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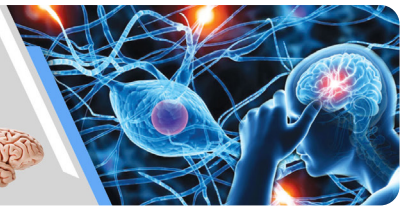
Research Article

JOURNAL OF PSYCHIATRY AND PSYCHIATRIC DISORDERS

ISSN: 2572-519X



To Maximize the Advantage of the Uprising Visualization System: Modified Retro-Sigmoidal Approach for Purely Endoscopic MVD Surgery for HFS

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Abstract

Aim: The number of reports on endoscopic MVD for HFS has been growing swiftly. However, the majority of the literature has been focusing on the advantage of endoscope and the comparison between endoscope and microscope. Little was mentioned to modify the surgical approach to promote the use of endoscope. In order to maximize the advantage of endoscope, we present a series of HFS cases treated with MVD, using a retro-sigmoidal approach that is specially modified for purely endoscopic surgeries.

Method: 86 consecutive cases with primary HFS treated by our team with purely endoscopic MVD were retrospectively included in this study. During surgery, the patient's head remained in a horizontal position without rotation for a face-down tendency and the vertex of the head was only slightly tilt towards the floor. Angled endoscopes were used for better view and more manipulating space.

Results: Of all the 86 patients, the symptom of 67 cases (77.9%) was released immediately after operation and in 15 (17.4%) cases there was a delayed relief. Post-operative neck and shoulder pain, mild transient hearing loss and transient facial paralysis were reported in 5 (5.8%), 3 (3.5%) and 2 cases (2.3%) respectively.

Conclusion: The modification of the retro-sigmoidal approach in order to facilitate the application of endoscope improved the intra-operative exposure and space for manipulation, and reduced the post-operative discomfort of the patients. Purely endoscopic MVD surgery is a safe and effective treatment for HFS.

Keywords: Modified approach; Retro-sigmoidal approach; Endoscope; Microvascular decompression; Hemifacial spasm

Introduction

Hemifacial Spasm (HFS) is a facial movement disorder, featured by involuntary and unilateral spasm of muscles innervated by facial nerve. It is caused by vascular compression on the Root Entrance Zone (REZ) of the facial nerve. A procedure aiming to identify the offending vessels and remove them from the facial nerve was invented by Jannetta. The procedure was named Microvascular Decompression (MVD) and has been established as the only cure for HFS. Traditionally the procedure was carried out under a surgical microscope.

Following its robust development in the past two decades, neuro-endoscope, as a visualization system, has participated in many aspects of neurosurgery.

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Citation: Chongjing Sun, Puyuan Zhao, Chenghui Qu, Jin Xu, Xiaobiao Zhang, Wei Zhu, Yu Zhang. Modified Retro-Sigmoidal Approach for Purely Endoscopic MVD Surgery for HFS. Journal of Psychiatry and Psychiatric Disorders 7 (2023): 12-16.

Received: January 17, 2023
Accepted: January 27, 2023
Published: February 03, 2023

Sun C, et al., J Psychiatry Psychiatric Disord 2023
DOI:10.26502/jppd.2572-519X0178

In a number of surgeries, the endoscope has even taken the place of microscope and functioned as the major visualization tool, e.g. trans-nasal skull base surgeries and ventricular surgeries. In MVD surgery for HFS, endoscope was initially used to provide supplementary view that was beyond the capacity of microscope [1,2]. As far as we are aware, the first report of fully endoscopic MVD was published in 2008 [3]. Since then, the number of reports on endoscopic MVD for HFS has been growing swiftly.

Up to now, the majority of the literature has been focusing on the advantage of endoscope and the comparison between endoscope and microscope. The application of endoscope provides superior illumination and visualization, revealing neurovascular conflicts that might be missed by microscopic survey, and minimizes the need for brain retraction and extensive dissection that might be inevitable in purely microscopic procedures [2-4]. There have been at least three reports comparing endoscope and microscope in MVD for HFS directly. Based on their meta-analysis, two team concluded that endoscopic MVD was superior to microscopic MVD both in perioperative and postoperative efficacy [4-8]. Conversely, Zhu J [9] stated that fully endoscopic MVD for HFS had a higher total incidence of complications than microscopic MVD. Generally speaking, in the setting of MVD procedure for HFS, endoscope can function at least as well as microscope according to the published data by far.

