ORIGINAL CONTRIBUTION

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Contribution of the medial orbital floor to endoscopic orbital decompression*

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SUMMARY

Problem: *This study explores contribution of the orbital floor to mechanical outcomes of orbital decompressions.*
Method of Study: *Endoscopic medial wall orbital decompressions with and without extensive medial orbital floor removal (OFR) were performed on opposite sides of ten thawed fresh-frozen cadaver heads Bone removal was compared on pre- and post-dissection CT scans and after orbital exenteration.*
Results: *Bony removal in the anterior orbital apex was significantly better after OFR. An average of 10.3% of the orbital floor directly under the globe was removed with the OFR technique. The orbital floor preservation (OFP) technique resulted in average bone removal of 3.6 cm^2, whereas OFR decompression resulted in average of 5.7 cm^2. Post-operative recession of the globe was significant in both arms of the study relative to the unoperated state.*
Conclusions: *Endoscopic removal of the medial orbital floor when performed in addition to medial wall decompression removes > 60% more orbital bone and an additional 51° of orbital apex bone. Extensive endoscopic removal of the mid-portion of the medial orbital floor results in bone loss beneath the globe itself.*

Key words: endoscopic, cadaveric, orbital floor, decompression

INTRODUCTION

Orbital decompression is performed to relieve vision-threatening pressure on the orbit and to reduce exophthalmos caused by increased orbital volume. Endoscopic decompression techniques permit the safe removal of the medial orbital wall and the orbital floor medial to the infraorbital nerve under direct vision while preserving an anterior portion of orbital floor that functions to support the globe. These endoscopic techniques have been used successfully as stand-alone procedures or as part of balanced decompressions, which also remove the lateral orbital wall [1]. However, controversy surrounds the decision to remove the orbital floor as part of an endoscopic medial wall decompression [2,3]. Critics of orbital floor removal (OFR) cite evidence that its removal is often unnecessary, leads to hypoglobus [4] and increases the incidence of diplopia [5,6]. Proponents note that the orbital apex has the smallest cross-sectional area in the orbit and that neural decompression is limited when the orbital floor is preserved [4,7]. Extensive endoscopic decompression limited to the orbital apex has been shown to be effective in addressing dysthyroid optic neuropathy [8].

The purpose of this study is to quantify endoscopic orbital bone removal in the orbital apex and the position of the recessed globe in relation to the dissected orbital floor. Endoscopic orbital floor decompression has been noted to concentrate bone removal in the middle and posterior portions of the medial orbital floor and lead to only limited removal of the anterior bony floor [7]. Formal characterization of the bone removed by endoscopic orbital floor removal may prove useful in understanding the risks and benefits of this procedure.

MATERIALS AND METHODS

Procedures

Wilford Hall Medical Center Institutional Review Board (Lackland AFB, TX, USA) approval was obtained prior to beginning the study. Twenty endoscopic orbital decompressions were performed on ten thawed fresh-frozen cadaver heads using standard FESS instruments, zero and thirty degree Hopkins II endoscopes and a videotower. In this prospective,

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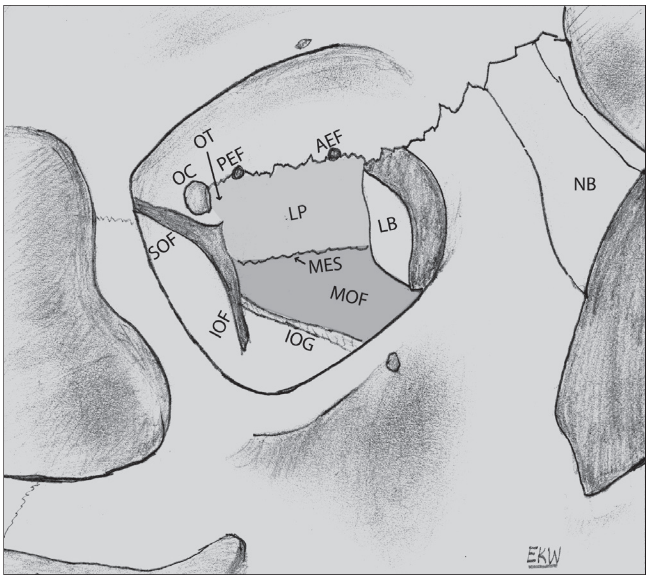

Figure 1. Right orbit demonstrating lamina papyracea (LP) which is removed in the orbital floor preservation technique (OFP). The medial orbital floor (MOF) is additionally removed during orbital floor removal technique (OFR).

