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BRIEF COMMUNICATION

Middle Fossa Approach: Applications in Temporal Bone Lesions☆

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Cholesterol granuloma

Abstract The middle fossa approach is a surgical technique that is very useful for lateral skull base surgery. However, it is true that it has limited surgical indications and implementation due to its technical complexity.

We present our experience in 10 patients in whom the middle fossa approach was the treatment of choice because of the extent of the injury and complexity of the lesion or process.

Despite the complexity of the cases, there was no mortality associated with surgery. Postoperative complications were found in 2 patients who presented an epidural haematoma and a cortico-subcortical haematoma. Hearing function was preserved in 5 patients out of the 7 who had adequate hearing at the time of surgery. House/Brackmann I-II facial nerve function was achieved in 8 patients; the remaining 2 had no deterioration of the nerve function. In 9 out of 10 patients, the surgery achieved complete solution of the lesion.

The middle fossa approach is a safe and reliable surgical technique. It gives us great control and exposure of different skull base processes. We consider its knowledge of great importance, because it may be the only viable surgical alternative in some specific patients. That is the reason why it is important to learn this approach and know about it in our specialty.

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PALABRAS CLAVE
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Granuloma de colesterol

Abordaje por fosa media, aplicaciones en lesiones del hueso temporal

Resumen El abordaje por fosa media es una técnica quirúrgica de gran utilidad en la cirugía de base de cráneo lateral. Si bien es cierto, que por sus restringidas indicaciones así como por su complejidad técnica ha tenido una implantación limitada.

Presentamos nuestra experiencia en 10 pacientes en los cuales por gran complejidad del proceso, la situación o la extensión de la lesión, el abordaje por fosa media fue el tratamiento de elección.

A pesar de la gran complejidad de los casos no hubo ningún caso de mortalidad asociada a la cirugía. De la morbilidad registrada destacar un hematoma epidural y un hematoma córtico-subcortical. La función auditiva se preservó en 5 pacientes de los 7 pacientes que presentan audición en el momento de la cirugía. En 8 pacientes se logró una función facial House/Brackmann I-II y en los 2 restantes no hubo empeoramiento de la misma función. En 9 de los 10 pacientes se realizó una cirugía resolutiva de la patología.

El abordaje por fosa media es una técnica quirúrgica segura y fiable. Nos proporciona un gran control y exposición de los diferentes procesos patológicos de la base de cráneo. Consideramos de gran importancia su conocimiento, pues en determinados pacientes puede ser la única alternativa viable y resolutiva, de ahí la importancia de difundir este abordaje en nuestra especialidad.

Introduction

Since William House described the middle fossa approach in 1961[1] several diverse modifications have been presented to expand on it. In 1986 House and Hitselberger reported the middle fossa approach as a means of access to the skull base medial and superior to the internal auditory canal in cases of CPA tumours and the extended middle fossa approach for tumours involving the petrous apex and clivus.[2] However, the absence of stable references in the surface area of the temporal bone, determine that this be one of the most difficult neuro-otological approaches to dominate.[3]

This approach and its modifications may be classified in accordance with its extension into several anatomical regions. The standard middle fossa approach leads to control of the IAC, with the possibility of hearing preservation. The extended middle fossa or Kawase approach enables access to the anterior cerebellopontine angle, petrous apex, and upper clivus.[4,5] This approach therefore becomes an extremely useful tool in certain lesions of the temporal bone.[5]

Material and Methods

We carried out a retrospective review of middle fossa approaches over 5 years between 2008 and 2012, for the treatment of different temporal bone tumours, with both a single approach or part of combined transpetrous approaches. Vestibular schwannoma surgery used for hearing application was excluded from this review.

We analysed patient variables such as age and gender, type of temporal bone pathology, history of previous surgery, size and location of the tumour, and clinical presentation symptoms. With regard to surgery, we analysed the type of surgical approach, the presence of intraoperative complications, early and late postoperative complications, and functional auditory and facial outcome in addition to the resolution of the pathology and follow-up time.