The retro-sigmoidal approach is one of the most classic neurosurgical approaches. Countless details of the approach have been modified for better surgical outcomes of MVD surgery in the era of microscope in which there were no other options if considerable accuracy and delicateness were required. Therefore, the retro-sigmoidal approach currently used in most centers, can be considered as achievement of continuous refinement to facilitate the application of microscope over decades. In most literature concerning endoscopic MVD, endoscope functioned merely as a supplement or replacement for microscope. Even in reports of purely endoscopic MVD, little was mentioned to modify the approach to promote the use of endoscope. Hence, in order to maximize the advantage of endoscope, we present a series of HFS cases treated with MVD, using a retro-sigmoidal approach that is specially modified for purely endoscopic surgeries.

Methods

Patient data

Patients' date was retrospectively collected from cases of HFS treated with purely endoscopic MVD from October, 2019 to June, 2021 in our center. 86 cases with full follow-up data, including 24 (27.9%) male patients and 62 (72.1%) females, were enrolled. The symptom was on the left side in 47 cases (54.7 %) and on the right side in 39 cases (45.3%). There were no cases with bilateral symptom. The age of the patients ranged from 27 to 79 years old, with an average of 53.8 years. All patients were diagnosed by sign, symptom and cranial imaging studies. In all cases, Magnetic Resonance Tomographic Angiography (MRTA) was inspected preoperatively. Follow-up duration ranged from 6 to 26 months, with an average of 15.2 months.

Surgical procedure

All MVD procedures were performed via a suboccipital retro-sigmoid approach, using endoscope (Karl Storz GmbH and Co., Tuttlingen, Germany) as the only visualization system. The endoscope was fixed to a self-retaining holding device most of the time, and would be held by the assistant on condition that more flexible view was needed. The patients were under general anesthesia and Abnormal Muscle Reaction (AMR) monitoring was carried out intra-operatively.

The patients were placed in a lateral oblique position that was slightly different from the traditional manner. Unlike microscopic surgeries in which tremendous efforts have been made to create enough space for the operative microscope and the operating surgeons, more consideration could be taken into account for other aspects of the procedure in purely endoscopic MVD: (1) The head remain in a horizontal position without rotation for a face-down tendency in order that the cerebellum would be easily pulled away from the petrous bone by gravity (Figure 1). (2) For the purpose of patients' post-operative comfort, the vertex of the head was only slightly tilt towards the floor and the upper shoulder needed not to be intensively retracted away from the neck.

Angled endoscopes, 30 degrees or 45 degrees, were used in most cases. Angled lenses can be used to look around the corner, enabling visualization of pathology that was not seen at 0 degree. In addition, the angled endoscope would be usually placed in a position that was more distant from the working instruments than 0-degree endoscope, creating an overlooking view. The precious space provided by the placement of the angled endoscope would greatly benefit the endoscopic manipulation, which was normally completed in a very crowded environment with 0-degree endoscope (Figure 2).

Results

Intra-operative findings

In all 86 cases, offending vessels were identified intra-operatively (Figure 3, 4 and 5). The responsible arteries included anterior inferior cerebellar artery (42, 48.8%), posterior inferior cerebellar artery (36, 41.99%), vertebral artery (17, 19.8%) and unspecific artery (5, 5.8%). More than one offending vessel was found in 14 cases (16.3%). The endoscope provided excellent view of the REZ of the facial nerve and the angled lenses made it even more difficult for the

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neurovascular compression to hide from surgical inspection. During the procedures, AMR was recorded in all the 86 cases. AMR disappeared in 81 cases at the end of the surgery (Figure 3, 4 and 5).

Surgical outcomes

Of all the 86 patients, the symptom of 67 cases (77.9%) was released immediately after operation and in 15 (17.4%) cases there was a delayed relief. In 4 (4.7%) cases, there was no relief even at the latest follow-up (at least 6 months). 3 cases of recurrence were reported at the end of the follow-up period. Only 5 (5.8%) patients reported post-operative neck and shoulder pain, all of which resolved within 3 days. No critical complications, e.g. intra-cranial hematomas, intracranial infection, occurred in this series. Mild transient hearing loss was reported in 3 (3.5%) cases but the hearing all recovered at 3-months follow-up. 2 (2.3%) patients reported transient facial paralysis which was all resolved at early follow-up. There were no other post-operative complications.

