Zygomatic Anterior Subtemporal Approach for Lesions in the Interpeduncular Cistern

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ABSTRACT

The interpeduncular cistern is a difficult region to approach through conventional methods due to its deep location and important adjacent neurovascular structures. Therefore, it is usually difficult to expose the region sufficiently. Technical problems associated with various surgical approaches have led to emergence of combined approaches and their modifications (i.e., the removal of the zygomatic arch). In addition, a frontotemporal craniotomy is reported to provide a wide exposure of the anterior temporal base, thus allowing oblique access to the interpeduncular cistern with minimal brain retraction. This study describes clinicians' experience and the surgical results of 24 patients who underwent a zygomatic anterior subtemporal approach.

KEYWORDS: Basilar aneurysm, chordoma, craniopharyngiomas, interpeduncular cistern, skull base, zygomatic approach

Basilar aneurysms, craniopharyngiomas, epidermoids, and chordomas are some of the lesions in the interpeduncular cistern.¹⁻⁶ Pterional and frontotemporal approaches provide insufficient exposure of lesions in the interpeduncular cistern, which remains one of the most difficult regions to access even though advances in neuroanesthesia, microtechniques, cerebrospinal fluid drainage, steroid treatment, intraoperative dehydrating agents, and hypotension have minimized

the need for brain retraction.^{5,7-13} Without excessive retraction of the temporal lobe, it is still impossible to gain a wide exposure of this region and serious complications such as infarction of the temporal lobe can occur. Because of the danger posed by retraction-related cerebral injury, the involvement of the basal blood vessels and cranial nerves with the tumor, and the proximity of the hypothalamus and third ventricle, extensive lesions of this region are difficult to handle through any radi-

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cal resection. Safety is achieved only when the carotid and basilar arteries and their branches are managed. Most lesions in the interpeduncular cistern are located under the chiasm and extend to the third ventricle, occasionally as far as the lateral ventricles. Thus, it is vital for the surgeon to visualize all important structures and dissecting areas.

During the past decade several advances have permitted total or near-total resection of many such neoplasms with low rates of morbidity.^{2,4,14-18} Along with others, the zygomatic anterior subtemporal approach is one operative approach introduced as a result of a profound understanding of cranial base anatomy. This approach provides a wide exposure of the anterior temporal base with minimal brain retraction as well as a supra- and infratentorial route through an anterolateral corridor directly along the floor of the middle fossa. Therefore, an excellent exposure of lesions of the interpeduncular cistern can be obtained with the zygomatic approach. This study reports the surgical outcomes associated with the zygomatic anterior subtemporal approach to the interpeduncular cistern (Table 1).

MATERIAL AND METHODS

Between 1995 and 1999, 14 males and 10 females (9 to 64 years) underwent the frontotemporal zygomatic approach. There were 10 craniopharyngiomas (Fig. 1), four epidermoids, two trigeminal neurinomas, three chordomas, two giant pituitary adenomas, two basilar aneurysms, and one clival meningioma. The mean follow-up period was 24 months for all patients.

Operative Technique

With the patient's head in three-point pin fixation, the head is rotated 60 degrees to the contralateral side and the neck is hyperextended 30 degrees. This position allows the surgeon to control the infra- and suprachiasmatic cisterns obliquely from below. A bicoronal skin incision is used with the inferior extension over the root of the zygoma. The scalp is reflected anteriorly, and the temporal muscle is reflected inferiorly to expose the anterior temporal base maximally. The fascia covering the

Table 1 Clinical Summary of 24 Patients Undergoing the Zygomatic Anterior Subtemporal Approach

	Number	Excision	Postop. Complications	Last Neurological Status	Recurrence	Follow-up
Craniopharyngioma	10	8 total 2 subtotal	—	Neurologically intact	—	24 months
Epidermoid	4	4 total	Temporary third nerve palsy in one case	Neurologically intact	—	18 months
Chordoma	3	3 gross total	Moderate hemiparesis in one case	Mild hemiparesis	—	18 months
Trig. neurinoma	2	2 total	—	Neurologically intact	—	12 months
Giant pituitary adenoma	2	1 total 1 gross total	Mild hemiparesis in one case	Neurologically intact	—	24 months
Basilar aneurysm	2	successfully clipped	—	Neurologically intact	—	48 months
Meningioma	1	gross total	—	Neurologically intact	—	12 months

Figure 1 Preoperative (A) axial, (B) coronal, and (C) sagittal MRI of the tumor invading the interpeduncular cistern.

outer surface of the zygomatic arch is incised. A frontotemporal craniotomy is usually performed. The temporal squama is removed inferiorly to obtain a flat viewing angle along the floor of the middle fossa.

