Validity of the Lateral Supraorbital Approach as a Minimally Invasive Corridor for Orbital Lesions

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BACKGROUND: Many approaches were recommended for surgical treatment of orbital lesions via either transorbital or transcranial routes. The frontolateral craniotomy through eyebrow skin incision (lateral supraorbital approach) is a combined cranio-orbital approach that could be used in different orbital lesions.

OBJECTIVES: To evaluate the efficacy and safety of the lateral supraorbital approach for resection of orbital lesions.

PATIENTS AND METHODS: Ten patients with different orbital lesions were treated by this minimally invasive technique. The technique is described in details. The postoperative outcome was evaluated with casting light on the specific parameters related to this approach.

RESULTS: This study included 6 females and 4 males, ranging in age from 2 years to 65 years with mean age of 37.3 years. Proptosis was the most common presenting complaint. Six patients were operated on via the right supraorbital approach, and 4 patients via the left supraorbital approach. Various pathological lesions were treated. The excision was total in 7 patients, subtotal in 1 patient, and partial in 2 patients. Two patients suffered transient supraorbital hypothesia, 1 patient showed temporary superficial wound infection with CSF leak and 1 patient died within 6 months.

CONCLUSION: The lateral supraorbital approach is a minimally invasive approach that provides excellent exposure of the superior, lateral, and medial orbit, as well as the orbital apex.

Key words
- Approaches to the orbit
- Eyebrow incision
- Supraorbital approach

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
CT: Computed tomography
F: Female
M: Male
MRI: Magnetic resonance imaging

INTRODUCTION

The small, circumscribed orbit is an integral part of the skull base containing delicate structures essential for the function of vision and freely communicates with the intracranial compartment through the optic foramen and the superior orbital fissure, relating the orbit closely to the cavernous sinus (19).

Orbital lesions can be divided schematically into primary lesions, originating from the orbit itself; secondary lesions extending to the orbit from neighboring structures; and metastatic lesions from distant structures (7).

The earliest reports of surgery for orbital lesions involved approaches directed through the lateral wall of the orbit (21). The first report of a transcranial approach to the orbit was published by Dandy (2). Since then, both extracranial and intracranial routes to orbital lesions have been developed (1, 4, 10, 18, 23, 25). Most require bone removal through orbitotomies and/or craniotomies. The lateral supraorbital approach was proposed as a good alternative for treatment of orbital lesions.

PATIENTS AND METHODS

Ten cases operated on with the lateral supraorbital approach were selected among patients with orbital tumors admitted to Banha University Hospital between 2011 and 2014. Information on clinical manifestation, histopathology, surgical approach, and outcome was obtained retrospectively by review of the patient charts and radiological reports. Follow-up was available from 6–24 months. One patient with metastasis orbital lesion died after 6 months.

SURGICAL TECHNIQUE

The patient is placed in a supine position with the head fixed in a Mayfield head holder, elevated 15 degrees and rotated 15 degrees to the contralateral side. The skin incisions is made in the eyebrow...
and extends from the supraorbital notch to the lateral aspect of the brow holding the scalp in an oblique position parallel to the hair follicles to avoid cutting directly across the hair follicles. The frontal skin flap is dissected subcutaneously upward and retracted with temporary stitches. The frontal muscle is incised and retracted upward, and the temporal muscle is stripped from its bony insertion and retracted laterally. The frontal and orbicular muscles should gently be pushed downwards to the orbit. The pericranium is reflected downward with the base at the orbital rim, thereby maintaining continuity with the periorbita. The supraorbital nerve is dissected, and the periorbita is exposed. A single piece fronto-orbital craniotomy is fashioned with the following limits: A. medial line, formed by the supraorbital foramen; B. lateral line, formed by the frontozygomatic suture; C. lower limit, formed of the orbital arch and anterior part of the orbital roof; and D. superior margin, 3 cm above the orbital margin. Two small burr holes are made by the cutting burr of the drill, one just lateral to the medial line and the other just medial to the lateral line. Then the saw of the craniotome is used (after dissection of the dura from the inner table of the skull by a small dissector through the two burr holes) to cut the frontal bone 3 cm above the orbital rim and passed carefully through the medial burr hole to cut the orbital from medial to lateral as posterior as possible with meticulous retraction of the skin and muscle flap. Care should be taken to avoid falling down of the bone flap (Figure 1).

