PRESIGMOID TRANSPETROUS APPROACH (PARTIAL PETROSECTOMY) COMBINED WITH SUBTEMPORAL TRANSTENTORIAL APPROACH FOR PETROCLIVAL MENINGIOMA

Abordaje presigmoideo transpetroso (petrosectomía parcial) combinado con abordaje subtemporal transtentorial para meningioma petroclival

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ABSTRACT

Introduction: Petroclival meningiomas constitute 3 to 10% of meningiomas of the posterior fossa, they originate in the petroclival fissure, in the upper part of the clivus, petrosal apex, and medial to the trigeminal nerve. Resection of these tumors is a neurosurgical challenge. The combined partial petrosectomy approach associated with a sub-temporal approach is a technique described by various authors; however, its performance is considered highly complex. We report the case of a petroclival meningioma operated successfully in our hospital using a combined presigmoid and subtemporal transtentorial transpetrosal approach.
Clinical case: 33-year-old female patient with a clinical picture of headache, nausea, and gait disturbance. Brain magnetic resonance imaging showed a large right petroclival tumor (4.2x3.9x3.8cm) that displaced the brainstem and secondary hydrocephalus. The hydrocephalus was treated with a ventricular peritoneal shunt. Then, the tumor was resected using a combined presigmoid and subtemporal transpetrosal approach, a technique that allowed adequate exposure of the tumor, achieving complete resection, without intraoperative complications. Postoperative evolution was favorable, with no sequelae.
Conclusion: The combined presigmoid and transtentorial subtemporal transpetrous approach for petroclival meningiomas is an effective and feasible technique to perform in our environment. The support of technology such as Neuronavigation, the ultrasonic aspirator, intraoperative monitoring, and adequate experience in skull base surgery are fundamental factors for the success of this surgery.

Keywords: *Meningioma, Skull Base Neoplasms, Craniotomy, Neurosurgical Procedures. (Source: MeSH NLM)*

RESUMEN

Introducción: Los meningiomas petroclivales constituyen del 3 al 10% de los meningiomas de la fosa posterior, se originan en la fisura petroclival, en la parte superior del clivus, ápex petroso y medial al nervio trigémino. La resección de estos tumores constituye un reto neuroquirúrgico. El abordaje combinado de petrosectomía parcial asociado a abordaje sub temporal es una técnica descrita por diversos autores, sin embargo, su realización es considerada de muy alta complejidad. Presentamos el caso de un meningioma petroclival operado con éxito en nuestro hospital mediante un abordaje combinado transpetroso presigmoideo y subtemporal transtentorial.
Caso clínico: Paciente mujer de 33 años, con cuadro clínico de cefalea, náuseas y alteración de la marcha. Resonancia magnética cerebral mostró tumoración petroclival derecha de gran tamaño (4.2x3.9x3.8cm) que desplazaba el tronco cerebral, e hidrocefalia secundaria. La hidrocefalia fue tratada con una derivación ventrículo peritoneal. Luego, se procedió a la resección tumoral mediante un abordaje combinado transpetroso presigmoideo y subtemporal transtentorial, técnica que permitió una exposición adecuada del tumor logrando su resección completa, sin complicaciones intraoperatorias. La evolución postoperatoria fue favorable, sin presentarse secuelas.
Conclusión: El abordaje combinado transpetroso presigmoideo y subtemporal transtentorial para meningiomas petroclivales es una técnica efectiva y factible de realizar en nuestro medio. El apoyo de la tecnología como el uso del neuronavegador, el aspirador ultrasónico, el monitoreo intraoperatorio, así como una adecuada experiencia en cirugía de base de cráneo son factores fundamentales para el éxito de esta cirugía.

Palabras Clave: *Meningioma, Neoplasias de la Base de Cráneo, Craneotomía, Procedimientos Neuroquirúrgicos (fuente: DeCS Bireme)*