All the patients were operated on by the author, under general anaesthesia and with intraoperative administration of antibiotics and diuretics. Intraoperative facial nerve monitoring in all surgery was conducted using NIM II (Medtronic®). The patient was in a supine position with lateralisation of the head at 70°–80° and fixture using Mayfield cranial stabilisation. Preauricular cutaneous incision was made in the sign of an inverted question mark (extended preauricular temporal region to approximately 7 cm). Dissection of the musculocutaneous flap took place and it was pushed back towards the fronto-orbitary region. Drilled 5-5 craniotomy was performed. Dissection and stripping of the dura mater of the temporal bone to obtain the selected surgical site tool place. Retraction of the temporal lobe was maintained using the Leyla retractor and malleable metallic spatulas. An extended approach was made when needed, with the Kawasse triangle (Figs. 1–3). Repair of the bony defect of the temporal bone, if required, carried out with a temporal muscle pediculated flap or positioning of the intracranial titanium mesh covered with an autologous fat graft (Fig. 3). Repair of the cerebrospinal fluid fistula was carried out by sealing with fat without the need for lumbar draining.

Hearing function was assessed using the American Academy of Otorhinolaryngology-Head and Neck Surgery[6] guide and the facial function was assessed with the House Brackmann scale comparing the preoperative and postoperative function at 3 months.

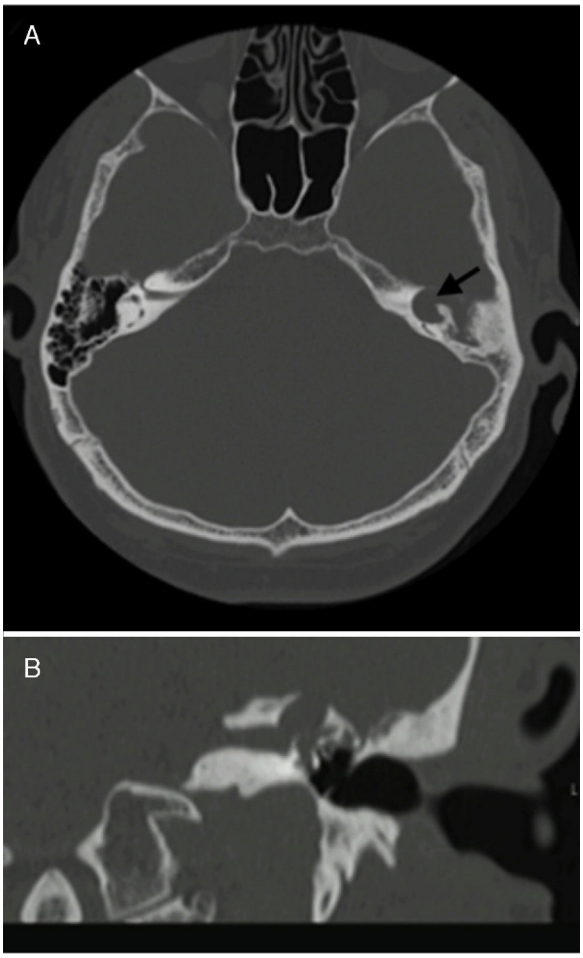

Figure 1 CT of the petrous, congenital cholesteatoma in the geniculate ganglion area. (A) Axial section, involvement of left (arrow) geniculate ganglion. (B) Coronal reconstruction with involvement of the IAC and facial labyrinthine segment.