If the frontal air sinus is violated, the sinus mucosa is stripped away and the space packed with Gelfoam soaked with antibiotic. Next, the defect leading to the sinus cavity is plugged with a small piece of temporal muscle. All instruments used in this step are separated and not used anymore in the operation.

A spatula connected to a self-retaining retractor system is gently applied to the basal surface of the exposed frontal dura. If necessary, additional parts of the posterior orbital roof may be rongeured off, including unroofing of the optic canal for tumors that involve it. Finally, exposure and standard microsurgical technique is carried out either purely intraorbital or orbitocranial, intradural or extradural and intracranal or extraconal. After finishing the surgical job, the defects (e.g., periorbita, dura) are repaired. The bone fragments obtained from excision of the roof are sandwiched between two small sheets of Gelfoam and used for reconstruction of the orbital roof. We found this method of reconstruction simple, cheap, and more anatomic, and it resulted in no postoperative complications (Figure 2). The bone flap usually fits in place if the edges are beveled and secured with sutures. The reflected pericranium is sutured, and it also assists in holding the bone flap in place. The subcutaneous layer is closed with interrupted sutures. A small suction drain is placed for 1 day, and the skin is closed in a subcuticular fashion.

RESULTS

Four patients were males, and 6 were females. The ages ranged from 2 to 65 with a mean age of 37.3 years. At admission, proptosis was the most frequent presentation in 9 patients, followed by visual manifestations in 5 patients, disturbed eye movement in 4 patients, ocular pain in 3 patients, and excessive...
tearing and lid swelling in 2 patients. The duration of symptoms ranged from 1 month to 24 months. The mean duration was 6.9 months.

The lesion was on the right side in 6 patients and on the left side in 4 patients. Six lesions were intraorbital (4 extraconal and 2 intraconal), and 4 lesions were intracranial with intraorbital extension (Table 1).

In one patient in whom the frontal air sinus was violated, the sinus mucosa was removed with obliteration of its cavity. There were no other significant intraoperative events. The excision was graded as total achieved in 7 patients, subtotal (≥70% was removed) achieved in 1 patient, and partial (<70% was removed including biopsy) achieved in 2 patients (Table 2).

At follow-up, none of the patients deteriorated and 1 patient died as a result of progression of systemic hepatic cancer with multiple secondaries. Symptoms did not improve in 2 patients. Seven patients showed improvement of preoperative symptoms without additional deficits. The patients were doing well in their activities and cosmetically satisfied.

Eyebrow elevation was lost early in all patients but subsided during follow-up visits in all patients. Transient periorbital edema occurs in all patients and was maximally resolved by the end of the first week. Supraorbital hypoaesthesia was evident in 2 patients and resolved by the second postoperative month. During the follow-up period 1 patient showed superficial wound infection and CSF leak that decreased gradually and finally stopped under conservative treatment. No cosmetic problems were recorded, and no frontal or temporal muscle wasting occurred.

Case 4
A male patient aged 12 years presented with left proptosis. General, neurologic, and ophthalmologic examination revealed no abnormality. Computed tomography (CT) and magnetic resonance imaging (MRI) showed a round cystic lesion in the left greater sphenoid wing with an intraorbital extraconal soft tissue component. This lesion was hypointense in T1 hyperintense in T2. Postcontrast studies showed heterogeneous enhancement in the soft tissue component and marginal enhancement in the cystic component (Figure 3).