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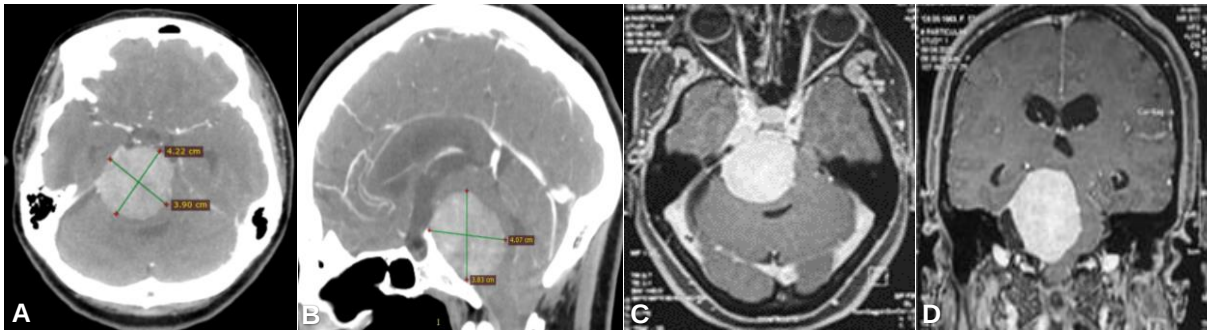

Fig 1. (A and B) Brain tomography with contrast in **(A)** axial section and **(B)** sagittal section, showing a large petroclival tumor (4.22 x 3.90 x 3.83 cm). **(C and D)** Brain MRI with contrast in **(C)** axial section and **(D)** sagittal section showing petroclival tumor that compresses and displaces the brainstem and cerebellum.

The Meningiomas are one of the most common benign tumors of the CNS, with a frequency of 2.3 cases per 100,000 habitants, which constitutes 13 to 36.4% of primary tumors of the central nervous system according to the literature.[1,2] These tumors can be of diverse locations such as convexity, falx, tentorium, intraventricular, and skull base. The latter are classified as anterior, medial, and posterior cranial base meningiomas. The posterior cranial base meningiomas can be located at the foramen magnum, petrous bone, clivus, and petroclival region. Meningiomas of the posterior fossa constitute 8% of all locations, and petroclival ones have a frequency of 3 to 10% of tumors of the posterior cranial base. [3]

Traditionally, these tumors are very difficult to treat due to the adjacent compromised structures such as the brain stem, arteries of the basilar vertebral system, especially the basilar artery and its perforating branches, venous circulation of the brain stem, and the cranial nerves. However, in recent series, reported mortality and morbidity have decreased thanks to the introduction of modern technology, improved neurosurgical techniques, and intraoperative monitoring.

In this case report, the first case performed at the Guillermo Almenara National Hospital of a combined transpetrosal presigmoid + transtentorial subtemporal approach for resection of this type of tumor is presented, achieving excellent results.

CLINICAL CASE

History and examination: 33-year-old female patient, with a medical history of infection by Sars Cov-2 one month before admission. She began her symptoms 4 months before admission, she presented headache, nausea, vomiting, gait disturbance, and finally swallowing disturbance. Evaluated in other institution, the placement of a ventricle peritoneal shunt (VPS) was proposed as a palliative treatment for intracranial hypertension. In our hospital, the case was analyzed by the Medical Board of the Vascular, Tumors and Functional Neurosurgery of the Guillermo Almenara National Hospital (HNGAI), confirming that it was an extra-axial expansive lesion of a large petroclival location on the posterior fossa skull base, measuring 4.2 x 3.9 x 3.8 cm, highly vascular, contrast-binding and apparently hard in consistency according to the T2 sequence of the MRI. Due to the large volume, this lesion displaces the brain stem to the left and the marked displacement of the basilar artery and its main branches is observed. AngioCT showed the feeding vessels of the tumor that came from the middle cranial base and tentorium on the right side. *(Fig 1)*

Surgical Treatment: In the surgical planning, images in DICOM format were used and the Radiant DICOM Viewer software program was used, with which 3D reconstructions of the skull, brain, tumor, and their relationship with the skull base were performed. A virtual craniotomy in bone window *(Fig 2)* was performed and the possibility of resection of the lesion through this route was evaluated,

