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Clinical Efficacy of Neuroendoscope-assisted Microsurgery Through an Anterior Transpetrosal Approach in the Treatment of Meningiomas

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Abstract

Objective: This study probed the clinical efficacy of neuroendoscope-assisted microsurgery through an anterior transpetrosal approach in the treatment of meningiomas. **Methods:** In this study, we retrospectively analyzed 31 patients with meningiomas who underwent neuroendoscope-assisted microsurgery, operated using the anterior transpetrosal approach, from September 2020 to October 2023. **Results:** The tumor was totally resected in 5 patients, subtotally resected in 23 patients, and mostly resected in 3 patients. There was one case of postoperative trochlear nerve injury and one case of mild facial paralysis. All patients had no postoperative cerebrospinal fluid leakage or intracranial hemorrhage, with normal hearing. No recurrence or death occurred at the 1-month postoperative follow-up. **Conclusion:** Neuroendoscope-assisted microsurgery through the anterior transpetrosal approach yields satisfactory clinical outcomes in the treatment of meningiomas, as evidenced by alleviated symptoms, reduced serious postoperative complications, recurrence, and mortality, and increased quality of life of patients with high patient satisfaction.

Keywords

Neuroendoscope, Microsurgery through the anterior transpetrosal approach, Meningiomas, Efficacy

Meningiomas are slow-growing tumors that develop from the meninges and are asymptomatic in the early stages. Although meningiomas are the second most common intracranial tumor, they are mostly benign and have a good prognosis. Meningiomas are slightly more prevalent in adult women than in adult men, with the elderly and children at low risk [1]. Patients with meningiomas usually present with a single tumor and occasionally develop several tumors growing simultaneously. The symptoms of meningiomas vary from headache as the first symptom to other symptoms including limb weakness, limb movement limitation, sensation loss, vision loss, papilledema, and anosmia. In addition, in this study two patients with meningiomas developed epilepsy and one patient developed exophthalmos. Meningiomas preferably involve the scalp, skull, orbits, sinuses, semilunar ganglion, and outer dura mater layer [2]. According to the 2021 World Health Organization Classification of Tumors of the Central Nervous System, meningiomas are classified into 3 grades: WHO grade I (most common, slow-growing), WHO grade II (atypical meningiomas, more invasive), and WHO grade III (anaplastic meningiomas, locally invasive and high risk of recurrence), among which WHO grade I meningiomas account for about 80% of cases, and meningiomas at WHO grades II−III account for approximately 20% of cases. Low-grade meningiomas (WHO grade I) have a good prognosis with surgery and/or radiotherapy [3]. The primary treatment options for meningiomas include conservative treatment, surgery, and radiotherapy [4]. Specifically, patients with asymptomatic small-sized meningiomas can be followed up with close observation to closely monitor changes in the tumor [5]. Radiotherapy is recommended for

patients with non-total resection and recurrence, including Gamma-Knife, X-Knife, and Cyber-Knife [6]. Surgery is the preferred treatment for meningiomas because it offers a cure by completely removing the tumor. The type of surgery is determined by several factors including tumor site, preoperative cranial nerve injury (posterior fossa meningiomas), vascular structure, invasion of venous sinus, and arterial encasement. Therefore, the specific treatment regimen should be tailored to the specific situation of patients, with control of tumor growth and prevention of neurological deterioration as the principle [7]. Unfortunately, the surgical treatment of petroclival meningiomas has been problematic since they have a difficult anatomical location, are closely associated with important cerebral neurovascular vessels, as well as the brainstem, basilar artery, perforating arteries, and cranial nerves, and are partially obscured by the temporal bone. A prerequisite to effective tumor resection is adequate exposure of the meningioma [8]. In recent years, some scholars have used an anterior transpetrosal approach based on the relationship between petroclival meningiomas and neurovascular structures and their rich surgical experience. However, the anterior transpetrosal approach for petroclival meningiomas has been rarely reported. This study retrospectively analyzed the clinical outcomes of 31 patients with meningiomas who underwent neuroendoscope-assisted microsurgery through the anterior transpetrosal approach from September 2020 to October 2023.

1. Materials and methods

1.1 General data

This retrospective study enrolled 31 patients with meningioma undergoing neuroendoscope-assisted microsurgery through the anterior transpetrosal approach from September 2020 to October 2023, who were aged 40-72 years with a mean age of 55.23 ± 11.34 years. These patients consisted of 5 males and 26 females.

