Transorbital microsurgery (TOMS): Step-by-Step technique, tips and tricks

Microcirugía transorbitaria (TOMS): Técnica paso a paso, recomendaciones consejos y trucos quirúrgicos

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Resumen

Introducción: La microcirugía transorbitaria (TOMS) representa una innovación transformadora en el abordaje mínimamente invasivo de la base anterior del cráneo. A través de una discreta incisión en el párpado superior y una precisa craneotomía orbitofrontal, este abordaje permite un acceso directo al espacio subfrontal y a estructuras neurovasculares críticas, sin necesidad de craneotomías extensas ni retracción cerebral significativa. La técnica combina los principios de la microcirugía clásica -visualización tridimensional, control bimanual y ergonomía operatoria- con la eficiencia de un corredor anatómico natural, preservando la estética facial y minimizando la morbilidad. Su desarrollo respondió a la necesidad de soluciones quirúrgicas que mantuvieran seguridad y control, conservando al mismo tiempo un carácter mínimamente invasivo. En manos entrenadas, la TOMS amplía el alcance de la neurocirugía moderna, permitiendo intervenciones complejas mediante accesos selectivos, máxima precisión y mínima invasión. **Objetivo:** Describir integralmente la técnica TOMS, establecer sus fundamentos anatómicos y demostrar su aplicabilidad en patologías orbitocraneales mediante casos clínicos reales, destacando su capacidad para reemplazar abordajes abiertos en escenarios seleccionados. **Métodos:** La técnica se detalla paso a paso: incisión en el párpado superior, craneotomía orbitofrontal, disección subperióstica amplia y visualización intracraneal bajo microscopio. Se presentan tres aplicaciones clínicas (trauma, tumoral y vascular) como validación funcional del abordaje. **Resultados:** La TOMS proporcionó un acceso directo y controlado al nervio óptico, a la bifurcación de la arteria carótida y al piso frontal, con mínima retracción cerebral, control bimanual completo y óptimos resultados cosméticos. No se reportaron complicaciones mayores. La recuperación fue generalmente rápida y todos los pacientes fueron dados de alta sin secuelas. **Conclusiones:** La microcirugía transorbitaria constituye una alternativa útil para determinadas patologías de la base anterior del cráneo. Combina la elegancia estética de un abordaje transpalpebral con el rigor técnico de la microcirugía moderna. En el contexto adecuado, la TOMS no solo complementa, sino que puede reemplazar los abordajes tradicionales para lesiones orbitobasales, ofreciendo al cirujano precisión, visibilidad y dominio anatómico en una región previamente considerada de difícil acceso.

Palabras clave: Abordaje transorbitario, microcirugía mínimamente invasiva, base anterior del cráneo, aneurismas, meningiomas, TOMS, cirugía orbitocraneal.

Abstract

Introduction: Transorbital microsurgery (TOMS) represents a transformative innovation in the minimally invasive approach to the anterior skull base. Through an inconspicuous upper eyelid incision and precise orbitofrontal craniectomy , this approach allows direct access to the subfrontal space and critical neurovascular structures without the need for extensive craniotomies or significant brain retraction. The technique combines the principles of classical microsurgery 3D visualization, bimanual control,

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and operative ergonomics with the efficiency of a natural anatomical corridor, preserving facial aesthetics and minimizing morbidity. Its development responded to the need for surgical solutions that maintain safety and control while maintaining minimal invasion. In trained hands, TOMS expands the scope of modern neurosurgery, enabling complex interventions with selective access, maximum precision, and minimal invasiveness. **Objective:** To comprehensively describe the TOMS technique, establish its anatomical foundations, and demonstrate its applicability to orbitocranial pathology through real-life cases, highlighting its ability to replace open approaches in selected scenarios. **Methods:** The technique is detailed step by step: upper eyelid incision, orbitofrontal craniectomy, wide subperiosteal dissection, and intracranial visualization under a microscope. Three clinical applications (trauma, tumor and vascular) are presented as functional validation of the approach. **Results:** TOMS provided direct and controlled access to the optic nerve, the carotid artery bifurcation, and the frontal floor, with minimal brain retraction, complete bimanual control, and optimal cosmetic results. No major complications were reported. Recovery was generally rapid, and all patients were discharged without sequelae. **Conclusions:** Transorbital microsurgery is a useful alternative for some anterior skull base pathologies.. It combines the aesthetic elegance of a transpalpebral approach with the technical rigor of modern microsurgery. In the appropriate setting, TOMS not only complements but can replace traditional approaches to orbitobasal lesions , offering the surgeon precision, visibility, and anatomical mastery in a previously seemingly inaccessible area.

