Lateral Orbital Rim Osteotomy in the Treatment of Certain Skull Base Lesions

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ABSTRACT

Quantitative data from a recent human cadaveric study suggested that removal of the lateral orbital rim alone may be sufficient to reach many targets for which the orbitozygomatic craniotomy has been used. Consequently, a lateral orbital rim osteotomy was substituted for an orbitozygomatic craniotomy in seven patients with a variety of pathologies located in the anterior, middle, and interpenduncular fossae. In each case, lateral orbitotomy provided a satisfactory surgical corridor for diagnosis and treatment. Compared with the orbitozygomatic craniotomy, the lateral orbital rim osteotomy offers several advantages: technical simplicity, shorter operating time, and a low risk of postoperative malocclusion. If, however, prolonged access to a wide expanse of the anterior portion of the middle fossa and inferotemporal area is needed, an orbitozygomatic approach is a better choice.

KEYWORDS: Basilar apex, cavernous sinus, orbital lesion, surgical technique

The frontotemporosphenoidal craniotomy provides access to many structures of the anterior, middle, and interpenduncular fossae.^{1,2} Nevertheless, the associated surgical corridor is both long and narrow. To remedy this problem, various skull base procedures have been devised to disarticulate the orbit³⁻¹⁰ and zygoma.¹⁰⁻¹⁶ In this way, bone removal rather than brain retraction provides the means to create a shallow and wide surgical path.

Of the related skull base approaches, the orbitozygomatic osteotomy is perhaps the best known and most popularized. Certain quantitative measurements have documented an increased field-angle view from a variety of trajectories when the addition of orbitozygomatic bone is removed.^{17,18} Findings from a recent study using human cadavers suggested that removal of the lateral orbital rim alone may be sufficient to reach many of these

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same targets for which the orbitozygomatic craniotomy has been used.¹⁹ In this study, the lateral orbital rim osteotomy was substituted for the orbitozygomatic craniotomy to treat certain lesions. This article presents our initial observations.

SURGICAL TECHNIQUE

Our procedure (Fig. 1) is not unique and draws heavily on the descriptions of others^{6,10,20,21}; modifications are detailed below. The head is turned 45 degrees to the opposite side, and the vertex is tilted downward 10 to 15 degrees. Depending on the patient's hairline, either a standard pterional incision (broken line in Fig. 1A) is made or a modified bicoronal incision (solid line in Fig. 1A) is used. The scalp is incised down to the pericranium and temporalis fascia and is reflected anteriorly (Fig. 1B). The pericranium is incised, left attached, and reflected anteriorly (Fig. 1B). The superficial and deep fat pads are split, and the scalp is elevated to expose the orbit, lateral orbital rim, and a portion of the zygoma. The pericranium is incised along the lateral orbital rim and adjacent zygoma, and a cuff of temporalis fascia is left attached. The temporalis muscle is elevated (Fig. 1B).

A single craniotomy can be performed, but bone often is removed in two steps. First, a trephine is placed in the "keyhole." A second, optional trephine is made posteriorly and inferiorly to the superior temporal line. A free bone plate then is turned (Fig. 1C). The lateral orbit is scored medially, lateral to the supraorbital notch and laterally just medial to the junction between the lateral orbit and the zygoma (Fig. 1D). Holes for miniplate attachment are drilled, screws are placed (Fig. 1D), one of the screws is removed, and the miniplate is swung from the field (Fig. 1E). The back wall of the orbit is dissected free, and the lateral orbital rim is released by cuts with a fine drill bit and osteotome and removed (Fig. 1E). The sphenoid

wing is removed until it is flat (Fig. 1E). Additional bone removal is tailored based on the target.

After the procedure is completed, the lateral orbital rim and bone plate are reattached (Fig. 1F). A piece of titanium mesh is shaped to fit the bone defect and held in place with screws (Fig. 1F). Bone chips mixed with fibrin glue²² are placed over the mesh and other cranial defects. The incision is closed in anatomic layers. A subgaleal drain is placed and removed the next day.

CLINICAL MATERIAL AND OUTCOMES

Seven patients (6 women, 1 man) underwent lateral orbital rim osteotomy in conjunction with a standard frontotemporosphenoidal craniotomy at University Hospitals (Table 1). Clinically, each patient was symptomatic, had experienced growth of the lesion, or both.