1.1.1 Inclusion criteria: Patients were included in this study when fulfilling the following criteria: (i) patients with imaging findings suggestive of occupancy in the petroclival region [9]; (ii) patients diagnosed with meningiomas through pathological examination; (iii) patients with complete clinical data; and (iv) patients who and their families were informed about the surgery and the purpose and methods of the study and signed an informed consent form.

1.1.2 Exclusion criteria: Patients matching the following criteria were excluded from this study [10]: (i) patients with multiple occupying lesions in the central system; (ii) patients aged less than 20 years; (iii) patients with extremely poor adherence and refusal to comply with prescribed treatments and examinations; and (iv) patients with an advanced malignant tumor that had spread throughout the body.

1.2 Methods

1.2.1 Collaborative approach to imaging

Advanced imaging techniques such as magnetic resonance imaging (MRI) and computed tomography (CT) have been widely used in the diagnosis and localization of meningiomas. In general, the blood supply to the tumor is assessed with CT and MRI, CT angiography, magnetic resonance angiography, or magnetic resonance venography prior to neuroendoscope-assisted microsurgery through an anterior transpetrosal approach. In this study, patients underwent intravenous contrast-enhanced CT scans with Iopromide (50 mL) as the contrast agent. It should be noted that iodinated contrast media are contraindicated in patients with hyperthyroidism and should be cautiously used in patients with allergy to iodinated contrast media, severe liver and kidney dysfunction, heart disease, emphysema, advanced cerebral arteriosclerosis, long-term diabetes mellitus, spasticity of cerebral origin, mild nodular goiter and multiple myeloma.

1.2.2 Imaging results

The CT findings showed that the density (signal) of tumors was relatively homogeneous and large lesions were generally lobular. On enhanced CT scans, the tumor parenchyma was significantly enhanced, and in most cases, the tumor body was uniformly enhanced, with a clear boundary and a round or oval shape. Atypical CT revealed that tumors were interspersed with hypointense foci with no significant enhancement or with circumferential enhancement or wall-nodular enhancement.

MRI results displayed that the tumors of 31 participants showed long T1 and long T2 signals and slightly high signals on fluid-attenuated inversion recovery images. On enhanced MRI, the tumors exhibited inhomogeneous enhancement and extended posterolaterally along the border of the petrous bone to the internal carotid artery. Among all participants, the tumors had a maximum diameter of 26-66 mm, with a mean diameter of 44.2 ± 11.8 mm. There were 25 cases of invasion of the internal carotid artery and 6 cases of invasion of the cavernous sinus.

1.2.3 Surgical procedure

The patients were instructed by the nursing staff to lie in the supine position. An arch-shaped incision was created 0.5 cm below the zygomatic arch of patients and extended along the outer auricle superoposteriorly. A hole was then drilled in the base of the temporal bone to the level of the middle fossa floor, and a bone flap of 3.5 cm × 4 cm × 5 cm was milled down. The upper portion of the mastoid process of patients was skillfully resected, and then the dura mater was opened to release the cerebrospinal fluid, followed by electrocoagulation and peeling of the middle meningeal artery. The greater superficial petrosal nerve and geniculate ganglion of patients were accurately located, and next a conical retractor was used to identify the petrous ridge from the inside. The dura mater of the posterior cranial fossa anterior to the sigmoid sinus was exposed by abrading the petrous bone of the Trautmann triangle, during which attention needed to be paid to avoid exposing the tympanum and labyrinthine capsule of patients. The posterior part of the Superior petrosal sinus and the Kawase triangle were further exposed. After complete exposure to the meningioma, the blood supply to the meningioma was blocked through bipolar electrocoagulation. Subsequently, the meningioma was decompressed and then peeled from the surrounding structures. After the meningioma was excised under the assistance of a microscope, patients were further observed with a 45° neuroendoscope to ensure that the flank of the patients was free of meningioma remnants.

2. Results

There were 5 cases of total resection (total resection of the tumor and its surrounding normal tissues), 23 cases of subtotal resection (resection of a portion of the tumor tissues, leaving a portion of normal tissues to protect the structure and function of the surrounding organs), and 3 cases of partial resection (resection of a large portion of the tumor tissues during the surgery). The symptoms of meningiomas were relieved to varying degrees in 31 patients after surgery. Among the included patients, one patient developed postoperative trochlear nerve injury and one patient experienced mild facial paralysis. All of the included patients fully recovered within one month after targeted treatment. All patients did not show postoperative cerebrospinal fluid leakage or intracranial hemorrhage, with normal hearing. No recurrence or death appeared at the 1-month postoperative follow-up.