Keywords: Transorbital approach, minimally invasive microsurgery, anterior skull base, aneurysms, meningiomas , TOMS, orbitocranial surgery.

Introduction

Transorbital surgery has re-emerged in the last two decades as a minimally invasive alternative for accessing the anterior skull base. Although historically employed in a rudimentary and even controversial manner, as in the transorbital lobotomy described by Freeman in the mid-20th century, its revival is due to advances in endoscopic and microsurgical techniques that allow the use of this anatomical corridor with precision and safety[1]. The development of the transorbital endoscopic approach (TONES) since 2010 represented a turning point in this field. This approach allows access to the skull base, frontal sinus, cribriform plate, and optic canal through a discreet eyelid incision, minimizing brain manipulation and avoiding extensive craniotomies[2].

Several studies have shown that TONES is useful for the management of multiple pathologies, such as cerebrospinal fluid (CSF) leaks, meningoencephaloceles, optic nerve decompression, resection of orbital and intracranial tumors, and repair of skull base fractures[3-5]. Furthermore, the combined use of transorbital access with endonasal approaches has been shown to expand working angles and improve maneuverability in complex skull base lesions[6]. Despite these advances, the transorbital endoscopic approach has inherent limitations, including narrow surgical space, two-dimensional visualization, portal congestion with instruments, and lack of tools specifically designed to work at depth[7].

In order to overcome these limitations, a new technical concept has emerged: transorbital microsurgery (TOMS). Unlike the purely endoscopic approach, TOMS employs the operating microscope to provide stereoscopic vision, coaxial illumination, and the possibility of bimanual manipulation with conventional microsurgical instruments. This facilitates precise dissection, improves surgical ergonomics, and reduces the risk of instrument collision in the orbital corridor[8].

A recent anatomical study has characterized the TOMS corridor in detail, demonstrating that an orbital roof craniectomy allows controlled access to the frontalis base, optic nerve, and carotid bifurcation (A1-M1) without the need for frontalis retraction [9]. This exposure is comparable to that obtained by a supraorbital craniotomy, but with less morbidity and a virtually invisible scar. These observations support the hypothesis that TOMS represents a safe and effective evolution of the transorbital approach.

The present work aims to describe in detail the transorbital surgical technique with microscopic visualization, illustrate its clinical applications through real cases, and discuss its role within the arsenal of minimally invasive approaches to the skull base.

Surgical technique

Transorbital microsurgery (TOMS) is structured as a minimally invasive approach to the anterior cranial fossa through the orbital roof, allowing intracranial exposure without conventional craniotomy. Unlike endoscopic TONES, TOMS employs a surgical microscope that provides three-dimensional vision, coaxial illumination, and bimanual freedom for microsurgical maneuvers[9].

1. Patient position and planning

The patient is placed supine on the operating table with slight cervical extension; a shoulder roller can be used to facilitate the line of vision to the skull base. The head is secured in a Mayfield head restraint and rotated 10° to 45° to the contralateral side, depending on the anatomical location of interest[9]. For example, a 10-20° rotation allows ipsilateral frontal access, while a 45° rotation allows exposure of the A1-ACom -A2 complex. The surgeon is positioned in line with the