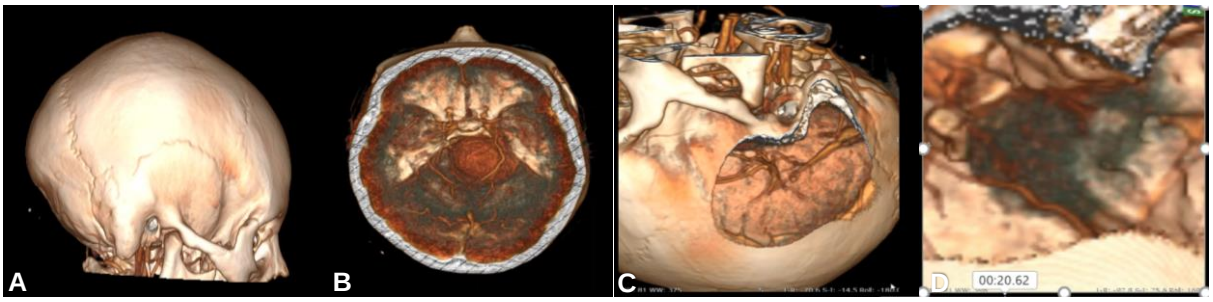

Fig 2. (A-D) Images of the surgical planning with the use of the software by performing a virtual craniotomy for the analysis of the viewing angles, the width of the craniotomy, vascularization of the tumor, and adjacent structures.

based on the measurements and characteristics of the petrous bone. The drilling of the petrous bone, craniotomy size, and the need for Neuronavigation equipment for intraoperative topographic confirmation, the use of intraoperative neuromonitoring equipment, ultrasonic aspiration equipment, and surgical microscope with angiofluorescence capacity were planned.

Surgical procedure: The patient underwent general anesthesia, electrodes were placed for neurophysiological control, the patient was placed in the ¾ prone position, with a pinhead, asepsis, and sterile fields were placed. An inverted "J" incision, dissection of the subcutaneous tissue, dissection of the aponeurosis of the temporal muscle anteriorly, and posterior dissection up to the retromastoid region and then retraction of the latter backward to be used for closure was made. We dissect the temporal muscle based on the zygomatic arch and allow it to be retracted downwards with traction hooks. The landmarks were identified for the drilling of the mastoid: the spine of Henle in front, the digastric groove behind, and the posterior temporal crest above. *(Fig 3)*

We delimited this triangle for the posterior petrosectomy, for which we used a high-speed electric drill, with which we drilled this triangle, keeping in mind the trajectory of the intrapetrosal facial nerve, for which we began the drilling by first identifying the sigmoid sinus backward and then, having already its anterior border as an additional parameter. Then, we continue drilling the bone enough to make an opening of the presigmoid dura. At the upper limit, we drill until we reach the dura of the middle fossa and then we continue drilling until we identify the superior petrosal sinus, which joins the sigmoid sinus. At this stage, we do not consider it necessary to expose the facial nerve or try to denude it from its bony covering, since this brings greater possibilities of postoperative facial paresis. The dura repair points were placed, and the latter was opened at the subtemporal and presigmoid levels, both incisions reaching the source of the superior petrosal vein, identifying the tentorium cerebelli from behind. The superior petrosal sinus is ligated, and we gradually cut the tentorium under microscope vision to identify the passage of the IV cranial nerve along the medial edge of the tentorium. *(Fig 4, A-B)*

After the opening of the tentorium, a wide exposure of the surgical field is achieved, being able to approach the tumor in front of the V, VI, VII, VIII cranial nerves. Coagulation of the tumor surface was performed, and internal decompression of the tumor began with punch forceps, as well as with an ultrasonic aspirator, releasing adjacent structures such as the ipsilateral III, IV, V, VI, VII, VIII, and