Figure 2. Post-dissection cadaver displaying both techniques. Dotted black lines approximate the orbital apex as a circle. Dashed black radial lines mark the sector of the apex that has been decompressed.

case-controlled study, each head served as its own control. Total ethmoidectomy, sphenoidotomy, complete frontal dissection, and wide middle meatal antrostomy were performed on each side of all heads. For the orbital floor preservation (OFP) sides, the lamina papyracea was removed from the posterior lacrimal crest anteriorly to the optic tubercle posteriorly, and from the maxilloethmoid suture inferiorly to the skull base superiorly. For the OFR sides, in addition to the bone removed during OFP dissection, the medial component of the orbital floor was removed medially to the infraorbital nerve as completely as the anatomy would permit (Figure 1). In the anterior direction, endoscopic access is limited by the lacrimal crest. Thus, the anterior third of the orbital floor is generally retained after dissection. A small antero-superior region of lamina papyracea was retained in all specimens to keep the frontal sinus outflow tract unobstructed [(9)]. Orbital periosteum was incised at 3 mm intervals with cross-hatching to obtain maximal prolapse of orbital fat.

Analysis

Pre-dissection and post-dissection 1 mm direct axial CT scans of the sinuses were performed with coronal and sagittal reconstructions. Three dimensional multi-planar reconstructions were performed on the DICOM data using OsiriX 3.5.1 software (http://www.osirix-viewer.com/). All statistics were determined with an alpha of 0.05 and a 95% confidence interval. Comparison analyses were computed using a paired 2-tailed Student's t-test.

Orbital apex decompression

Rene states that, "The orbital apex provides the route of communication between the intracranial cavity and the orbit via the superior orbital fissure and the optic foramen. The posterior part of the inferior orbital fissure and its connections with the pterygopalatine ganglion also occupies the orbital apex" [(10)]. For this study, the anterior-most portion of the orbital apex was considered key for analysis since the optic nerve remains intraconal and Graves' related extraocular muscle congestion transmits significant pressure on the nerve in this region. The measurement was performed in the coronal plane immediately posterior to where the infraorbital nerve enters the infraorbital fissure. To geometrically measure this, the orbital apex was modeled as a circle. The arc of bony removal was then measured (Figure 2).

Anterior bony removal

The Frankfurt horizontal was established on sagittal CT by defining a line from the superior aspect of the inferior orbital rim to the superior external auditory canal. The coronal plane of the CT was reconstructed along a plane running orthogonal to the Frankfurt Horizontal using the 3D multiplanar reconstruction capability of OsiriX. The length of bone removed directly under the globe was then determined on a slice by slice basis. The measured segmental defects were then used to calculate the total area of bone removal by trapezoidal rule numerical integration (Figure 3).

Total area of bone removed

Following endoscopic decompression, the orbits were exenterated and orbital walls directly analyzed. Bone removal was established by measuring the cross-sectional area of orbital bone removal. Length and width of the bony defect in each orbit was measured with a ruler and the area of the resulting trapezoidal defects were calculated using the base and height

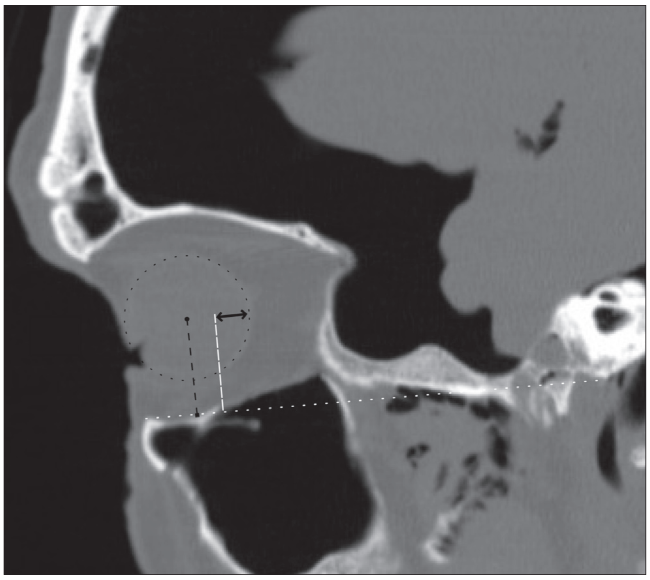

Figure 3. Anterior floor remaining after endoscopic orbital floor resection in relation to Frankfurt Horizontal (dotted white line). Although bone remains directly under the center of globe (dashed black line), the black arrow demonstrates the degree to which bone has been removed under part of the globe.

measurements (1/2 × h × [b1 + b2]).

Globe recession

On axial CT cuts, measurements were taken from the optic tubercle to the center point of the optic nerve attachment to the globe. Pre-dissection distance was compared to post-dissection distance to determine total axial displacement.