The patient was operated on via the left supraorbital approach. The lesion consisted of necrotic material and purulent fluid, and the dura was thickened. It was attached to the orbital roof, which was thickened. The lesion was totally removed. Pathological examination showed nonspecific granuloma, and culture showed no growth. A subcutaneous drain was inserted. In the early postoperative period the patient had difficulty in elevating the eyebrow and periorbital edema, which subsided during follow-up. On discharge a 6-week antibiotic course was advised.

Postoperative clinical follow-up indicated that the proptosis improved and the incision healed by primary intention and was not visible. Postoperative radiological follow-up indicated total excision of the lesion (Figure 4). The patient was reassessed again with the last assessment 1 year after the operation and was clinically stable.

<table>
<thead>
<tr>
<th>Case</th>
<th>Extent of Resection</th>
<th>Histopathology</th>
<th>Complications</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total</td>
<td>Venous malformation</td>
<td>None</td>
<td>Improved</td>
</tr>
<tr>
<td>2</td>
<td>Total</td>
<td>Cavernous hemangioma</td>
<td>None</td>
<td>Improved</td>
</tr>
<tr>
<td>3</td>
<td>Total</td>
<td>Dermoid cyst</td>
<td>None</td>
<td>Improved</td>
</tr>
<tr>
<td>4</td>
<td>Total</td>
<td>Nonspecific granuloma</td>
<td>None</td>
<td>Improved</td>
</tr>
<tr>
<td>5</td>
<td>Total</td>
<td>Dermoid cyst</td>
<td>Supraorbital hypoaesthesia</td>
<td>Improved</td>
</tr>
<tr>
<td>6</td>
<td>Subtotal</td>
<td>Epidermoid</td>
<td>Supraorbital hypoaesthesia</td>
<td>Not improved</td>
</tr>
<tr>
<td>7</td>
<td>Total</td>
<td>Meningioma</td>
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<td>Improved</td>
</tr>
<tr>
<td>8</td>
<td>Partial</td>
<td>Plexiform neurofibroma</td>
<td>Wound infection and cerebrospinal fluid fistula</td>
<td>Not improved</td>
</tr>
<tr>
<td>9</td>
<td>Partial</td>
<td>Metastasis</td>
<td>None</td>
<td>Died within 6 months</td>
</tr>
<tr>
<td>10</td>
<td>Total</td>
<td>Pleomorphic adenoma</td>
<td>None</td>
<td>Improved</td>
</tr>
</tbody>
</table>
Case 5
A 13-year-old girl presented with proptosis of her left eye. A CT scan showed a retrobulbar mass with erosion of the bony orbit that was confirmed by MRI. The lesion was totally excised via left lateral supraorbital approach. Pathological examination of the mass revealed a dermoid cyst. Postoperative MRI confirmed total excision (Figure 5). Proptosis improved, and the eyebrow scar was cosmetically accepted on follow-up visits (Figure 6).

DISCUSSION
The presence of the periorbita allows classifying the orbital lesions into intradural (deep to the periorbita) and extradural (between the periorbita and the bony orbit) (24). On the basis of the relationship to the muscle cone (the extraocular rectus muscles and their intermuscular septae), the orbit divides into intracanal and extracanal spaces. Although the intracanal lesions are always intradural, the extracanal lesion can be either intradural or extradural (24). The intracanalicular lesions refer to those lesions lying at least partially within the optic canal (31).

This understanding is paramount in classifying the orbital lesions and selecting the best approach providing good exposure of anatomic structures, preserving their function, and providing good cosmetic results (22).

There are 2 major types of surgical approaches to the orbit: transorbital approaches mainly for anterior lesions and extraorbital or transcranial approaches mainly for posterior lesions and lesions of the periorbita (2, 4, 22). This distinction is not absolute because some posterior lesions can be approached via extended or combined transorbital approaches, and lesions of the middle third of the orbit are easily accessible via the extraorbital approaches (2).