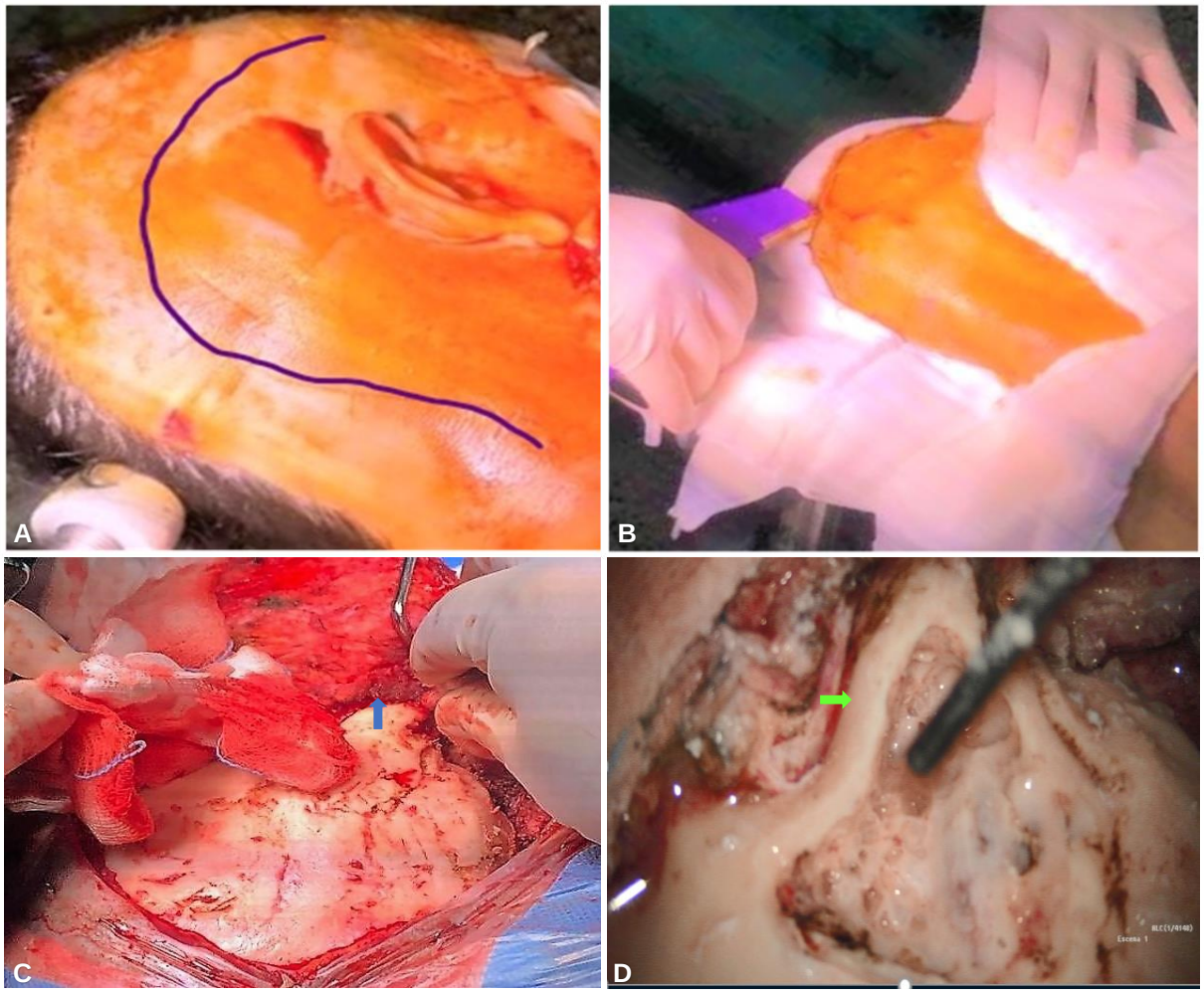

Fig 3. Intraoperative images at the beginning of surgery showing: **(A)** Inverted "J" shaped incision that extends from the temporal region to the retromastoid region. **(B)** Preparation of the operative field. **(C)** Dissection of subcutaneous cellular tissue, the opening of the aponeurosis and temporal muscle *(blue arrow)*, **(D)** identification of landmarks, and initiation of mastoid drilling *(green arrow)*.