To expose pathological processes that extend considerably above the dorsum sellae, a more basal-to-vertex trajectory may be needed. In the case of a high-riding basilar bifurcation aneurysm, removing the zygoma can significantly increase the exposure.

Removal of the zygoma begins with an incision parallel to the long axis of the zygoma at its

junction with the temporal bone. The second cut, perpendicular to the first, is made along the orbitozygomatic process near the lateral orbital rim. This maneuver increases inferior retraction of the temporal muscle, enabling the operating microscope to be positioned to gain a more lateral-to-medial and inferior-to-superior trajectory. The dura is opened and retracted.

Opening the anterior of the sylvian fissure widens the exposure of the superior clival area; the internal carotid artery and proximal A1 and M1 segments are well exposed at this point. The tem-

poral lobe is retracted posterolaterally and the frontal lobe posteromedially in a similar fashion. The oculomotor nerve, from its origin at the midbrain to its dural entrance into the oculomotor trigone, is exposed. In conventional approaches, the posterior clinoid process is often removed to visualize the tip of the basilar artery. In the zygomatic approach, however, it is most easy to gain access to and manage the tip of the basilar artery without removing the clinoid process. To gain better management of the structures of the posterior fossa, the tentorium can be incised under the fourth cranial nerve while the superior petrosal sinus is protected. Thus, an exposure extending to the upper half of the basilar artery and fifth cranial nerve on both the ipsilateral and contralateral sides is provided. At the end of the procedure the dura is closed in a watertight fashion, utilizing a fascial patch graft if necessary. During the opening the precranial flap is preserved for this purpose. The zygoma is secured using a titanium miniplate system, which gives superior cosmetic results. The temporal muscle should be sutured securely to the bone along the temporal line to prevent postoperative inferior retraction of the muscle bulk.

RESULTS

Of the 10 craniopharyngiomas, eight were totally (Fig. 2) and two were partially resected. The former had no neurological deficits and no recurrences. Three patients in this group are receiving hormonal treatment. The latter received no radiation or other treatment because no tumor growth has been detected. These two patients had no postoperative complications or hormonal deficiencies.

Four patients with epidermoid tumors underwent a total excision. Two patients developed paralysis of the third nerve, but both recovered 3 months after the operation. There have been no recurrences.

The two trigeminal neurinomas were also totally resected. Both patients are neurologically intact and follow-up MRI revealed no tumors. Neither patient is experiencing any problems.

All three chordomas were totally excised. One patient suffered hemiparalysis in the early postoperative period but gradually recovered. Patients were advised against additional treatment during the follow-up examination.

One patient with a giant pituitary tumor underwent gross total excision (the capsule remained) while the other underwent total excision. Both had preoperative pituitary deficiencies and now receive hormonal replacement treatment. There is no recurrence in the patient who received a total excision. In the early postoperative period the latter patient experienced a slight hemiparalysis that recovered within 6 months. No growth has been detected in the former, but this patient is being followed.

The patient with the clival meningioma underwent a gross total excision. He remains intact at this writing and is being followed. One patient with a basilar aneurysm experienced a slight third nerve paralysis soon after surgery but had recovered by the follow-up examination 3 months after the operation. The other patient is also neurologically intact.

DISCUSSION

Surgical treatment of lesions involving the interpeduncular cistern is challenging because the lesions are deep-seated and the operative field is restricted by nerves and vascular structures.^{1,2,4,19-25} The excision of the tumors from interpeduncular cistern also poses many technical problems and risks. The surgical procedure requires deep neuroanatomical knowledge and three-dimensional orientation.^{1,14,18,19,23,24} While accessing the interpeduncular cistern, brain retraction must be minimized and the distance from

Figure 2 Postoperative axial, coronal, and sagittal MRIs after resection.

the surface to the lesion must be as short as possible. Multiple routes of dissection must be possible and adverse functional and cosmetic outcomes must be avoided.

Several approaches, including the pterional, supraorbital, subtemporal, temporopolar, zygomatic, and orbitozygomatic infratemporal approaches, have been used to achieve these goals.^{1-9,13,16,18,20} Subtemporal and supraorbital approaches usually require deep retraction of the temporal and frontal lobes; the pterional approach requires even more re-

traction and exposure is limited. The exposure gained with the temporopolar approach is insufficient, while that of the orbitozygomatic infratemporal approach is too extensive because of the unnecessary removal of the infratemporal and orbital bones.