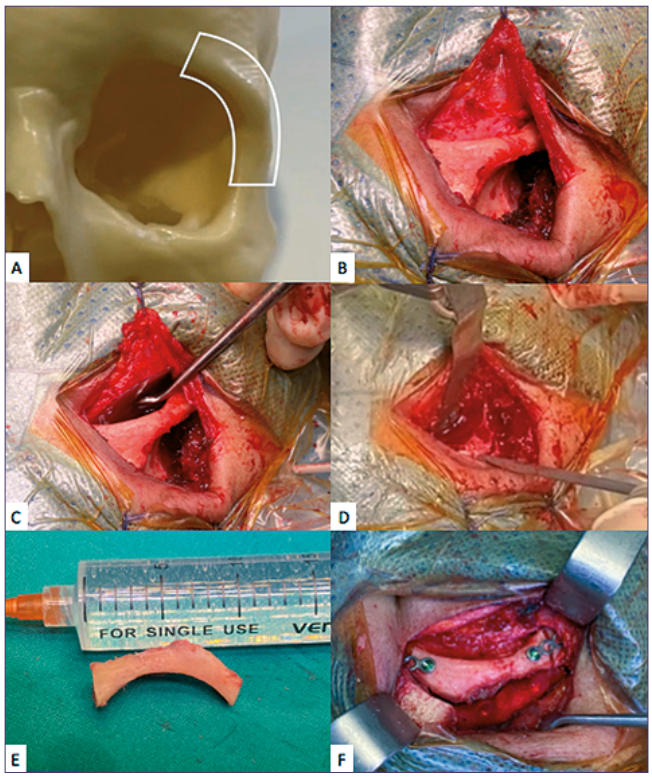

Figure 1. Operative sequence of the transorbital microsurgical approach (TOMS). A: Bone projection of the orbitofrontal corridor on a dry skull, delimited by a rectangle on the superior orbital roof; B: Superior eyelid incision with subcutaneous dissection and separation of skin and muscle flaps, exposing the orbital rim surface; C: Subperiosteal dissection of the orbital roof and isolation of the bony rim; the lateral muscular plane is retracted to expose the temporal margin; D: Stabilization of the surgical field using a Leyla -type retractor, allowing dynamic displacement of orbital contents without ocular compression during craniectomy; E: Extracted orbital bone fragment; F: Primary reconstruction with repositioning of the fragment and fixation with medial and lateral titanium miniplates , restoring the integrity of the orbital roof.

planned axis of view, and the microscope is aligned with the orbitofrontal corridor[9].

2. Eyelid incision and dissection

The ipsilateral upper eyelid is identified. After protecting the eye with a corneal shield and applying anesthetic solution with epinephrine, a 4 to 5 mm horizontal incision is made over the palpebral sulcus, preserving the aesthetics approximately 1 cm laterally of the supraorbital notch[10]. The dissection continues in the preseptal plane with a scalpel and dissection, detaching the orbicularis oculi muscle and the subcutaneous muscle over the orbital septum, until the superior orbital rim is exposed. It is crucial to avoid damage to the aponeurosis of the levator palpebrae muscle, whose injury generates ptosis[11].

The supraorbital nerve, which emerges from the medial supraorbital foramen, is identified and carefully dissected if exposed, normaly this is not needed. It can be freed from its bony canal if greater mobility is required. The dissection continues until reaching the lateral frontozygomatic suture , which delimits the posterolateral end of the anterior cranial fossa[9] (Figure 1-B).

3. Subperiosteal orbital access

The periosteum over the orbital rim is incised, creating a window for subperiosteal dissection. A blunt dissector is introduced along the superior curvature of the orbit, separating the periosteum from the bony wall (Figure 1-C), duly identifying the frontozygomatic and frontosphenoid sutures. The orbital contents are mobilized medially. The dissection continues until the lateral border of the superior orbital fissure is identified[12].

With this maneuver, the eyeball is made inferiorly and laterally mobile, maximizing surgical space and avoiding the need for prolonged fixed retractors. It is recommended to use dynamic retractors (such as a Leyla retractor system), and to check the pupil every 15-20 minutes to prevent optic ischemia secondary to sustained intraorbital pressure[13] (Figure 1-D.

4. Orbitofrontal craniectomy

Once the orbital contents have been released, an orbitofrontal craniectomy is performed. Using a craniotome and a high-speed motor with Kerrison edge support, a bony window is delineated with an opening as required by surgery[9] (Figure 1-E]. The anatomical boundaries are:

- Lateral: from the frontozygomatic to the frontosphenoid suture.
- Medial: junction of the frontal sinus with the cribriform plate.
- nterior: posterior border of the frontal sinus.
- Posterior: the lateral apex of the superior orbital fissure.