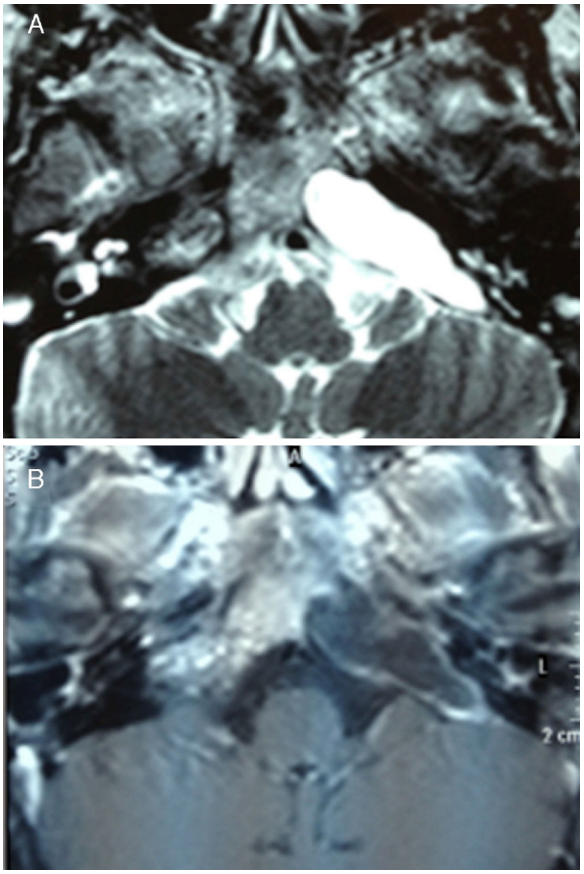

Figure 2 MRI of the brain, epidermoid tumour of the petrous apex with involvement of the clivus. (A) Axial section of T2 hyperintense tumour. (B) Axial section in T1. Hyperintense tumour with inner mottled areas suggestive of epidermoid tumour.

Results

10 surgical interventions were made with the middle fossa approach. Three of these approaches were combined, two involving subtotal petrosectomy and the other an infratemporal and cervical approach. In two cases an extended middle fossa approach was required. The mean age was 46 (ranged from 27 to 63), with 8 males and 2 females. The most frequent lesion was cholesteatoma (4/10), with the left temporal bone (7/10) as the most affected side (Fig. 1). The majority of cases (7/10) were due to recurrent or persistence of postsurgical temporal lesion, with 4 of them presenting with two or more previous surgical interventions. The primary most frequent symptom was headache (4/10) followed by otorrhoea (3/10) (Table 1).

With regard to surgical technique analysis, the absence of associated mortality was of note. The middle fossa or in combination led to a resolution of the lesion in 9/10 patients, with one patient requiring a further intervention after two months. Average clinical follow-up of this series was 44 months (ranging from 22 to 66 months).

The repair of the bony defect at the base of the skull was carried out using a titanium mesh in three patients, the temporal muscle flap was used in two cases, one of which became necrotic, in the context of a chronic mastoiditis.

In 3 cases there were intraoperative complications of CSF fistulas, which together with the before-mentioned case of cerebrospinal fluid otorrhea caused by meningoencephalocele, were resolved by sealing with autologous fat graft and did not require lumbar draining.

Three serious intra-surgical cases of bleeding were also reported, two due to upper petrous sinus lesion which was resolved with bipolar Floseal® coagulation and one as a result of the angiomatous lesion which was resolved using conservative treatment.

Regarding postsurgical complications, one case of early postsurgical epidural haematoma presented after 48 h which required emergency draining, with no other incidents. Another patient developed an episode of nominal aphasia associated with cortico-subcortical haematoma in the parieto-occipital region which was resolved with medical treatment.

With regard to hearing function, of the 10 patients operated on, 3 had presented with deafness at diagnosis. After surgery, the same hearing function was preserved in 5 patients and was poorer in two. Out of the patients where hearing was preserved, this is functional for 4 of them.

Table 1 Clinical Characteristics.

Case	Age	Gender	Side	Clinical symptoms	Previous surgery	Type of tumour	MRI (mm)
1	35	M	L	Trigeminal V1 nerve headache, pain	No	Granuloma cholesterol apex	21×32×35
2	51	F	R	PFP HBVI, trigeminal V1 pain	Approach RS	Haemangiomas of the geniculate ganglion	15×13×11
3	49	M	R	Headache	1 TPM	Mastoid cholesterol or intracranial granuloma	38×42
4	61	F	L	Autophony, optic plenitude	No	Epidermoid tumour of clivus peñasco-mastoides-cervical	30×95×40
5	36	M	L	Headache Otorrhoea	1 TP	Epidermoid tumour of the temporal bone. cholesteatoma	40×22×25
6	63	M	L	Headache Otorrhoea	2 TPM	Meningoencephalocele+cholesteatoma	Not referred to
7	60	M	L	Meningitis CBF otorrhoaea	1 TP, 2TPM	Meningoencephalocele+CSF fistula	23×15
8	27	M	R	Otorrhoea	1TP, 1TPM	Cholesteatoma with intracranial involvement	32×20
9	33	M	L	PFP HBV, abscess RA	2 TPM	Cholesteatoma with intracranial involvement	Not referred to
10	50	M	L	PFP HB IV, cofosis	NO	Congenital cholesteatoma with CAI extension	9×10×8

Y: years; R: right; F: female; HB: House/Brackmann; L: left; M: male; m: months; PFP: peripheral facial paralysis; RA: retroauricular; MRI (mm): size in millimeters in anteroposterior×craniocaudal×transversal axes; RS: retrosigmoid; TP: tympanoplasty; TPM: tympanoplasty+mastoidectomy.