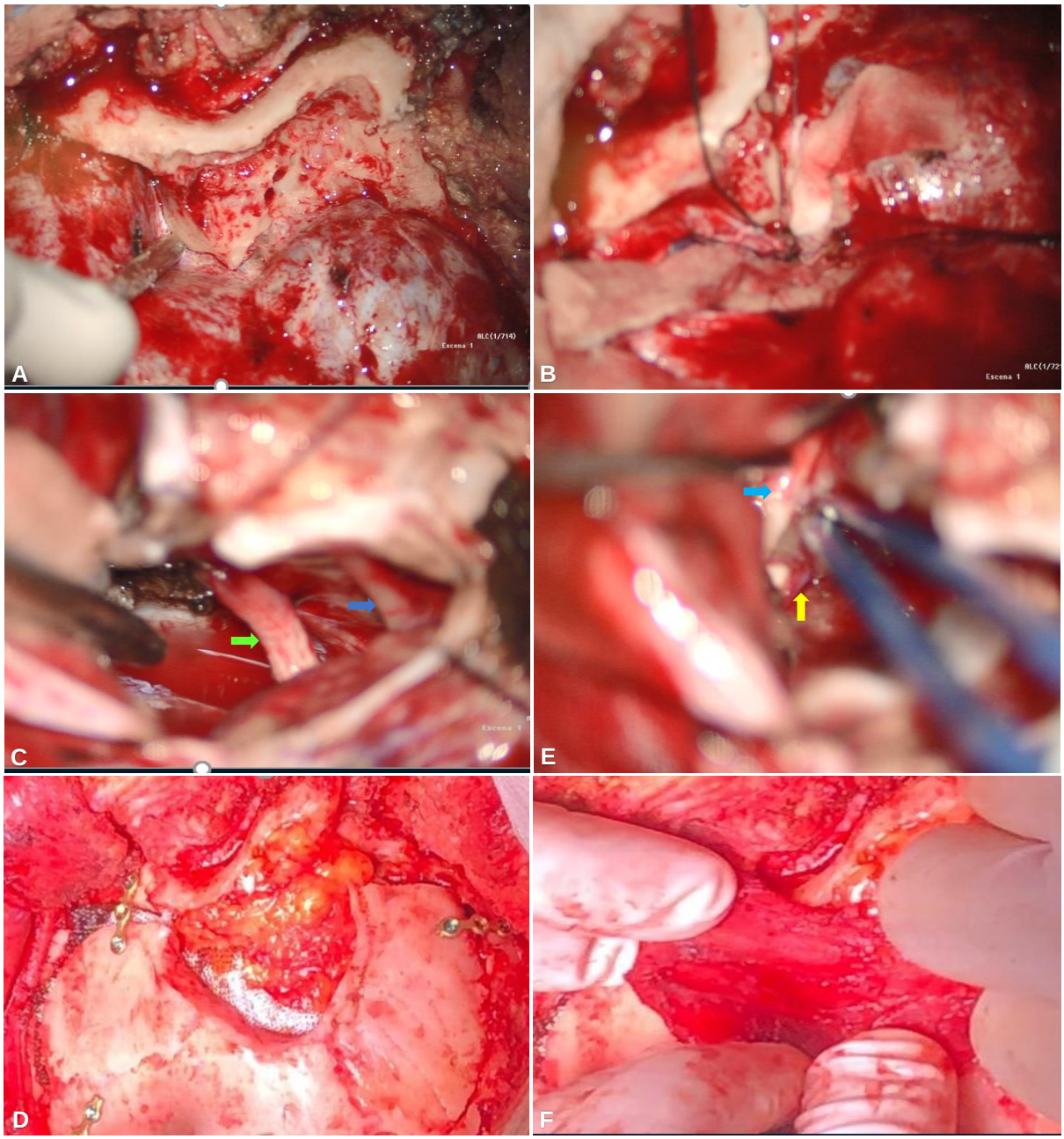

Fig 4. Intraoperative images showing: **(A)** Exposure of the posterior fossa and middle fossa dura after mastoid drilling and temporal craniotomy. **(B)** Opening of the presigmoid and subtemporal dura until it converges in the superior petrosal sinus, which is coagulated and ligated with repair points, followed by the opening of the tentorium. **(C)** Image at the end of tumor resection showing cranial nerve V *(green arrow)*, complex VII and VIII displaced backward *(blue arrow)*. **(D)** Contralateral view showing the basilar artery *(yellow arrow)* and VII and VIII cranial nerves on the left side *(light blue arrow)*. **(E)** Final closure: Dura suture, placement of abdominal wall fat, biological rubber (Bioglue), and repositioning of the bone plate with mini-plates and titanium screws. **(F)** The temporalis muscle is fixed back over the cranial defect and then the temporal fascia is sutured inverted.

IX cranial nerves, and, also the contralateral V, VII, and VIII cranial nerves, the release of the Basilar artery completely displaced to the opposite side (to the left) and the brainstem that is free of tumor compression. Coagulation of the tumor implantation sites was performed: the apex of the petrous bone, clivus, and tentorium cerebelli; in this way achieving a total macroscopic resection with coagulation of the implantation site (Simpson II) *(Fig 4, C-F)*

Clinical evolution: In the postoperative period, the patient evolved favorably. She awakes at the end of the surgery, stay in Glasgow (GCS) 15, with a good level of consciousness, and without presenting complications. Postoperative cerebral tomography showed total resection of the petroclival meningioma, with no evidence of bleeding from the surgical site. The patient was discharged on the 7th day and returned to her daily activities at 2 weeks. *(Fig 5)*

DISCUSSION

The combined partial petrosectomy approach associated with a sub-temporal approach for the treatment of petroclival lesions is not a new technique, this technique was