The reaming should be done lateral to the supraorbital nerve, respecting its course. The reamer works on the thin orbital bone until the frontal dura mater is exposed. The bone fragment can be removed en bloc or in fragments. In all cases, penetration of the frontal sinus is avoided. Neuronavigation Intraoperative imaging may be useful for defining bone margins, especially in complex sinus anatomies[14].

Dural opening and intracranial exposure

Once the orbitofrontal craniectomy is completed and bone hemostasis is assured, the dura mater of the anterior cranial fossa is exposed. If the intervention requires it, it is opened with a microsurgical scalpel. For tumoral lesions, a linear or arcuate incision is preferred, allowing reflection of the flaps and facilitating subsequent closure. For access to deep vascular structures, a curvilinear incision toward the medial edge of the bony window is preferred, facilitating access to the optic nerve, chiasmatic cistern, and carotid bifurcation without the need for frontal cortical retraction[15].

Opening the basal cistern results in spontaneous CSF drainage, which relaxes the brain and improves the angle of vision without the use of retractors. Under microscopic vision, the ipsilateral optic nerve can be identified emerging from the canal, followed laterally by the paraclinoid internal carotid artery and medially by the A1 segment of the anterior cerebral artery[9]. With microdissection in the subarachnoid plane,

the course of A1 can be followed toward the midline and the anterior communicating artery (ACom) can be exposed, as well as the bifurcation into A2 and M1. In most cases, the complete origin of the middle cerebral artery (M1) and the basal parenchyma of the frontal lobe can be visualized, all without fixed retractors[16].

The working field is narrow but sufficient for manipulation with conventional microsurgical instruments. The advantage of the microscope is that it allows ergonomic bimanual control with high-definition stereoscopic imaging, unlike the endoscope, which requires unimanual maneuvers and lacks depth[17].

6. Surgical manipulation

Once the target lesion has been identified, its approach is based on its nature. In tumor lesions, resection is performed using standard microsurgical techniques, starting with coagulation and section of the dural base , followed by centripetal dissection. In the case of aneurysms, proximal control of the internal carotid artery is achieved from its paraclinoid segment to the carotid bifurcation, allowing direct clipping if the neck is accessible[18].

Microdissection is facilitated by the direct proximity of the surgical field. Hemostatic control is supported by low-intensity bipolar force and oxidized hemostatic gauze. In all cases, retraction of the frontal parenchyma is avoided by careful manipulation and the use of gravity as a positional advantage[19].

7. Closure and reconstruction

After intracranial surgery, closure is performed in layers. The dura mater is sutured tightly with 5-0 nonabsorbable material. Prevention of CSF leaks is critical; therefore, it is complemented with fibrin sealant and, if necessary, a pericranial or fascia patch. The orbital bone fragment can be relocated if it was extracted en bloc and fixed with low-profile titanium miniplates (Figure 1-F)[20].

The orbit is inspected to verify globe integrity, pupillary symmetry, and soft tissue tension. The orbital contents are repositioned, and the orbital periosteum is sutured if it has been elevated. The orbicularis oculi muscle and subcutaneous layers are then closed with absorbable sutures. Finally, the palpebral skin is closed with fine, nonabsorbable sutures, concealing the scar in the natural eyelid crease[10].

Postoperative bandaging is not routinely used by the authors, but strict ocular monitoring should be performed postoperatively. Recovery is generally rapid, with minimal morbidity and excellent cosmetic results[21].

Illustrative Cases

Case 1: Left sphenoid wing meningioma

A 54-year-old woman presented with a history of left orbitotemporal headache and progressive visual impairment. MRI showed an extra-axial lesion with homogeneous enhancement, hyperossification of the sphenoid wing, and extension into the lateral orbitocranial region. A total resection was performed using a transorbital approach (TOMS). The resection allowed complete decompression of the optic nerve and orbitocranial wall (Figure 2). Histology confirmed WHO grade I meningioma. Postoperative imaging follow-up showed complete resection.

