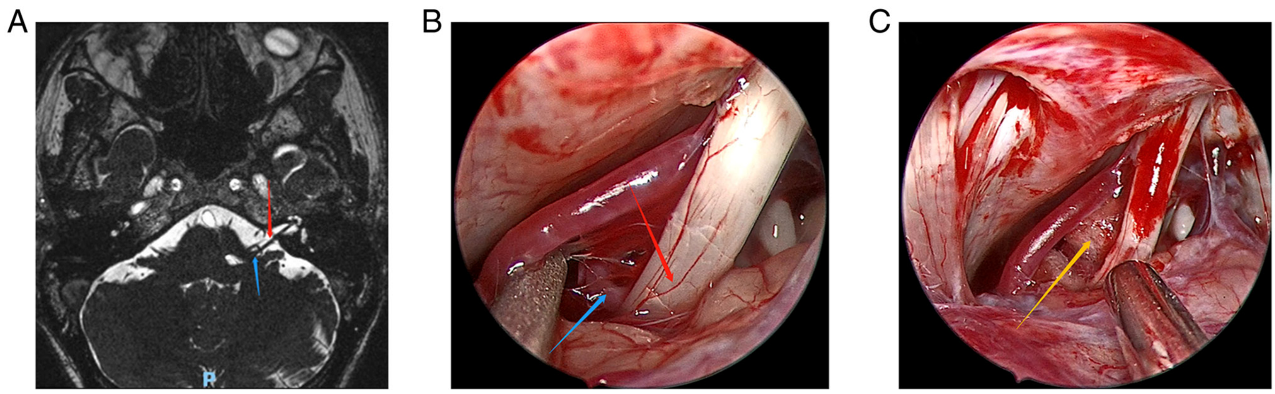

Figure 4. Patient 4. (A) Preoperative head magnetic resonance imaging of the patient. (B) The the posterior inferior cerebellar artery and compressed cranial nerves were clearly visible under the endoscopic view. (C) The Teflon pad was placed between the root exit zone of cranial nerve 7 and the posterior inferior cerebellar artery under the endoscopic view. Red arrows indicate the compressed cranial nerve vessels, blue arrows indicate the posterior inferior cerebellar artery and the yellow arrow indicates the Teflon pad.

When the symptoms are relatively severe, it can cause serious psychological obstacles to patients, and even affect their QOL, work and social communication. Therefore, the treatment desire of patients is strong. In 1947, Campbell and Keedy (13) reported 2 cases of HFS caused by abnormal blood vessels in the posterior fossa compressing the facial nerve roots. Both patients underwent surgery through the suboccipital approach, and cirsoid aneurysms of the basilar artery were both observed and separated from the facial nerve root during surgery. The involuntary facial convulsion symptoms were relieved to a certain extent after the surgery. In 1962, Gardner (3) first proposed that the HFS was caused by vascular compression of the facial nerve roots. In 1966, Jannetta and Rand (14) hypothesized that the REZ of the facial nerve was compressed by the offending blood vessels, resulting in demyelination of the facial nerve and

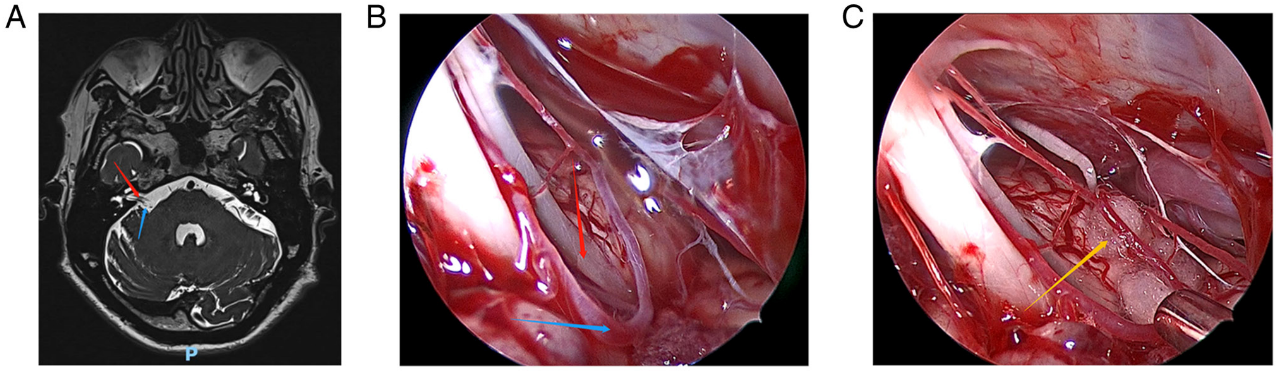

Figure 5. Patient 5. (A) Preoperative head magnetic resonance imaging of the patient. (B) The the anterior inferior cerebellar artery and compressed cranial nerves were clearly visible under the endoscopic view. (C) The Teflon pad was placed between the root exit zone of cranial nerve 7 and the anterior inferior cerebellar artery under the endoscopic view. Red arrows indicate the compressed cranial nerve vessels, blue arrows indicate the anterior inferior cerebellar artery and the yellow arrow indicates the Teflon pad.