Discussion

As one of the pioneering neurosurgical centers in the field of endoscopic surgery in China, we have been performing and promoting purely endoscopic MVD surgery for years. According to our experience, endoscopic MVD procedures require smaller craniotomy and less retraction, and provide superior view of neurovascular compression with merely controlled dissection. Nonetheless, the focus of our study is not the advantage of the endoscope. In order to further promote the application of the endoscope in MVD surgeries, we aimed to adjust the surgical approach. The present study demonstrated that the modification of the retro-sigmoidal approach in order to facilitate the application of endoscope, especially the adjustment of patients' position and the use of angled endoscope, improved the intra-operative exposure and space for manipulation, and reduced the post-operative discomfort of the patients. Excellent relief rate and minimum complication rate were achieved in this series.

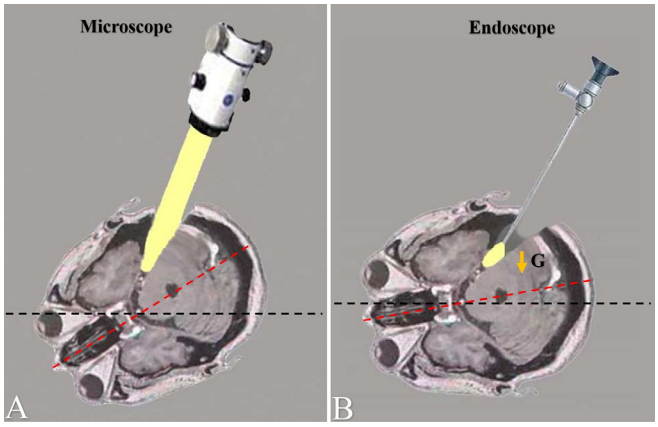

Figure 1: The difference between the head positions of the microscopic and endoscopic MVD surgeries. A: In microscopic MVD, the head of the patient is usually rotated face-down for a more vertical working angle. B: In microscopic MVD, the patient's head can be placed in a more neutral position, which would allow gravity pull the cerebellum away from the petrosum (G= gravity).

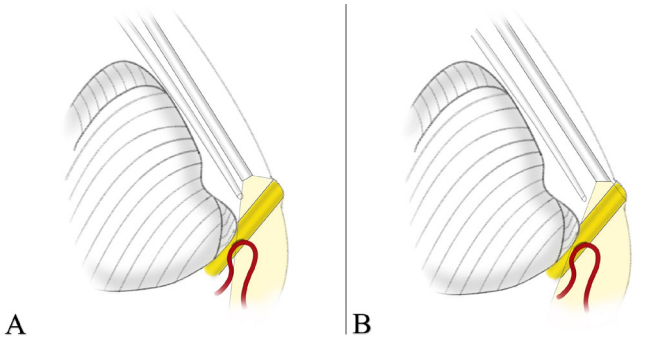

Figure 2: 0-degree lens and angled lens. A: When 0-degree endoscope is used, the view is regional and the endoscope is close to the surgical instrument, which leaves limited space for manipulation. B: Angled endoscope provides an over-looking view and more space for manipulation.

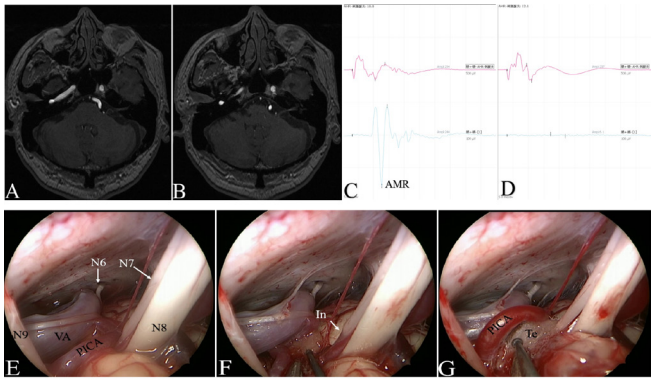

Figure 3: The case of left HFS (48 year's old, male). A-B: Pre-operative MRTA images. C-D: AMR disappeared at the time of decompression. E-G: Intra-operative images showed the recognition and decompression of the offending vessels under endoscopic view. (N6=abducent nerve; N7=facial nerve; N8=vestibulocochlear nerve; N9=Glossopharyngeal nerve. VA= vertebral artery; PICA=posterior inferior cerebellar artery; In=indentation; Te=Teflon).