The choice of approach depends on the location, size, demarcation, vascularity, characteristics of the tumor, probable pathology anticipated (7, 23, 32), and goal of surgery (biopsy for confirmation of a diagnosis, debulking of diffusely infiltrating processes, or gross total excision of well-circumscribed lesions) (33). Modern diagnostic methods including angiography, ultrasonography, CT, and MRJ have been used to define these criteria (7).

A transcranial approach is preferable for processes extending into the cranial cavity or located in the optic canal or superior orbital fissure (30, 31). A classic pterional approach is standard and is used for orbital apex tumors as well (32). An exclusively extradural pterional approach can be used to decompress the optic nerve in the optic canal and superior orbital fissure, as well as for tumor biopsy or resection (13). Processes located exclusively within the orbit can be reached by a wide variety of relatively noninvasive extracranial approaches, including lateral...
orbitotomy (3), transthyroidal (16, 21, 26), transconjunctival (11-15), and frontal-sinusoidal approaches (20). The supraorbital approach occupies an intermediate position between the extracranial and transcranial approaches (30).

The earliest description of a supraorbital approach via a bicoronal flap, a burr hole behind the zygomatic process with detached temporal muscle, was by Jane et al. in 1982 (18). This approach was modified fracturing the orbital roof (8) or including a temporal extension of the craniotomy (9). The inferior extension of the supraorbital craniotomy by removal of the orbital rim was also described using an alternative technique with two bone flaps (10). Maus and Goldman used a transorbital craniotomy through an approach above the eyebrow to remove a hemangioma of the orbital apex (25). The current supraorbital approach is comparable with this approach but less extensive in bone removal. It is a miniaturized version of the classic pterional approach and represents its subfrontal portion (5). The fundamental philosophy of this minimally invasive approach is to operate with a minimum of iatrogenic traumatization and to achieve a maximum efficient neurosurgical therapy (29).

Removing part of the frontal bone and orbital roof as a single piece allows wide access to the orbit. The superior, lateral, and medial orbit is clearly visualized, as well as the orbital apex. Exposure of orbital tumors is achieved with minimal intracranial exposure and no brain retraction. The orbital roof can be removed to the superior orbital fissure and anterior clinoid, allowing decompression of the optic nerve (25).

The supraorbital approach has major advantages. The short skin incision is later hidden by the eyebrow with better cosmetic results; there is less risk of injury to the neurovascular structures supplying the temporal and frontal regions avoiding muscle wasting; there are significant reductions in approach-related surgical morbidity, which allows early physical recovery and short hospital stay; and the resection of the upper supraorbital rim creates a focused surgical corridor, so brain and orbital manipulations are minimized (17, 27, 28, 33).

![Figure 5](A) Magnetic resonance imaging (MRI) showing left retrobulbar mass. (B) Postoperative MRI revealing no residual tumor tissue.

![Figure 6](A) Immediate postoperative scar. (B) Three-month postoperative scar.
Complications related to the supraorbital approach may be frontal hypoesthesia due to injury or compression of the supraorbital nerve, which usually recovers; lost eyebrow elevation, which is usually temporary; rhinorrhea, which may develop when the frontal air sinus is opened and thus should be well packed and secured; cosmetic problems (e.g., eyebrow alopecia, visible scar or bone defects); and limited exposure of pericranium, which restricts the use of a pericranial graft (5, 6, 17, 27-29).

The major limitation of this approach is that it can never be a standard approach for all lesions, so the craniotomy must be evaluated to cope with the type, extent, and size of the lesion, especially those with an intracranial component, in order for the goal to be achieved (17). Extensive frontal sinuses are a limitation, especially with a small pericranial flap done in this approach. In these cases a mixture between a lateral and a supraorbital craniotomy may be performed or the classical pterional craniotomy may be used (33).

CONCLUSION

The lateral supraorbital approach is a mixed transorbital-transcranial, minimally invasive cosmetic approach that provides excellent exposure of the superior, lateral, and medial orbit, as well as the orbital apex. This approach cannot be used for all orbital pathologies but is recommended as a golden option for many orbital lesions.