Application of a modified infratemporal fossa type B approach to the resection of lateral skull base tumors

Yu-Bin Xue, Pu Wang, Yin Xia, Qiang Liu, Wen-Yang Zhang

Department of Otolaryngology Head and Neck Surgery, Beijing Tiantan Hospital, Capital Medical University, Beijing 100070, China.

The infratemporal fossa approach was designed for the removal of large tumors located at the temporal bone and lateral skull base. This approach has several subtypes, including types A, B, C, and D. The infratemporal fossa type B (ITFB) approach exposes the petrous apex, clivus, and horizontal segment of the internal carotid artery (ICA) and is used to remove tumors in this area. The classical ITFB approach to fully exposing the horizontal segment of the ICA includes subtotal resection of the petrous bone, removal of the anterior wall of the external auditory canal and zygomatic arch, resection of the articular disc and condylar process of the mandible, downward traction of the mandible, and transection of the mandibular branch of the trigeminal nerve and middle meningeal artery.

Clinical practice has shown that some patients have lesions mainly located in the zygomatic arch and middle ear cavity. These lesions may extend downward into the temporomandibular joint or upward into the middle skull base, or temporal lobes, but not invading the horizontal segment of the ICA. This approach has several subtypes, including types A, B, C, and D. The infratemporal fossa type B (ITFB) approach exposes the petrous apex, clivus, and horizontal segment of the internal carotid artery (ICA) and is used to remove tumors in this area. The classical ITFB approach to fully exposing the horizontal segment of the ICA includes subtotal resection of the petrous bone, removal of the anterior wall of the external auditory canal and zygomatic arch, resection of the articular disc and condylar process of the mandible, downward traction of the mandible, and transection of the mandibular branch of the trigeminal nerve and middle meningeal artery.

All operations were performed under general anesthesia; the surgical procedure is shown in Figure 1 and Supplementary Video http://links.lww.com/CM9/A316. The modified ITFB approach was utilized in six patients for tumor removal during the study period. The six patients included four males and two females, of mean age 37.5 years (range, 3.0–65.0 years). Before surgery, all six patients showed hearing loss, including one with mild (PTA 35 dB HL) and three with moderate conduction hearing loss (PTA 50, 50, 55 dB HL, respectively) and two with extremely severe sensorineural hearing loss (both PTA >80 dB HL). In addition, three patients had tinnitus, one had purulent ear discharge, one had facial paralysis (HB grade II), and one had headache.

Before surgery, all patients underwent routine examination of the ear, head and neck, including the external auditory canal, tympanic membrane, and movements of the facial expression muscles. Facial nerve (FN) function was assessed using the House-Brackmann (HB) scale. Auditory function was evaluated by pure ton audiometry (PTA) at thresholds of 500, 1000, 2000, and 4000 Hz. The level of hearing was classified based on pure tone average (the average air conduction hearing thresholds across the four frequencies) according to the standards recommended by the World Health Organization in 1997. Normal hearing was defined as 0 to 25 dB hearing level (HL), mild hearing loss as 26 to 40 dB HL, moderate hearing loss as 41 to 60 dB HL, severe hearing loss as 61 to 80 dB HL and extremely severe hearing loss as >80 dB HL. Each patient underwent computed tomography and enhanced magnetic resonance imaging (MRI) of the temporal bone.

This study was approved by the Review Committee of Beijing Tiantan Hospital and conforms to the principles of the Declaration of Helsinki. The modified ITFB approach was utilized by surgeons in the Department of Otolaryngology Head and Neck Surgery of Beijing Tiantan Hospital to remove lateral skull base tumors from six patients between August 2014 and August 2017. Patients were included if they had lesions located in the middle ear cavity, zygomatic arch, temporomandibular joint, middle skull base, or temporal lobes, but not invading the horizontal segment of the ICA.

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All six patients underwent microscope-guided radical resection of the tumor, with enhanced MRI 1 week after surgery confirming the absence of residual tumor in all six patients. Pathologic examination showed that two patients had giant cell reparative granulomas and that the other four patients had giant cell tumor of the bone, epidermoid cyst, squamous cell carcinoma, and mature teratoma, respectively. None of the patients experienced vascular injuries, including those of the ICA, jugular bulb, and sigmoid sinus, with mean blood loss being <100 mL.

After the surgery, four patients with mild or moderate conductive hearing loss before operation experienced severe conductive hearing loss (PTA increased to 60 dB HL for the patient with mild conduction hearing loss and by 10 to 15 dB HL for the three patients with moderate conductive hearing loss before the surgery) and two still had severe sensorineural hearing loss (both PTA >80 dB HL, identical to those before the surgery). One patient, with normal FN function before surgery, developed facial paralysis due to tumor invasion and resection of the FN during the operation, resulting in a postoperative FN function of HB grade VI. The patient having preoperative FN function of HB grade II showed worsening of FN function one week after surgery to HB grade III, but recovered to HB grade II after one year. The FN function of the other four patients was normal after surgery. Because the lesions in three patients had invaded the dura mater of the middle cranial fossa, and even involved the temporal lobe, the invaded dura and intracranial tumors were removed, and artificial dura was used to repair the defective dura. Head computed tomography 6 h after surgery showed that none of the patients experienced intracranial hemorrhage, with follow-up for 2 to 6 years showing no leakage of cerebrospinal fluid. All patients were evaluated by enhanced MRI once yearly after surgery. None of the patients experienced tumor recurrence or serious postoperative complications, such as cerebrospinal fluid otorrhea, intracranial hemorrhage, intracranial infection, hemiplegia, and death.

Although the ITFB approach was originally designed for the removal of epidural lesions, it has also been used to remove intracranial lesions. In this study, the lesions in three patients invaded the dura or even the temporal lobe and were successfully removed using the modified ITFB approach. This approach was especially suitable for removal of tumors located in the middle skull base and temporal lobe and invading the middle ear and temporomandibular joint. In addition, the routine closure of the external auditory canal and eustachian tubes, and packing the operative cavity with fat could reduce the likelihood of cerebrospinal fluid leakage or intracranial infection.

Similar to classic ITFB, modified ITFB allows direct microscopic exposure of the lesions, as well as maximally protecting the dura mater, ICA, FN, and other important structures during removal of the lesions. Compared with the classic ITFB approach, the modified ITFB approach results in better retention of the mandibular nerve and middle meningeal artery, without exposing the horizontal segment of the ICA. The modified ITFB approach also avoids facial numbness in the innervated area of the mandibular nerve and delayed bleeding resulting from the resection of the middle meningeal artery, as well as maximally protecting the ICA from injury. This approach also reduces the occurrence of cerebrospinal fluid leakage and intracranial infection.
The major disadvantages of the modified ITFB approach include the need to sacrifice hearing function and the temporomandibular joint, similar to those encountered using the classic ITFB approach.

In summary, the modified ITFB approach has great advantages in the resection of lateral skull base lesions involving the petrous apex, zygomatic arch, temporomandibular joint, and even the temporal lobe. This approach can also reduce complications associated with the classic ITFB approach, such as damage to the horizontal segment of the ICA, mandibular nerve, and middle meningeal artery.

Conflicts of interest
None.

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