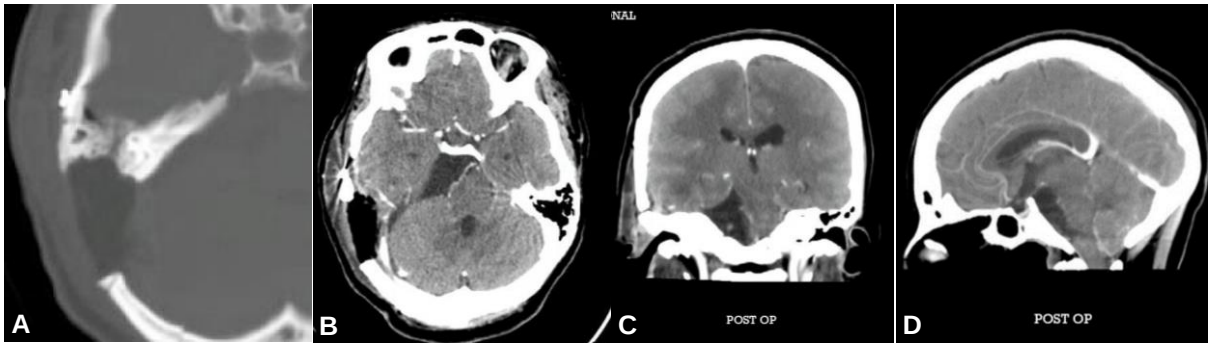

Fig 5. Postoperative brain tomography showing **(A)** the area of the presigmoid transpetrous craniotomy; and total resection of the lesion in the **(B)** axial, **(C)** coronal, and **(D)** sagittal sections.

already described by various authors [5,6,7,8,9,10,11,12] since 1988; however, its performance is considered very complex by most neurosurgeons and is only performed in centers of very high specialization. This is due to the need to carry out previous dissections in anatomical pieces to have a clear idea of the anatomy of the mastoid and in most Latin American countries we lack anatomical laboratories for this. However, when expertise of dissecting anatomical specimens is achieved, the implementation of this approach is carried out with relative ease.

This was the first case performed at the Functional, Tumors and Vascular Neurosurgery Service of the Guillermo Almenara National Hospital (HNGAI), since previously tumors in this location were attempted to be resected only by retromastoid routes or subtemporal approaches combined with retromastoid but without petrosectomy. This later approach lets us widen the angle of vision a little more, but it is not the same as performing a presigmoid approach since the great difference is that, by coagulating the superior petrosal sinus and hence cutting the tentorium, greater exposure is achieved with a greater angle of vision. In addition, the approach to the tumor is anterior to the VII and VIII cranial nerves, thus reducing the possibility of postoperative facial paralysis.[13, 14, 15]

There has always been a lot of concern of causing an injury to the facial nerve in its intrapetrosal portion during the drilling, however, this possibility is minimal when the drilling is performed considering anatomical aspects and following the recommendations of surgeons with more expertise in this surgical approach. It is also of interest to know in what proportion a partial petrosectomy can cause hearing impairment in a patient who still maintains a certain degree of auditory function, so it is necessary to emphasize that, if the patient still has the auditory function the most advisable thing is to perform a partial petrosectomy and leave the trans-labyrinthine and trans-cochlear approach for those cases in which there is total hearing damage.[16]

Regarding the total surgical time required, this may vary from case to case, depending on the characteristics of consistency, size, and vascularization of the tumor, and the first phase of the surgery consisting of mastoid drilling and temporary craniotomy can be performed in one day. prior to or on the same day as tumor resection, depending on the means available. In this case, the surgery was performed in 7 hours, but we consider that in other cases it might be necessary to do it in two stages.[17]

Finally, we must express that this approach has been very satisfying for the entire surgical team, and the service in general due to the wide degree of resection achieved, the rapid and excellent postoperative evolution, without any added neurological deficit, and why it opens the possibility of treating other patients with tumors of a similar location.

CONCLUSION

The combined presigmoid transpetrosal and transtentorial subtemporal approach for the resection of petroclival meningiomas is an effective and feasible technique to perform in our environment. The support of technology such as the use of the Neuronavigation, the ultrasonic aspirator, intraoperative monitoring, as well as adequate experience in skull base surgery are fundamental factors for the success of this surgery.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Authors Contributions

Conception and design: All authors. *Drafting the article:* Palacios F. Critically revising the article: Palacios F. *Reviewed submitted version of manuscript:* Palacios F. *Approved the final version of the manuscript on behalf of all authors:* Palacios F.

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