3. Conclusions

Meningiomas have an age-related incidence, occurring most frequently in middle-aged and older adults aged between 40 and 60 years and rarely in children aged between 10 and 15 years. The incidence of meningioma is also disparate to sex and higher among women. Likewise, the incidence of meningioma is related to the occupation. Populations exposed to radiation for a long time are susceptible to meningioma and should undergo regular physical examinations. Symptoms of meningioma mainly include headache, movement dysfunction, and sensation dysfunction, as well as changes in mood, personality, and cognitive function, which may be accompanied by nausea, vomiting, and epilepsy in some patients. To be specific, headaches in patients with meningiomas are generally focal and may become more extensive as the tumor grows progressively and occupies a region. Epileptic symptoms occur in approximately 30% of patients with meningiomas and are more common in patients with glioneuronal tumors (70-80%), especially patients with frontotemporal or insular lesions. Epileptic seizures compromise the cognitive function of patients and increase the risk of psychiatric complications such as depression and anxiety, thus exhibiting a significantly negative impact on the quality of life of patients. Fortunately, surgical resection can free 60-90% of patients with meningiomas from epileptic seizures [11]. Limb weakness may occur when the meningioma further compresses brain tissues. When the meningioma compresses the sensory center, patients present with hypoesthesia in the corresponding sensory regions, such as numbness and pain in the hands and feet. Additionally, patients with meningiomas often experience mood changes and even psychiatric symptoms, such as sudden personality changes, who become calculating or verbally abusive or express depression or anxiety more frequently than before. Although neuropsychiatric symptoms are common in patients with brain tumors, they may often be the only manifestation in most patients with early-stage meningiomas. Therefore, neurological examination and neuroimaging are necessary for patients presenting to the clinic, especially those with atypical symptoms [12]. As the disease progresses, patients with meningiomas may also develop cognitive decline, such as dementia, which may be accompanied by a decline in the ability to attention, calculation, language and logic, thereby seriously inflicting the normal work and life of patients. Hence, effective treatment is required to intervene in meningiomas, especially petroclival meningiomas.

Our study unveiled 5 cases of total resection, 23 cases of subtotal resection, and 3 cases of partial resection. There was one case of postoperative trochlear nerve injury and one case of mild facial paralysis. All patients had no postoperative cerebrospinal fluid leakage or intracranial hemorrhage, with normal hearing. No recurrence or death was

observed at the 1-month postoperative follow-up. These results indicated that neuroendoscope-assisted microsurgery through the anterior transpetrosal approach can obtain satisfactory clinical results in the treatment of meningiomas, including mitigated symptoms and diminished serious postoperative complications, recurrence, and mortality. These effects of neuroendoscope-assisted microsurgery through the anterior transpetrosal approach may be associated with the following reasons. First, neuroendoscope-assisted surgery can be performed through a small incision, which prevents extensive craniotomy, reduces damage to brain tissues, and greatly shortens the postoperative recovery time. Second, neuroendoscope provides a high-definition view, which allows for more accurate localization of the meningioma and observation of the anatomical relationship between the meningioma and the surrounding tissues, thus increasing the precision of the surgery. Third, the less damage of neuroendoscope-assisted surgery to the brain tissues decreases the incidence of postoperative complications in patients with meningiomas.

The anterior transpetrosal approach can enable microsurgery to directly reach the petroclival region with a relatively short surgical path, which reduces surgical time and trauma. During surgery, this approach can also effectively avoid opening the meninges and stretching the brain tissues, which reduces the surgical damage to the brain of patients, expedites postoperative recovery, and lowers the incidence of postoperative complications, such as hearing damage, intracranial hemorrhage, intracranial infection, and cerebrospinal fluid leakage. The anterior transpetrosal approach can also provide better exposure of the meningioma, which is conducive to total resection of the meningioma and diminishes the risk of recurrence. Microscopic surgery for meningioma can confer greater protection of surrounding neurovascular vessels and other important structures in patients and reduce neurological damage. More importantly, this surgery can block the tumor blood-supplying arteries, which originate from the tentorial artery, in patients with petroclival meningiomas. However, microsurgery through the anterior transpetrosal approach is relatively difficult, as it needs to proceed through the petrous bone and skull base, which complicates the surgical pathway and requires extensive experience and proficient skills for surgeons. Meanwhile, important structures such as surrounding neurovascular vessels may be damaged during the surgery, thus inducing the occurrence of trochlear nerve injury or mild facial paralysis. Postoperatively, patients require strict postoperative management, such as intracranial pressure control and infection prevention, which is difficult and demands the use of advanced microscopes and surgical instruments.