The adjustment of patients' positions not only promoted the application of endoscope, but also embodied its advantage. Theoretically, manipulation under a surgical microscope can be performed at any desired working angle. In practice, however, a more vertical angle is preferred, because a more horizontal working angle would require the surgeons to stretch their arms much more forward to make up for the space that was occupied by the microscope, which would greatly influence the persistence and stability of the manipulation. Therefore, when microscope is used, the head of the patient is usually rotated face-down for a more vertical working angle, which would unfortunately leave the cerebellum resting on the petrosum and probably require more retraction for adequate exposure (Figure 2). On the contrary,

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the endoscope provides the surgeons equal comfort level at all working angles. Hence in an endoscopic MVD procedure, the patient's head can be placed in a more neutral position. Head position like this would allow gravity pull the cerebellum away from the petrosum, which would increase the exposure, decrease or even eliminate the need for retraction (Figure 2). In addition, outside the surgical field, the endoscope itself does not require so much space as the microscope. As a consequence, all the measures aimed for creating space for the operative microscope and the operating surgeons such as tilting the head towards the floor and retracting the shoulder caudally, became dispensable, erasing the discomfort that was frequently complained in microscopic cases.

The application of angled lenses provided superior view and space for manipulation. It was natural to consider lenes with different angles when endoscope was used to complete MVD, enabling visualization of pathology that was not seen at 0-degree [1]. In addition, according to our experience, the use of angled endoscope provided an over-looking view. The over-looking view improved the control of the overall situation, superior to the view of 0-degree lens that was more close-up and more regional. More importantly, under the current tendency towards smaller incision and smaller bone window, when the endoscope was added to the intracranial space, the endoscope itself became an obstacle for manipulation, especially for surgeons who had just taken up endoscope. The angled endoscope would be usually placed in a position that was more distant from the working instruments than 0-degree endoscope, creating precious extra space for the endoscopic manipulation.

Although the improvement provided by our modification might be trivial, it symbolized a new era for endoscopic neurosurgery. In the time of microscope, with no other options for MVD procedure, neurosurgeons had to tailor

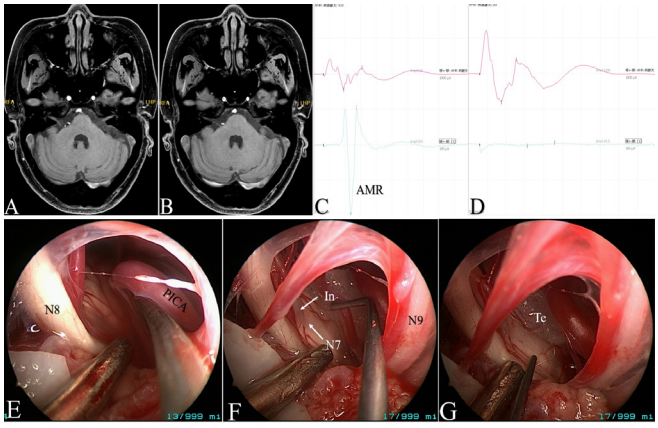

Figure 4: The case of right HFS (59 year's old, female). A-B: Pre-operative MRTA images. C-D: AMR disappeared after decompression. E-G: Intra-operative endoscopic images. (N7=facial nerve; N8=vestibulocochlear nerve; N9=Glossopharyngeal nerve; PICA=posterior inferior cerebellar artery; In=indentation; Te=Teflon).