In patients 1 and 3, the goal of surgery was to decrease the size of the tumor to prepare for radiation therapy. In patient 2, the surgical goal was to remove the intradural component of the meningioma and to treat the cavernous sinus tumor with radiosurgery. Patient 4 underwent a planned biopsy only to obtain a clinical diagnosis.

Surgery in patient 6 was uneventful. She awoke with no new neurologic deficits. The next day, routine cranial computed tomography (CT) showed no new cerebral infarction. On the second postoperative day, she developed respiratory distress and was intubated. A mechanical malfunction of the ventilator caused a hypoxic insult coupled with intracranial hypertension, related to hypercarbia caused by apnea. Angiography was refused. Her recovery was incomplete.

In all patients, exposure of the target area in the orbit, cavernous sinus, or interpeduncular fossa was adequate. In no case was it considered that removal of the zygoma would have affected an outcome. None of the complications were caused by

Figure 1 Schematic drawing of lateral orbital rim osteotomy. See text for description of technique.

Table 1 Clinical Summary of Seven Patients Undergoing Lateral Orbital Rim Osteotomy

Case No.	Sex	Age (yr)	Clinical Presentation	Site (R/L)	Lesion Size (cm)	Pathology	Extent Resection	Outcome
1	F	59	Light perception only in OD	AF + MF (R)	3.6 × 4.5 × 4.5	Meningioma	Subtotal	No change
2	F	52	Headache, ↓ visual acuity with central scotoma	CS + MF (R)	3.5 × 1.8 × 2.0	Meningioma	Intradural complete, CS—no change	↓ Visual acuity, ↑ central scotoma
3	F	70	Headache, tumor growth	Sph W (R)	4.5 × 4.2 × 3.5	Meningioma	Subtotal	Mild ↓ in mentation
4	M	30	↓ Visual acuity, afferent pupillary defect, III and VI n palsy	SOF (L)	1.0 × 0.3 × 1.5	Granuloma	Biopsy	No change
5	F	46	Optic atrophy, ↓ visual acuity, afferent pupillary defect, lesion growth	CS (L)	1.5 × 1.2 × 2.0	CM	Total	No change in vision, incomplete ophthalmoplegia, V, hypesthesia
6	F	40	SAH, H-H III, L III n palsy	IP F (L)	1.0	BA-SCA aneurysm	Angio refused	No change in L III n palsy, mild R hemiparesis and dysphasia, independent at home
7	F	41	Headache	IP F	1.0	BA-apex aneurysm	2–3 mm remnant	No change

AF, anterior fossa; BA, basilar artery; CM, cavernous malformation; CS, cavernous sinus; F, female; H-H III, Hunt-Hess Grade III; IP F, interpeduncular fossa; L, left; M, male; MF, middle fossa; n, nerve; No., number; OD, right eye; R, right; SAH, subarachnoid hemorrhage; SOF, superior orbital fissure; Sph W, sphenoid wing; SCA, superior cerebellar artery; III, oculomotor; VI, abducens; ↑, increased; ↓, decreased

retractor injury or technical inadequacies related to the surgical approach.

ILLUSTRATIVE CASES

Case 5

A 46-year-old right-handed woman was evaluated because her left cavernous sinus lesion had enlarged (Fig. 2A,B) and vision in her left eye had declined. About 8 years earlier, she had undergone a left frontotemporal craniotomy. Significant

bleeding was encountered, and a biopsy was nondiagnostic. Postoperative angiography showed no vascular lesion. After surgery, she developed an incomplete right oculomotor palsy that resolved.

Initially, the patient was evaluated for radiosurgery and then was referred for surgery. On examination, she had an afferent pupillary defect. Her visual acuity was 20/70; optic disc pallor was noted on the left side.

The patient underwent a lateral orbitotomy in conjunction with a left frontotemporal craniotomy. The sphenoid wing was removed, and an extradural partial anterior clinoidectomy was performed. The cervical carotid vessels were exposed.

Figure 2 Cavernous malformation of the cavernous sinus. Preoperative axial magnetic resonance images (A) without (TR, 650 msec; TE, 14 msec) and (B) with (TR, 650 msec; TE, 9 msec) contrast illustrate a cavernous malformation (arrows) in the cavernous sinus. Similar axial images without (C) (TR, 500 msec; TE, 14 msec) and with (D) (TR, 450 msec; TE, 14 msec) contrast obtained 12 months after surgery confirm resection of the cavernous malformation.