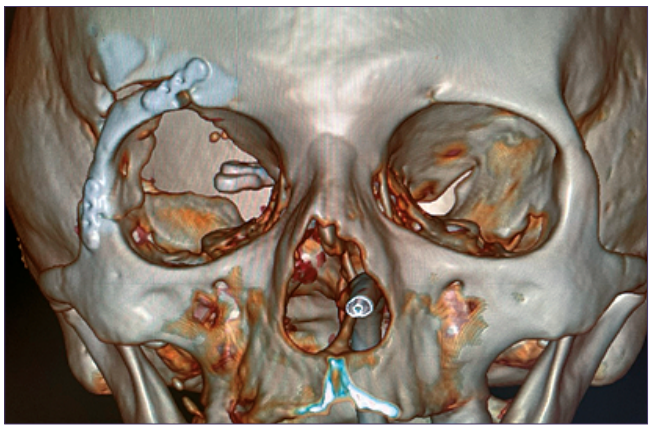

Figure 2. Three-dimensional computed tomography reconstruction in the immediate postoperative period. Frontal view demonstrating the left orbitofrontal craniotomy performed using the TOMS approach. The bone defect in the left orbital roof, corresponding to the surgical corridor created to access the anterior cranial fossa, is clearly visible. Partial bone reconstruction and preservation of the lateral orbital contour allow visualization of the access window without significant surface architectural distortion.

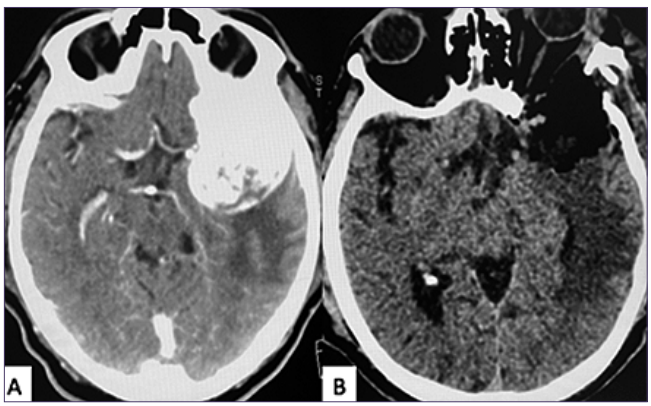

Figure 3. Axial computed tomography studies in a patient with a right sphenoid wing meningioma, before and after resection using a transorbital microsurgical approach (TOMS). A: Preoperative contrast-enhanced image demonstrating an extra-axial lesion. Hyperdense with homogeneous enhancement, located in the region of the right sphenoid wing, with orbitocranial extension and adjacent hyperostosis. A mass effect is observed over the temporal pole and superior orbital displacement; B: Immediate postoperative image without contrast shows complete resection of the lesion and is associated with complete decompression of the optic canal and the orbitotemporal wall.

Case 2: Clipping transorbital right ophthalmic aneurysm

A 60-year-old female patient presented with right-sided hemicranitic headache and progressive visual impairment in the right eye. An angiographic study revealed a saccular aneurysm of the right ophthalmic artery. Clipping was