The zygomatic anterior subtemporal approach enables the surgeon to view the interpeduncular fossa, both cerebral peduncles, and posterior floor of the third ventricle with an exposure wide enough to permit safe manipulation. Removing the

zygomatic bone to gain access to cranial base lesions has been described in detail by Fujitsu and Kuwabara.¹ Detaching the zygomatic arch extensively exposes the anterior temporal base and permits obliquely upward access to the interpeduncular fossa along the lowest possible supratentorial route. It also minimizes retraction of the temporal lobe. Although it is possible to gain access to the interpeduncular cistern through the surgical approaches mentioned above, the zygomatic anterior subtemporal approach enables the manipulation of neural and vascular structures to be much easier and safer, even with large tumors. Its greatest advantage is the ability to manipulate below and above the chiasm simultaneously.

Not only does the zygomatic anterior subtemporal approach facilitate complete excision of tumors with an acceptable risk, but it also increases the chance of dissection in any direction, even when tumors have invaded most of the interpeduncular cistern. In approaches that lack these features, the only method of removing the tumor is to pull it through areas where dissection is impossible. However, when important neurovascular structures are present, such maneuvers inevitably risk significant mortality and morbidity rates.

The zygomatic osteotomy improves exposure of the medial aspect of the cranial fossa, the tentorial notch, cavernous sinus, and upper clival area. While the clinoid process often must be removed with a high-speed drill when a basilar aneurysm is clipped through conventional approaches, the zygomatic approach provides easy access to the tip of the basilar artery as well as the ability to manage the lesion without removing the clinoid process. When the tip of the basilar artery is not easily exposed, it may be necessary to remove the clinoid process with a high-speed drill. When large tumors infiltrate neurovascular structures, they risk serious injury during dissection. If bleeding occurs, immediate intervention is necessary.

The zygomatic approach has been technically modified to improve access. One-piece oste-

otomy or monobloc resection offers an advantage.^{5,22} However, we usually perform a frontotemporal craniotomy and then remove the zygoma as a separate piece. A two-piece osteotomy does not increase the opening and closure time. We think that it provides a more controlled craniotomy, and the bones easily can be reattached with microplates and screws.

Extensive mobilization or transposition of the temporal muscle carries a significant risk of postoperative trismus and threatens the frontal branch of the facial nerve. The frontotemporal branches, running within the subcutaneous tissue over the zygomatic arch and continuing between the superficial and deep layers of the temporal fascia, can be injured during each zygomatic craniotomy.^{1,2,4,5,9,22} We preserved the frontotemporal branches of the facial nerve by interfascial separation of the temporal scalp flap. Subperiosteal dissection of the zygomatic arch is confined to where the bone was cut. The two-piece osteotomy avoids excessive dissection of the temporal muscle. Thus, none of our patients developed trismus after surgery. In our experience many lesions involving interpeduncular cistern are accessible and resectable with this approach. With proper application of the approach, lesions are handled with more ease.

Patients with a large tumor invading the interpeduncular cistern or with a high-riding basilar aneurysm should be offered surgical treatment. Most neurosurgeons do not prefer alternative treatments like radiation therapy and/or chemotherapy for tumors and embolization for aneurysms. Thus, the main issues are what the associated surgical morbidity and mortality rates are and whether a total cure is possible.

In our series, two basilar aneurysms were clipped successfully. Both patients are neurologically intact and able to carry out daily tasks. Of the 22 tumors, 15 were excised completely and there were no neurological deficits. Two patients receive hormonal treatment. The last examination of the 5 patients who underwent a gross total excision re-

vealed no recurrence of the tumor. These patients also can perform their routine tasks and have no neurological deficits. No tumor growth has been detected in the two craniopharyngioma patients with subtotal excisions. Both receive hormonal treatment. Surgical outcome of these 24 patients supports that most patients have a chance to be cured and the morbidity rate is acceptable. Surgery can be performed safely, and outcomes are better than they would have been if the disease had progressed naturally or if other treatment modalities such as irradiation or chemotherapy had been used.

This approach, however, also has disadvantages with serious potential consequences. Negative outcomes are possible if venous structures are damaged although we experienced no such problems. Venous structures must be well evaluated on preoperative angiographic studies, and these structures must be well protected during surgery.

CONCLUSION

The fundamental advantage of the zygomatic anterior subtemporal approach is that it provides excellent exposure of the interpeduncular cistern. It not only facilitates the surgical procedure but also shortens the distance from the surface of the brain to the lesion. Consequently, it provides multidirectional access to lesions without a prominent increase in the length of surgery. Additionally, it provides good cosmesis while offering patients a treatment associated with an acceptable amount of risk.