After the optic canal roof, optic strut, and anterior clinoid were removed intradurally, a cavernous malformation was removed completely from the cavernous sinus using standard microsurgical technique. The oculomotor, trochlear, abducens, and V_1 nerves were identified and manipulated during surgery, but they were in anatomic continuity at the conclusion of the operation.

The patient awoke from surgery with complete ophthalmoplegia and analgesia in the left V_1 distribution. Otherwise, her 4-day hospitalization was uncomplicated. Postoperative magnetic resonance (MR) images obtained 2 and 12 months

(Fig. 2C,D) after surgery confirmed complete resection of the cavernous malformation. By her last examination (12 months after surgery), she had returned to work. Her vision was unchanged, and her ophthalmoplegia and V_1 hypalgesia had recovered incompletely.

Case 7

A 41-year-old right-handed woman experienced an apoplectic headache associated with nausea and vomiting. A brain MR imaging study obtained

Figure 3 Basilar apex aneurysm. Preoperative anteroposterior (A) and lateral (B) left vertebral angiograms show a moderately sized posteriorly projecting aneurysm of the basilar apex located well above the posterior clinoid (arrow in B). Postoperative anteroposterior (C) and lateral (D) angiograms show a small residual aneurysm. The trajectory of the aneurysm clip (D) was achieved because the lateral orbital wall was removed.

elsewhere suggested a basilar apex aneurysm that was confirmed on MR angiography and conventional cerebral arteriography. The 1-cm basilar apex aneurysm, which projected to the right posteriorly, was located more than 1 cm above the posterior clinoid (Fig. 3A,B).

The patient was transferred to University Hospital, where her examination was normal. She was thought to have experienced a warning leak. On the fourth day after transfer, she underwent a right lateral orbital rim osteotomy in conjunc-

tion with a frontotemporosphenoidal craniotomy. Her aneurysm was clipped in an uneventful procedure. She awoke with a complete right oculomotor palsy but otherwise sustained no new neurologic deficit. Routine CT showed no cerebral infarction. The remainder of her 4-day hospital stay was uneventful. She declined angiography during that hospitalization.

Two months later, angiography showed a small remnant (Fig. 3C,D), which was stable on angiography repeated 6 months later. Her right

oculomotor palsy recovered completely, and she has returned to work part-time. She elected to have her residual aneurysm followed with angiography.

DISCUSSION

In this series, a lateral orbitotomy was used in conjunction with a standard frontotemporosphenoidal craniotomy in place of an orbitozygomatic approach to reach various lesions in the anterior, middle, and interpeduncular fossae. In each case, disarticulation of the lateral orbital wall provided a satisfactory corridor for reaching these lesions (Table 1; Figs. 2 and 3). Others have used this approach for similar targets^{3,4,6} as well as for certain aneurysms of the anterior circulation,^{3,5,7,23} but it has not been used to reach the basilar apex.

Compared with orbitozygomatic osteotomy, lateral orbitotomy has several advantages. Technically, it is simpler. Hence, the operation is quick, and the potential for cosmetic deformities is lower. Malocclusion after either procedure is rare. Muscle-induced malocclusion related to masseter or temporalis muscle spasm²⁴ would be less likely after lateral orbitotomy compared with orbitozygomatic osteotomy because the more limited exposure of the lateral orbitotomy is associated with less manipulation of the jaw muscle. Although certain anterior portions of the middle fossa and the inferotemporal area can be accessed by a lateral orbitotomy, removal of the zygoma allows the temporalis muscle to be reflected completely. Thus, access to these areas is increased for the treatment of large lesions that require the prolonged retraction of contents of the middle fossa. For this type of pathology in the latter location, the orbitozygomatic craniotomy is preferred.

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AUTHOR'S NOTE

Since submission of this manuscript, 4 additional patients underwent lateral orbital rim removal in place of an orbitozygomatic craniotomy. These cases included a single patient with each of the following lesions: ruptured "true" posterior communicating artery aneurysm; ruptured basilar apex aneurysm; ruptured basilar superior cerebellar artery aneurysm; and lateral sphenoid wing meningioma. In all patients, exposure of the target area was adequate. In no instance was it thought that zygoma removal would have influenced outcome.

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