RESULTS

Orbital apex decompression

The OFP technique resulted in mean bone removal of 66.7° of the total circumference of the orbital apex compared to 117.3° with the OFR technique ($p < 0.0001$).

Anterior bony removal

On average, 10.3% ± 10.1% (range 0%-45.5%) of the bone directly underlying the post-dissection resting position of the globe was removed on OFR sides. One cadaver was excluded from this analysis due to premature orbital exenteration prior to post-dissection scanning.

Total area of bone removal

The OFP technique resulted in average bone removal of 3.615 cm^2, whereas the OFR technique resulted in average bone removal of 5.665 cm^2. The difference was statistically significant (2.05 cm^2, $p = 0.0003$).

Globe recession

Post-dissection recession of the globe was significant in both arms of the study. On OFP sides, mean axial retrograde displacement of 2.99 mm was achieved ($p = 0.001$). On OFR sides, 4.25 mm of retrograde displacement was achieved ($p = 0.02$). The difference in axial decompression between OFP and OFR sides was not statistically significant.

DISCUSSION

Resection of the medial orbital floor as part of endoscopic orbital decompression is controversial. Advantages include improved neural decompression in the orbital apex region relative to removal of the lamina papyracea alone [11]. However, aggressive removal of the mid-portion of the medial orbital floor is reported to be associated with an increased risk of hypoglobus and diplopia [4-6]. The purpose of this study is to quantify important indices of bone removal during endoscopic orbital decompression in order to provide more objective data to better frame the current debate.

We found bone removal was significantly greater in the orbital apex when the medial orbital floor was removed (117.3° vs. 66.7°, $p < 0.0001$). Additionally, we found a greater total area of bone removal when the orbital floor removal was added to medial wall decompression (3.615 cm^2 vs. 5.665 cm^2, $p = 0.0003$). Finally, despite the endoscopic technique retaining a large portion of anterior orbital floor, we found that 6 out of the 9 recessed globes showed absence of at least a small amount of bone directly under the globe in relation to the Frankfurt Horizontal with the OFR technique. This is a novel finding within the English language literature and merits further study in living patients.

Significant limitations exist regarding the application of results from cadaveric studies on the orbit to patient populations. Freeze/thaw cycles change viscoelastic properties of soft tissue [12]. Additionally, post-recession position of the globe depends partly on inflammation and scarring, neither of which can be assessed in this model. Despite these limitations, these data do warrant additional study in a cohort of patients. If recapitulated, this finding may justify exploration of less aggressive medial floor resection in an anterior direction.

REFERENCES

1. Shepard KG, Levin PS, Terris DJ. Balanced orbital decompression for Graves' ophthalmopathy. Laryngoscope 1998; 108: 1648-1653.
2. Kennedy DW, Goodstein ML, Miller NR, et al. Endoscopic transnasal orbital decompression. Arch Otolaryngol Head Neck Surg 1990;116: 275-282.
3. Koay B, Bates G, Elston J. Endoscopic orbital decompression for dysthyroid eye disease. J Laryngol Otol 1997; 111: 946-949.
4. Kim JW, Goldberg RA, Shorr N. The inferomedial orbital strut: an anatomic and radiographic study. Ophthal Plast Reconstr Surg 2002; 18: 355-364.
5. Goldberg RA, Shorr N, Cohen MS. The medical orbital strut in the prevention of postdecompression dystopia in dysthyroid ophthalmopathy. Ophthal Plast Reconstr Surg 1992; 8: 32-34.
6. Ulualp SO, Massaro BM, Toohill RJ. Course of proptosis in patients with Graves' disease after endoscopic orbital decompression. Laryngoscope 1999; 109: 1217-1222.
7. Wee DT, Carney AS, Thorpe M, et al. Endoscopic orbital decompression for Graves' ophthalmopathy. J Laryngol Otol 2002; 116: 6-9.
8. Chu ES, Miller NR, Lane AP. Selective endoscopic decompression

of the orbital apex for dysthyroid optic neuropathy. Laryngoscope 2009; 119: 5.
9. Wormald PJ. Endoscopic Sinus Surgery, 2nd ed. New York: Thieme Medical Pub; 2007. p. 432.
10. Rene C. Update on orbital anatomy. Eye 2006; 20: 1119-1129.
11. Michel O, Oberlander N, Neugebauer P, et al. Follow-up of transnasal orbital decompression in severe Graves' ophthalmopathy. Ophthalmology 2001; 108: 400-404.
12. Clavert P, Kempf JF, Bonnomet F, et al. Effects of freezing/thawing on the biomechanical properties of human tendons. Surg Radiol Anat 2001; 23: 259-262.

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