Abstract

Objective To report experiences with use of otoendoscopy in cerebellopontine angle (CPA) surgeries.

Methods Twenty-five cases of CPA surgeries performed between November 2002 and December 2008 in which microscope enabled otoendoscopy was used were reviewed. The 25 cases included 19 cases of acoustic neuroma, 3 cases of CPA facial nerve tumors, 1 case of trigeminal neurinoma, a case of glossopharyngeal neuralgia and 1 case of hemifacial spasm. Endoscopy was used in all cases together with monitoring of brainstem auditory responses and facial electromyography. Postoperative hearing and facial nerve function were evaluated and compared to preoperative levels.

Results Endoscopy provided improved visualization of local anatomy, revealed hidden lesions and reduced unnecessary anatomical distortions. Total resection was achieved in 18 of the 19 acoustic neuroma cases. Facial nerve anatomical integrity was preserved in all 19 cases. One week postoperative House-Brackmann grading was I in 3 cases, II in 10 cases and III in 6 cases. Facial nerve function continued to improve in some cases at 3 months. Total tumor resection was achieved in all 3 patients with facial neurinoma. The facial nerve was sacrificed in 2 of the 3 cases with primary faciolhyoglossal nerve anastomosis. Facial nerve function was Grade II and Grade III one year after surgery, respectively. In the case with anatomically preserved facial nerve, postoperative facial nerve function was initially Grade III and improved to II at 3 months. The tumor was completely resected in the trigeminal neurinoma patient with a Grade III postoperative facial nerve function which improved Grade II three months later. Seventeen of the 19 patients with acoustic neuroma retained hearing postoperatively, of these 12 maintained preoperative levels of hearing. Preoperative hearing capacity was preserved in 2 of the 3 patients with facial nerve tumors, but lost in patients with other tumor types. Glossopharyngeal neurontomy (n=1) and microvascular decompression (n=1) resulted in satisfactory symptom relief and no recurrence at 5– and 3–year follow up, respectively. Conclusions Otoendoscopy–aided technique greatly helps surgical management of CPA and internal auditory canal lesions and other disorders. This minimally invasive technique overcomes many shortcomings inherent to the traditional retrosigmoid approach.

Key words CPA, endoscope, retrosigmoid approach

Introduction

Otologic surgery emerged during the 19th century, with a major breakthrough occurring in the middle of the 20th century. In 1952 Wullstein first used a surgical microscope in an otological operation, laying a foundation for otomicrurosurgery. Subsequently, surgical microscopes were used extensively; allowing the continuing evolution of microsurgical techniques in the middle ear.

When microsurgical techniques reached the inner ear and cerebellopontine angle (CPA) area, allowing access to the skull base and lateral skull base, the era of micro–ontoneurosurgery dawned 41. Because the surgical microscope can provide high magnification and illumination of the operative field, it has played an important role in middle ear surgeries for the past forty years. However, visualization through an operating microscope is limited to objects directly in front of the microscope along the object lens axis. Examination and operation in hidden areas require displacement, and sometimes de-
struction, of normal middle ear structures and later reconstruction. Otoneurosurgeons are challenged with eradicating pathology while preserving preoperative functional status. Minimally invasive techniques have arisen to meet the need to preserve function and promote quick recovery. Since the 1990s, otoneurosurgeons have been making progress in finding otoscopy applications.

Pathologies common to the CPA include acoustic neuroma, facial neural tumors, menigioma and dysfunction cranial nerves. Among these, acoustic neuroma accounts for a great portion. In the past 10 years, with rapid development of otoneurosurgery and imaging technologies, early diagnosis of CPA pathologies has improved, broadening scope of surgical practices for otologists. Surgical approaches to CPA lesions, especially acoustic neuroma, require gaining access to the CPA and maximal exposure of the internal acoustic meatus, all while attempting to maintain facial and auditory nerve function. Microscopy coupled with functional facial nerve monitoring greatly reduces both the mortality and the incidence of facial nerve paralysis in acoustic neuroma surgeries. Preserving auditory function remains a challenge because removal of the tumor often damages the cochlear nerve, and ischemia–induced deafness can happen due to damage to or spasm of the fragile internal auditory artery. Other CPA surgeries share this difficult bargain between tumor excision and preservation of function.

This paper presents the authors’ experiences with 25 cases of microscopic CPA surgeries assisted with otoscopy performed from November 2002 to December 2008, with satisfactory results.