an impulse short circuit between the afferent and efferent nerve fibers, which was the root cause of HFS. The vascular compression etiology theory was thus further improved. Based on this, MVD was pioneered to treat HFS (14). At present, MVD is mainly performed using a microscope (microscopic MVD), a microscope combined with an endoscope (endoscope-assisted MVD) or using an endoscope only (fully endoscopic MVD). Among these methods, microscopic MVD is the most traditional and is commonly used. However, the straight viewing field of the microscope limits the observation of deep structures and the angle, making it difficult for doctors to accurately determine the compression points of all offending blood vessels. A study has highlighted that ~23% of double vessel compression is difficult to detect under the microscope (15). With the rapid development of endoscopic technology, endoscopy now has advantages such as the wide field of vision, bright light, no obstruction of the field of vision and flexible operation, and so has become a standard operative tool for minimally invasive neurosurgery of the sellar and parasellar regions, and the ventricular system (16-18). As a representative of minimally invasive neurosurgery, endoscopy-assisted MVD has been applied in clinical treatment. For MVD, compared with the microscope, the endoscope has the greatest advantage of accurately identifying the offending blood vessels. Magnan *et al* (19) reported the first 43 cases of patients who received endoscopy-assisted MVD and suggested the endoscopy could accurately identify the offending blood vessels causing the facial nerve compression. It was then reported that for the same 60 patients, the confirmation rate of vascular nerve compression location by endoscopy was 65% higher than that by the microscope, which may be due to the complexity of local neurovascular anatomy, local vessels abnormalities or even branch entanglement, and the offending blood vessels being located in the deep part of the abnormal vascular plexus (20). Teo *et al* (21) also reported that in endoscopy-assisted MVD, endoscopy accurately identified 8% of offending blood vessels missed by microscope. In the same period, fully endoscopic MVD was also trialed to treat HFS. The first report on 3 cases of HFS treated with fully endoscopic MVD was published by Eby *et al* (22) in 2001, and the HFS symptoms of the patients were completely relieved after the operation. Cheng *et al* (23) reported that 10 cases with HFS were cured by fully endoscopic MVD without serious complications. Flanders *et al* (24) reported 27 cases of fully endoscopic MVD treatment for HFS, with the cure rate and postoperative complication rate recorded as 60.7 and 26.0%, respectively. Feng *et al* (11) reported 45 cases of HFS that were treated with fully endoscopic MVD, for which the cure rate was 93.3%, the total effective rate was 97.8% and the postoperative complication rate was only 4.4%. At total of two case series with complete data, including 56 cases of HFS treated with fully endoscopic MVD, were reviewed (11,25), for which the postoperative effective rate reached ~92.8% and the postoperative complication rate was ~7.2% (including 2 cases of temporary facial paralysis, 1 case of mild but significant hearing loss and 1 case of intracranial infection). In the present study, all 5 HFS patients underwent fully endoscopic MVD, and the offending blood vessels were accurately identified during the operation. The postoperative effective rate was 100%, and no serious complications occurred. Only 1 patient developed aseptic meningitis, but fully recovered after treatment. There was no hearing loss, facial paralysis or cerebrospinal fluid leakage recorded.

The manner in which complications can be reduced and the efficiency of surgery can be improved is a concern for all neurosurgeons. The complications of MVD treatment for HFS mainly include cranial nerve dysfunction, cerebellar brainstem injury, intracranial hypotension syndrome, cerebrospinal fluid leakage, vertebral artery injury, aseptic meningitis and wound infection (26-30). Specifically, when MVD is used to treat HFS, whether it is microscopic MVD, endoscopic-assisted MVD or fully endoscopic MVD, it is necessary to first identify the offending blood vessels, and then place a Teflon pad between the seventh and eighth pairs of cranial nerves (facial and auditory nerves) and the offending blood vessels to relieve vascular compression. Among the three types of MVD, fully endoscopic MVD has many advantages in the treatment of HFS. Firstly, the excellent visual field of endoscopy helps surgeons to accurately identify the blood vessels and nerves in the surgical area, so as to avoid damaging the surrounding brain tissue, blood vessels and nerves, and to reduce postoperative complications.

In addition, during the operation, endoscopy is helpful to evaluate the position of the Teflon pad, the decompression effect and other injuries in a timely manner, so that surgeons can adjust the operation strategy according to the intraoperative situation. Finally, fully endoscopic MVD can shorten the length of the surgical incision, eliminate excessive craniotomy exposure, avoid excessive separation of arachnoids, and reduce the traction of brain tissues and cranial nerves. In addition, the average operation time of fully endoscopic MVD is equivalent to that of microscopic MVD, which helps to avoid the wasted time of endoscopic-assisted MVD in terms of changing from the microscope to the endoscope to the microscope again. In addition to the aforementioned advantages, fully endoscopic MVD also has some disadvantages. For example, the endoscope occupies a certain operational space during surgery and can only provide two-dimensional images. Intraoperative bleeding may also pollute the endoscope lens, affecting the image quality and the continuity of the operation. Furthermore, it should be mentioned that the present study has certain limitations, as the follow-up time was relatively short and only 5 patients were studied. At the same time, it was designed as a non-randomized retrospective study and does not completely rule out potential selection biases.

In conclusion, with the rapid development of endoscopic technology, fully endoscopic MVD for the treatment of HFS is widely recognized, and its advantages are gradually obvious compared with other technologies. The present study reviewed 5 cases of HFS that were successfully treated using a fully endoscopic MVD technique. Fully endoscopic MVD should be considered as safe and effective to treat HFS. For surgeons, fully endoscopic MVD technology has certain challenges, but sufficient training, rich experience and constantly updated equipment can help them to successfully master this technology.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

HTJ, PW, DWZ, LWZ, BL and NW participated in the conception, design and data acquisition of the article. HTJ participated in drafting and revising the manuscript. PW critically revised the article. NW ensured that questions related to the integrity of any part of the work were appropriately investigated and resolved. HTJ, PW, DWZ, LWZ, BL and NW confirm the authenticity of all the raw data. All authors read and approved the final version of the manuscript.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Chongqing General Hospital (Chongqing, China).

Patient consent for publication

Written informed consent was obtained from the patients for the publication of anonymized data and any accompanying images.

Competing interests

The authors declare that they have no competing interests.

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