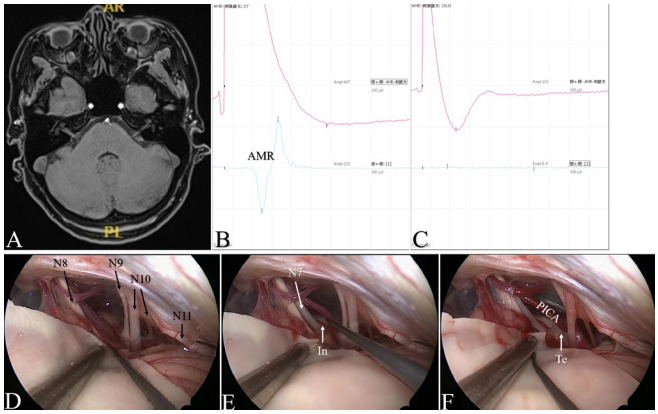

Figure 5: The case of right HFS (44 year's old, female). A: Pre-operative MRTA images. B-C: AMR disappeared in the process of decompression. D-F: Intra-operative images under endoscopic view. (N7=facial nerve; N8=vestibulocochlear nerve; N9=Glossopharyngeal nerve; N10= vagus nerve; N11= accessory nerve; PICA=posterior inferior cerebellar artery; In=indentation; Te=Teflon).

their surgical plans to the use of microscope. When the use of endoscope was introduced and even popularized, the majority of the neurosurgical community simply replaced the microscope with the endoscope and stuck to the surgical approach that was tailored to the microscope. When endoscope has already proved its safety and capacity in MVD [4,6,8], modification would be required to facilitate its application. Indeed, endoscope has its drawbacks, including blind areas in its lateral and rear visual fields, susceptibility to get dirtied by blood, water or fog, and relatively crowded space for manipulation. Nonetheless, it is all these limitations that require us to modify the procedure and allow us to expect an even better outcomes for endoscopic procedure in the future. On top of our research, efforts were made in other centers to promote the application of endoscope. Nagata et al. [7] described a multi-scope Technique, in which MVD is performed fully endoscopically using an exoscope that compensates for the intracranial blind area of the endoscopic view. Iwami et al. [5] reported their experience with underwater endoscopic surgery, in which the surgical field was continuously irrigated with artificial cerebrospinal fluid.

The current study was a single-centered retrospective study, with relatively small sample size and short follow-up period. Therefore, in the future, research with a larger sample size and control design is required to confirm the existing assumptions. Although the diameters of the endoscopes used in our series were identical, the diameter of the endoscope might be another factor that could influence the endoscopic procedure. Endoscope with a smaller diameter would take up less space, but the quality and range of the view would be compromised. Whether the application of thinner endoscope will benefit the surgical outcomes requires further study. We will consider addressing all these questions in future investigations.

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Table 1: Clinical characteristics of the included cases.

Factors	Value
Age(years), mean ± SD	53.8 ± 10.8
Sex	
Male (%)	24 (27.9%)
Female (%)	62 (72.1%)
HFS side	
Left (%)	47 (54.7%)
Right (%)	39 (45.3%)
Follow-up period (months), mean ± SD	14.1 ± 7.6
(SD=standard deviation)	

Table 2: Major surgical outcomes.

Outcomes	Number of cases (%)
Relief	82 (95.3%)
Immediate Relief	67 (77.9%)
Delayed Relief	15 (17.4%)
No Relief	4 (4.7%)
Complications	
Post-operative neck and should pain	5 (5.8%)
Transient hearing loss	3 (3.5%)
Transient facial paralysis	2 (2.3%)

Conclusion

The modification of the retro-sigmoidal approach in order to facilitate the application of endoscope, especially the adjustment of patients' position and the use of angled endoscope, improved the intra-operative exposure and space for manipulation, and reduced the post-operative discomfort of the patients. Purely endoscopic MVD surgery is a safe and effective treatment for HFS.

Sources of funding

The study was supported by the Clinical Research Project of Zhongshan Hospital, Shanghai, China. (No. 2020ZSLC18)

Highlights

Through improvements in retro-sigmoidal approach, patients' positioning, and use of angled endoscopes, purely endoscopic MVD surgery is a safe and effective treatment for HFS.

Disclosures

The authors declare that they have no financial or other conflicts of interest in relation to this research and its publication.

Guarantors

Wei Zhu M.D, Yu Zhang M.D.

Contributors

Chongjing Sun and Puyuan Zhao have contributed equally to this work and should be considered as co-first authors.

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