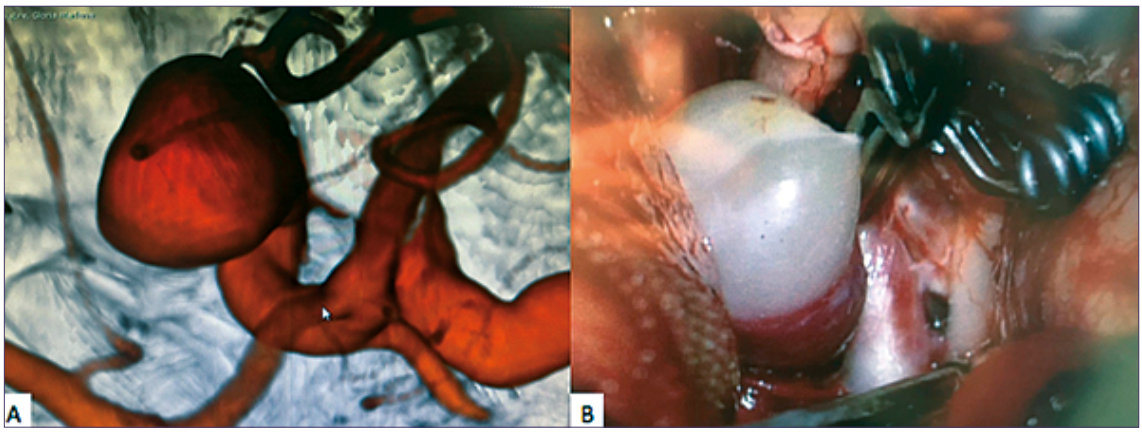

Figure 4. Right ophthalmic aneurysm treated by transorbital microsurgical approach (TOMS). A: Preoperative three-dimensional computed tomography angiography revealed a saccular aneurysm in the right ophthalmic artery; B: Intraoperative TOMS image with direct visualization of the aneurysm sac after selective clipping. A lateral closure clip was used without the need for frontal retraction or conventional craniotomy. The aneurysm was successfully excluded, preserving adjacent neurovascular structures.

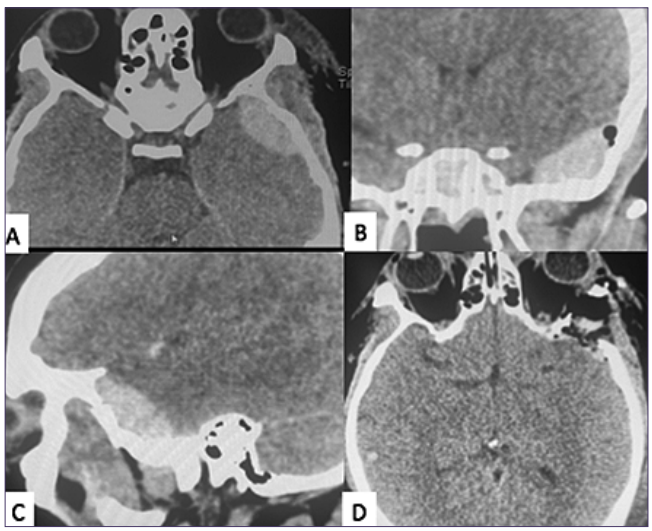

Figure 5. Evacuation of extradural hematoma. A-C: Preoperative axial; (A) coronal (B), and sagittal (C) CT images showing an extradural hematoma located on the left temporal pole, with adjacent mass effect, in a patient with closed head trauma and a Glasgow Coma score of 15. D: Postoperative CT scan showing resolution of the hematoma after evacuation via the TOMS approach. The access allowed direct exposure of the temporal pole.

performed using a transcatheter approach. transorbital (TOMS), achieving direct and selective exposure of the paraclinoid segment. The aneurysmal neck was excluded with a lateral closing clip, without the need for frontal retraction or conventional craniotomy. Neural and adjacent vascular structures were preserved (Figure 2 and 4).

The postoperative evolution was favorable, with improvement of the visual field and complete exclusion of the aneurysm confirmed by follow-up angiography.

Case 3: Temporary extradural hematoma

A 34-year-old male patient, involved in a traffic accident, was admitted with Glasgow 15. A cranial computed tomography scan revealed an extradural hematoma located in the left temporal pole. Complete evacuation of the hematoma was performed using a transorbital approach (TOMS). Direct exposure of the temporal pole allowed for effective drainage without the need for conventional craniotomy (Figure 5). The patient's neurological condition was unimpaired, with no postoperative complications. Neuroimaging showed complete resolution of the hematoma and anatomical restoration.

Discussion

Transorbital microsurgery (TOMS) represents a technical evolution of the classic transorbital approach , incorporating microsurgical principles into a minimally invasive corridor to the anterior cranial fossa. Initial anatomical and clinical results have demonstrated that this access is feasible and reproducible in trained hands, expanding the repertoire of minimally invasive approaches in skull base neurosurgery[9,22].