REFERENCES

1. Fujitsu K, Kuwabara T. Zygomatic approach for lesions in the interpeduncular cistern. *J Neurosurg* 1985;62:340-343
2. Davies HT, Neil-Dwyer G, Lees PD. The zygomaticotemporal approach to the skull base: a critical review of 11 patients. *Br J Neurosurg* 1992;6(4):305-312
3. Ikeda K, Yamashita J, Hashimoto M, Futami K. Orbitozygomatic temporopolar approach for a high basilar tip aneurysm associated with a short intracranial internal carotid artery: a new surgical approach. *Neurosurgery* 1991;28(1):105-110
4. Taniguchi M, Perneczky A. Subtemporal keyhole approach to the suprasellar and petroclival region: microanatomic considerations and clinical application. *Neurosurgery* 1997;41(3):592-601
5. Lesoin F, Pellerin P, Villette L, Dhellemmes P, Jomin M. Monobloc mobilization of the fronto-temporo-pterygion bone flap. *Acta Neurochir (Wien)* 1986;82:68-70
6. Pellerin P, Lesoin F, Dhellemmes P, Donazzan M, Jomin M. Usefulness of the orbitofrontomalar approach associated with bone reconstruction for frontotemporosphenoid meningiomas. *Neurosurgery* 1984;15(5):715-718
7. Lesoin F, Thomas CE III, Pellerin P, Villette L, Autricque A, Jomin M. An orbital-zygomatic-malar bone flap approach: a technical note. *Acta Neurochir (Wien)* 1986;83:154-156
8. Fujitsu K, Kuwabara T. Orbitocranibasal approach for anterior communicating artery aneurysms. *Neurosurgery* 1986;18(3):367-369
9. Hakuba A, Liu S, Nishimura S. The orbitozygomatic infratemporal approach: a new surgical technique. *Surg Neurol* 1986;26:271-276
10. Leonetti JP, Al-Mefty O, Eisenbeis JF, Carr WC. Orbitocranial exposure in the management of infratemporal fossa tumors. *Otolaryngol Head Neck Surg* 1993;109(4):769-772
11. Lee JP, Tsai MS, Chen YR. Orbitozygomatic infratemporal approach to lateral skull base tumors. *Acta Neurochir Scand* 1993;87:403-409
12. Hakuba A, Tanaka K, Suzuki T, Nishimura S. A combined orbitozygomatic infratemporal epidural and subdural approach for lesions involving the entire cavernous sinus. *J Neurosurg* 1989;71:699-704
13. Seifert V, Dietz H. Combined orbito-frontal, sub- and infratemporal fossa approach to skull base neoplasms. *Acta Neurochir (Wien)* 1992;114:139-144
14. Honeybul S, Neil-Dwyer G, Lees PD, Evans BT, Lang A. The orbitozygomatic infratemporal fossa approach: a quantitative anatomical study. *Acta Neurochir (Wien)* 1996;138:255-264
15. Huther G, Dörfl J, Van der Loos H, Jeanmonod D. Microanatomic and vascular aspect of the temporomesial region. *Neurosurgery* 1998;43(5):1118-1136
16. Alaywan M, Sindou M. Fronto-temporal approach with orbito-zygomatic removal. *Acta Neurochir (Wien)* 1990;104:79-83
17. Day JD, Giannotta SL, Fukushima T. Extradural temporopolar approach to lesion of the upper basilar artery and infrachiasmatic region. *J Neurosurg* 1994;81:230-235
18. Uttley D, Archer DJ, Marsh HT, Bell BA. Improved access to lesion of the central skull base by mobilization of the zy-

- goma: experience with 54 cases. *Neurosurgery* 1991; 28(1): 99-104
19. Honeybul S, Neil-Dwyer G, Lees PD, Evans BT, Lang A. The transzygomatic approach: an anatomical study. *Br J Oral Maxillofac Surg* 1997;35:334-340
20. Al-Mefty O. Supraorbital-pterional approach to skull base lesions. *Neurosurgery* 1987;21(4):474-477
21. Pitelli SD, Almeida GGM, Nakagawa EJ, Marchese AJT, Cabral ND. Basilar aneurysm surgery: the subtemporal approach with section of the zygomatic arc. *Neurosurgery* 1986;18(2):125-128
22. Shigeno T, Tanaka J, Atsuchi M. Orbitozygomatic approach by transposition of temporalis muscle and one-piece osteotomy. *Surg Neurol* 1999;52:81-83
23. Matsuno H, Rhoton AL, Peace D. Microsurgical anatomy of the posterior fossa cisterns. *Neurosurgery* 1988;23(1): 58-80
24. Pedroza A, Dujovny M, Ausman JI, et al. Microvascular anatomy of the interpeduncular fossa. *J Neurosurg* 1986; 64:484-493
25. Neil-Dwyer G, Sharr M, Haskell R, Currie D, Hosseini M. Zygomaticotemporal approach to the basis cranii and basilar artery. *Neurosurgery* 1988;23(1):20-22