Materials and methods

Patient data

Diagnoses in the 25 cases included acoustic neuroma (n=19), facial tumors (n=3), trigeminal neurinoma (n=1), glossopharyngeal neuralgia (n=1) and hemifacial spasm (n=1). The average age of the 19 patients with acoustic neuroma (9 males and 10 females) was 42.5 years (22–69 years). Tumor sizes were under 2 cm in 10 cases, between 2 to 4 cm in 5 cases and over 4 cm in 4 cases. Two of the patients with facial tumors were males and one was female. They were middle aged (37–56 years) adults, and their tumor sizes were between 1.9 and 2.8 cm. They were misdiagnosed with acoustic neuroma preoperatively. The patient with trigeminal neurinoma was a 56 years old male and his tumor size was 3.6 cm. The patient with glossopharyngeal neuralgia was a 47 years old woman with paroxysmal sharp pain in her left pharyngeal area radiating to the ear for 5 years, accompanied by discomfort in her pharynx and tightness in her neck. Local blocking treatments with lidocaine were ineffective. The patient with hemifacial spasm was a 63 year old female with severe convulsion in her right face for 6 years, which was unresponsive to cretoxin injection.

Description of procedure

The retrosigmoid approach and an endoscope were used in all cases. An L-shaped retroauricular incision was made for craniotomy behind the occipitomastoid suture and under the occipitoparietal suture. After rapid intravenous infusion of 20% mannitol, the dura was open in a “Y”-shape manner. The cerebellum was gently retracted and the CPA exposed. The leptomeninges were cut to release cerebrospinal fluid, reducing intracranial pressure. The CPA cistern was exposed and examined with microscope (Zeiss, Germany) enabled endoscope (angle: 0° and 30°; diameter: 27 mm; length: 104 mm, Rudolf and Karl Storz company, Germany).

In the cases of acoustic neuroma, facial nerve tumors and trigeminal neurinoma, facial electromyography (EMG) and auditory brainstem responses (ABRs) were monitored while the tumor capsule was opened and the tumor debulked (Fig.1 and Fig.2). Facial nerve monitoring helped guide separating the facial nerve and the tumor. Following tumor removal, the 30–degree angular endoscope was used to examine the fundus of the internal acoustic meatus for residual tumor, and to guide resection of residual lesions (Fig.2 and 3). In the case of glossopharyngeal neuralgia, the lower cranial nerves (IX and X) were visualized through an otoscopy following exposure of the CPA and the aditus of the internal acoustic meatus. The glossopharyngeal nerve was found encased by the arachnoid tissue. It
coursed straight through the cerebral dura mater from a single foramen, in front of a thick and loose vagus nerve. The glossopharyngeal nerve was freed from the arachnoid tissue and sectioned with micro-scissors. The vagus fibers adjacent to the glossopharyngeal nerve were also sectioned.

For hemifacial spasm, the 30-degree angular endoscope was used to identify the aditus of the internal acoustic meatus and lower cranial nerves. Examination of the facial nerve revealed its close proximity to the anterior inferior cerebellar artery. With facial nerve monitoring, the artery was separated from the facial nerve, and a small piece of gelatin sponge was placed between the facial nerve and artery.

Following abundant irrigation with normal saline and thorough hemastasis, the dura was closed. Muscle graft was sometimes needed to seal off dura defect. Open air cells near the sigmoid sinus were sealed off with bone wax. Pressure bandaging was applied after incision closure.

**Results**

All surgeries were completed smoothly with no mortality, nor lower cranial nerve injuries. Cerebrospinal fluid leakage occurred in 2 cases and resolved with pressure bandaging.

Total tumor resection was achieved in 18 of the 19 acoustic neuroma cases. In the case with subtotal removal, the tumor measured 4.1×3.5×3.0 cm and caused displacement of brainstem to the contralateral side with tight adherence to both the cerebellum and brain stem. Bleeding in the area of aditus of the internal acoustic meatus limited the use of the otoendoscope. Some tumor capsule was left on the surface of brainstem and the aditus of internal acoustic meatus. The anatomic integrity of the facial nerve was kept intact in all 19 cases. Post-operative House-Brackmann Facial Nerve Recovery Grading at 1 week was I in 3 cases, II in 10 cases and III in 6 cases. At 3 months, all Grade II cases were Grade I. Three of the 6 Grade III cases were Grade I and the rest 3 were Grade II. Hearing was preserved in 17 of the 19 acoustic neuroma patients, with 12 maintaining their preoperative levels of hearing (Fig.4). Balance disturbance and vertigo occurred in 3 patients postoperatively and improved within 10 to 14 days, and the patients became ambulatory. Near complete balance recovery occurred in two to four months.

Surgeries in all three patients with facial tumors resulted in total tumor resection. In 1 patient, anatomic in-
Integrity of the facial nerve was preserved with Grade III postoperative facial nerve function that improved to Grade II three months later. Hearing was also maintained in this patient. In the rest two cases, the facial nerve was sacrificed for tumor resection with primary faciohypoglossal nerve anastomosis. Their facial nerve function was Grade II and III one year after surgery, respectively, with no hearing preservation.

Tumor resection was also total in the trigeminal neurectomy case. Facial nerve function was Grade III immediately after surgery and Grade II at three months, with no hearing preservation.