One of the main advantages of TOMS over the transorbital endoscopic approach (TONES) is its three-dimensional visualization under a microscope. Coaxial illumination and depth perception allow for more precise manipulation of neurovascular structures, as well as the use of conventional microsurgical instruments in a bimanual configuration, facilitating tumor resection or vascular clipping[9,18,23].

The anatomic exposure achieved by TOMS has been validated in cadaveric studies demonstrating complete visualization of the optic nerve, internal carotid artery (paraclinoid segment), carotid artery bifurcation, and much of the proximal course of M1, all without frontal retraction[9]. This represents an operative field comparable to that obtained by supraorbital or subfrontal approaches, but through a transpalpebral route that is virtually invisible postoperatively[10,22]. Resection of the orbital roof with high-speed tools allows a working angle that respects the boundaries of the frontal and ethmoid sinuses, minimizing bone destruction and reducing the risk of CSF leak[14,19].

The clinical applications of TOMS are diverse. In neuro-oncology, it has been successfully used to resect meningiomas of the sphenoid wing, sphenoid planum, and sellar

tubercle, with results comparable to open craniotomies in terms of resection extent[22]. In the neurovascular setting, cases of clipping of ACom, ophthalmic, and supraclinoid aneurysms have been reported using a modified lateral transorbital approach, as described by Ulutaş et al., who managed to exclude 60 aneurysms with a low rate of permanent complications[23]. For anteriorly based lesions with bone involvement and encephalocele, as in case 3, TOMS allows effective dural repair with direct visualization and the possibility of rigid cranial floor reconstruction[24].

However, TOMS also has limitations. The small working space requires a significant learning curve and strict familiarity with and handling of orbitocranial anatomy. Instrumental congestion can be a technical obstacle, particularly when compared with multichannel approaches such as the combined transnasal - transorbital approach[21]. Furthermore, maneuverability may be restricted by the prominence of the superior orbital rim, so adequate globe mobilization and proper bone clearance are critical for safe surgery[8,13].

Orbital safety is a key concern. Subperiosteal dissection must be wide and meticulous, including ligation of the anterior and posterior ethmoidal arteries to avoid orbital hematoma and allow for further globe displacement[12]. During the procedure, frequent clinical monitoring of pupillary symmetry and globe status is essential, with periodic interruptions to verify optical perfusion, especially in prolonged surgeries[13].

transorbital approach has been shown to have a low rate of postoperative CSF leaks, attributed in part to intraorbital pressure collapsing the dural defect and promoting spontaneous closure[21]. However, inadvertent opening of the frontal or ethmoid sinuses may increase this risk, so planning is essential in these cases[14].

The optimal indication for TOMS remains a subject of study. In general, small to medium-sized lesions located anteriorly or paramedianly, without extensive sinus invasion or contrary lateralization, are ideal candidates. The technique can also be integrated into hybrid approaches, combining the transorbital route with other approaches (endonasal , minipterional), expanding the surgical field without the need for extensive craniotomies[5,6].

In summary, TOMS represents a minimally invasive alternative for the treatment of various orbitofrontal and anterior intracranial pathologies, with clear cosmetic and functional advantages. Its adoption requires specific training, careful patient selection, and progressive implementation in cases with favorable anatomical indications. Its future is projected as part of a hybrid skull base neurosurgery, combining refined microsurgical approaches with endoscopic and navigational technologies to achieve more precise, less invasive, and patient-centered surgery.

Conclusion

Transorbital microsurgery (TOMS) is an emerging surgical tool that combines minimally invasive principles with the control and precision of conventional microsurgery. This approach allows access to the anterior cranial fossa and paramedian regions through a discrete orbitofrontal corridor, avoiding extensive craniotomies and brain retraction. The technique offers cosmetic, functional, and anatomical advantages, being useful in selected cases of tumors, aneurysms, and hematomas. Although it presents limitations in terms of field of view and working space, its careful implementation has demonstrated low morbidity and effective surgical results. The consolidation of TOMS will require further clinical validation, specific instrument development, and systematic training in orbitocranial anatomy. In the context of increasingly precise and less invasive skull base neurosurgery, TOMS is emerging as a valuable addition to the contemporary surgical armamentarium.

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