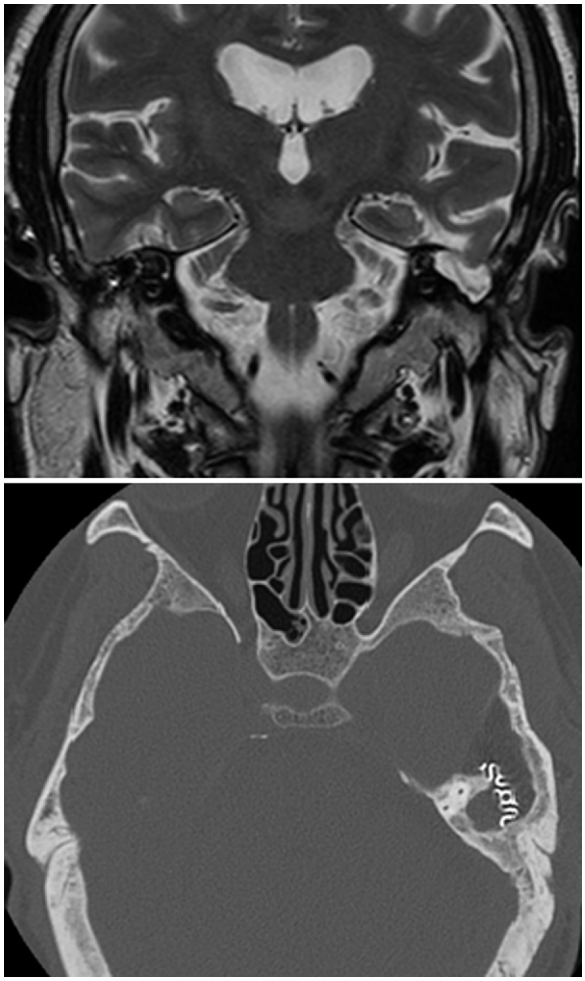

Figure 3 MRI of the brain, coronal section in T2 showing a meningoencephalocele. Postsurgical brain CT scan in axial section where resolution of the pathology may be appreciated and part of the titanium mesh.

There were no facial lesions in the 10 cases. In patients with correct preoperative facial functioning the functioning was preserved in all of them, obtaining a House Brackmann post surgical grade I function. The remaining 3 patients had already presented with facial involvement previously and there was no deterioration in this function as a result of surgery.

Late complications were that 2 patients presented temporarily with slight instability when walking. The patient who presented with a giant cholesteatoma with recurrent intracranial extension, developed a chronic mastoiditis caused by *Citrobacter kosieri* and required a lateral approach with resection of the superinfected fatty tissue 2 months after the combined approach (Table 2).

Discussion

On analysis of the results obtained, this technique provided a 90% resolution of the pathology, within a context of highly complex patients, due either to the temporal bone pathology itself, its locations, size or previous surgery (70% of cases). In the majority of our patients the middle fossa approach was not just the treatment of choice, it was also the only alternative to viable treatment. Although it is true that the absence of stable references determine that this is one of the most difficult neuro-otological approaches to dominate,[3] we agree with the majority of authors who believe that the middle fossa approach is the surgical technique of choice for this type of tumour.[7–11]

We would highlight the high level of safety offered by this technique, and wish to underline the absence of associated death, in addition to low incidence of complications arising despite the great complexity of the tumours reported. At the same time, this enabled us to have a notable rate of both facial and hearing function. This was the consequence of appropriate exposure and control of the dura mater, facial nerve, carotid nerve and upper petrous sinus provided by the middle fossa approach.[3,8,11]

Table 2 Complications.