Conclusively, neuroendoscope-assisted microsurgery through the anterior transpetrosal approach can achieve satisfactory clinical outcomes in the treatment of meningioma, which can ameliorate the symptoms, diminish serious postoperative complications, recurrence, and mortality, and increase the quality of life of patients with high patient satisfaction in clinical practice. Accordingly, this surgery method can be promoted in the clinic.

References

[1] He YB, Zhang GL, Guo JZ, et al. Complications and preventive measures of modified subtemporal transtentorial approach for resection of petroclival tumors [J]. Journal of Clinical Neurosurgery, 2020, 17(5): 549-553.

[2] Tao XG, Wei XT, Xue YK, et al. Resection of petroclival tumors through the anterior-subtemporal transanterior petrosal approach [J]. Chinese Journal of Minimally Invasive Neurosurgery, 2020, 25(12):529-532.

[3] Jiang C, Niu ZS, Ling SY. Clinical diagnosis and treatment of intraventricular central neurocytoma [J]. Chinese Journal of Stereotactic and Functional Neurosurgery, 2019, 29(3): 151-154.

[4] Jiang L, Sheng MF, Zhang Y, et al. The modified method of locating related bony structures in intradural anterior transpetrosal approach [J]. Chinese Journal of Experimental Surgery, 2019, 36(8): 1452-1454.

[5] Jiang C, Niu ZS, Ling SY, Jiang XF, Xia CY, Ding WH. Clinical diagnosis and treatment of intraventricular central neurocytoma [J]. Chinese Journal of Stereotactic and Functional Neurosurgery, 2016(3):151-154.

[6] Zhao P, Li B, Li CZ, Zhu HB, Gui SB, Zong XY, Wang XS, Zhang YZ. Complications and risk factors of neuroendoscopic treatment of intraventricular tumors [J]. Chinese Journal of Neurosurgery, 2018, 34(6):550-553.

[7] Tomio R, Horiguchi T, Borghei-Razavi H, Tamura R, Yoshida K, Kawase T. Anterior transpetrosal approach: experiences in 274 cases over 33 years. Technical variations, operated patients, and approach-related complications. J Neurosurg. 2021 Aug 13; 136(2):413-421. doi: 10.3171/2020.12.JNS204010. PMID: 34388716.

[8] Shin M, Hasegawa H, Miyawaki S, Kakigi A, Takizawa T, Kondo K, Shiode T, Kin T, Saito N. Endoscopic transmastoid posterior petrosal approach for locally aggressive tumors in the petrous part of the temporal bone involving the internal auditory canal, jugular foramen, and hypoglossal canal. J Neurosurg. 2019 Sep; 27:1-13. doi: 10.3171/2019.5.JNS19187. Epub ahead of print. PMID: 31561213.

[9] Li DM, Sun HW. Analysis of related factors of postoperative recurrence of WHO grade III meningiomas [J]. The Journal of Practical Medicine, 2018, 34(24):4110-4114.

[10] Li GQ, Luo YH, Yu Y, et al. Recurrence Rate and Risk Factors of Atypical Meningioma:a Meta-analysis [J]. Acta Academiae Medicinae Sinicae, 2022, 44(4):570-578.

[11] Elbadry Ahmed R, Tang H, Asemota A, Huang L, Boling W, Bannout F. Meningioma Related Epilepsy- Pathophysiology, Pre/postoperative Seizures Predicators and Treatment. Front Oncol. 2022 Jul 4; 12:905976. doi: 10.3389/fonc.2022.905976. PMID: 35860576; PMCID: PMC9289540.

[12] Gyawali S, Sharma P, Mahapatra A. Meningioma and psychiatric symptoms: An individual patient data analysis. Asian J Psychiatr. 2019 Apr; 42:94-103. doi: 10.1016/j.ajp.2019.03.029. Epub 2019 Mar 28. PMID: 30999261.