Endoscopy provided clear visualization of CPA structures in glossopharyngeal neurectomy. Despite the minor brain injury during the operation, total resolution of glossopharyngeal neuralgia was achieved postoperatively. Sciatica occurred on the third day after surgery and resolved one day later following intravenous infusion of 20% mannitol (250 ml) and dexamethasone (10 mg). Patient was symptom-free at five year follow-up.

The 30-degree angular endoscope helped visualizing the responsible blood vessels in the hemifacial spasm case. Facial spasm improved significantly after surgery, with only intermittent residual light convulsion. Postoperative facial nerve function was Grade II, and facial spasm did not relapse at three year follow-up.

Discussion

Medicine in the 21st century will become increasingly intelligent, humane, and minimally invasive. With the development and widespread use of minimally invasive surgeries, the boundary between minimally invasive surgical technology and traditional surgical technology are constantly broken. The unique anatomy of the CPA, with its deep location, narrow space and complex anatomic relationships, makes surgical treatment of lesions in this area a challenge. The otoendoscope-assisted minimally invasive surgical technique appears to be helpful in CPA surgery. The endoscope comes in different diameters, angles and lengths, meeting needs for exposure of various CPA structures, especially those normally hidden from an operating microscope. This allows improved lesion removal while maximizing preservation of normal structures. This is the most important advantage of the technology. Endoscopy also provides a brighter illumination and clearer image than a traditional microscope. This helps reduce the chance of injury to surrounding tissues. An add-on convenience is easy image acquisition, which facilitates data archiving for teaching and research.

Disadvantages of endoscopy include blood soiling the view field of endoscope, making visualization difficult or impossible. In one acoustic neuroma case in our series, bleeding at the aditus of the internal acoustic meatus made it impossible to observe the position and course of the nerves and residual tumor. Bimanual operating is frequently not possible because the endoscope at times must be held in one hand while the other hand is used to

![Fig.4](image-url) The action potential (AP) waves during operation (left) and the pre- and post-operative audiometric thresholds (right) in a patient with an acoustic neuroma.
perform surgery. Though it can be attached to a fixation device, this arrangement lacks flexibility. It also lacks stereovision, and its magnification adjustment is not flexible. CPA endoscopy is not yet mature. Numerous issues are yet to be solved. At present, the otoendoscope cannot replace the operating microscope but should be used as an assistive method. Its combination with an operating microscope to achieve the purpose of minimal invasion has great significance for further development of ear neurosurgery [5].

Retrosigmoid approach in acoustic neuroma surgery has been shown to be relatively straight forward and safe, but it does not provide complete exposure of the internal auditory canal, especially the bottom region [5, 9-11]. In this case series, endoscopes of different angles were used to visualize residual lesions at the bottom of the internal auditory canal. The endoscope was also used to facilitate excising CPA tumors in 19 patients. Facial nerve function preserved in all these patients. More importantly, hearing was preserved in 12 of these patients [3]. However, visualization of the tumor and nerves was made difficult by the large size of acoustic neuroma in one case (> 4 cm) and bleeding in the aditus of the internal acoustic meatus area. The authors’ experiences can be summarized as follows: 1) debulking of the tumor helps provide space for endoscopic operating; 2) appropriate hemostasis helps avoid the need to repeatedly clean the endoscope during the procedure; 3) when bleeding in the aditus of the internal acoustic meatus area makes using endoscope impossible attention should be focused on protecting the facial nerve and facial nerve monitoring should be employed; 4) the endoscope is an adjunct to the operating microscope, which should be used when bimanual operating is needed; and 5) hearing preservation is practically possible only when the tumors is less than 2.5 cm in diameter and difficult when it is larger than 4 cm.

Otoendoscopy provides clear visualization of CPA anatomy including important nerves and blood vessels [12], and proves to be useful in procedures such as trigeminal rhizotomy, vestibular neurectomy and vascular decompression [2, 11-12]. The glossoharyngeal neurectomy and vascular decompression procedures aided by endoscopy in this series resulted in satisfactory resolution of glossoharyngeal neuralgia and hemifacial spasm symptoms, with no complications. In treating glossoharyngeal neuralgia, our experiences indicate that simultaneous sectioning of superior vagus rootlets is important for complete resolution of neuralgia symptoms. This may have to do with the involvement of the vagus nerve innervating the affected areas. The authors feel that endoscopy is especially indicated in glossoharyngeal neurectomy and vascular decompression to achieve minimal invasiveness. Hemifacial spasm is caused by vascular cross-compression in the CPA, which needs decompression. Frequent cerebellum retraction is needed to expose CPA structures in traditional techniques, which easily causes distortion of anatomy of important structures in the CPA, confusing the original location of blood vessels and nerves. Otoendoscope-assisted techniques provide more accurate assessment of cross-compression by blood vessels and therefore more accurately specified decompression targets. Further investigation is warranted.

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References


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