Case	Approach	Intraoperative complications	Early postoperative complications	Late postoperative complications	Hearing function	Facial function	Pathology resolution	Control
1	EMF	None	None	None	A→A	HB I	Complete	22m
2	MF	CSF fistula Deep bleeding from lesion	None	None	A→A	HB VI	Partial	24m
3	MF	None	None	Slight instability when walking	B→B	HB I	Complete	52m
4	EMF+IT+TF	None	None	None	C→D	HB I	Complete	48m
5	MF+STP	None	Cortical–subcortical haematoma	Nominal aphasia	B→B	HB I	Complete	66m
6	MF+TM	Superior petrosal sinus bleeding	None	None	D→D	HB I	Complete	45m
7	MF+TM	None	Epidural haematoma	Slight instability when walking	B→C	HB I	Complete	42m
8	MF+TF	None	None	None	C→C	HB I	Complete	59m
9	MF+STP+CF	CSF fistula	None	Chronic mastoiditis *Citrobacter koseri*	D→D	HB III idem	Partial→ Complete	58m
10	MF+TM	CSF fistula	None	None	D→D	HB IV idem	Complete	25m

TF: temporal ms. flap; MF: standard middle fossa approach; EMF: extended middle fossa approach; HB: House/Brackmann; IT: infratemporal; CSF: cerebrospinal fluid; m: months; TM: titanium mesh; PO: parieto-occipital; STP: subtotal petrosectomy; T: temporal; TL: translabyrinthine approach; TM: transmastoid.

With regard to the surgical complications, both were the consequence of the process of temporal lobe retraction, correlating the epidural haematoma directly with the patient's previous process of meningitis.

With the intention of reducing the possibility of encephalic contusion, we decided to carry out a wide 5 cm×5 cm craniotomy, a careful dissection of the dura mater, pharmacological means of relaxation of the brain with diuretics and the use of the Leyla retractor and pliable spatulas. With this technique the encephalic surface can be adapted, minimising the mark or pressure point on the temporal lobe, compared with traditional rigid retractors (House®, Garcia Ibáñez®, Yasargil®) used by other surgeons.[2,7,10,12] It is our understanding that this reduces the incidence of temporal lobe lesions, which is one of the most negative aspects of this approach.

The main pathology of our series was cholesteatoma. In all cases, the surgical exposure obtained enabled complete removal of the tumour, with hearing preservation in 2 out of 3 patients, preserving facial function in all cases. We wish to highlight the favourable outcome in patients with supra labyrinthine cholesteatomas and which involved the geniculate ganglion, the region where the facial nerve is most vulnerable[13] (Fig. 1). This approach offers a magnificent exposure of the geniculate ganglion unlike the transmastoid approach, coinciding with the majority of authors[7,11–13] in recommending it for this type of cholesteatomas.

With regards to the repair of the bony defect, different repair materials have been reported in literature, including the temporal fascia, cartilage, muscle, synthetic materials, etc. In our series six secondary interventions were required. In four cases these involved CSF fistula which was resolved in 4 cases with titanium meshes associated with autologous fat graft (Fig. 3). We wish to underline the virtues of these compositions which have enabled us to correctly repair the defect, whilst simultaneously resolving all CSF fistulas without the need for lumbar draining. Although it has been reported, we have never had a case of superinfection[9] of the mesh or its migration. Regarding the CSF fistula control, this approach offers a satisfactory outcome,[9] whilst permitting the hearing function to be preserved unlike lateral approaches which require obliteration of the cavity and closure of the external auditory duct.[12–14]

Conclusions

Analysing the outcome obtained and those present in the literature, we consider that the middle fossa approach to be a safe, reliable and resolutive technique. It offers good exposure to the anatomical region facilitating surgical removal of the tumour, and with preservation of the facial and hearing function.

We consider that anatomical knowledge of the temporal bone is vital, owing to the major neurovascular structures exposed during this approach.

Despite being a surgical technique with limited indications and low applicability, this may be the technique of

choice in certain cases. We thus consider knowledge and applicability of the neuro-otological sections and skull base surgery to be of major importance in order to increase our resolutive capacity in different temporal bone pathologies.

Conflict of Interests

The authors have no conflict of interests to declare.

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