Minimally Invasive Orbital Decompression

Local Anesthesia and Hand-Carved Bone

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Objective: To investigate the safety and efficacy of a conservative orbital decompression using sharp-curette bony decompression and intraconal fat debulking through a transconjunctival incision in patients with thyroid-related orbitopathy and mild to moderate proptosis.

Design: Retrospective, noncomparative, interventional case series.

Participants and Methods: Data from all patients undergoing minimal orbital decompression at the Jules Stein Eye Institute, Los Angeles, Calif, over a period of 4 ¼ years were collected and analyzed. Data included visual acuity, exophthalmometry measurements, intraocular pressure, complete slitlamp examination results, ocular ductions, new-onset primary or downgaze diplopia, and patient satisfaction. Conservative decompression was performed through a transconjunctival incision using a manual curette and by removing cortical bone from the zygomatic marrow space on the anterior rim of the inferior orbital fissure; intraconal fat was bluntly dissected and excised or suctioned with a Frasier tip aspirator.

Main Outcome Measures: Patient perception of pressure pain and ocular discomfort, proptosis, visual acuity, intraocular pressure, postoperative complications, and new-onset primary or downgaze diplopia.

Results: Eighty minimally invasive orbital decompression surgeries were performed in 48 patients (6 male, 42 female). Six surgeries (4 patients) were performed for prominent globes with relative proptosis and no thyroid-related orbitopathy (non-Graves proptosis). All patients had improvement in congestive orbitopathy and pressure pain associated with thyroid-related orbitopathy. Exophthalmos decreased by a mean±SD of 2.4±2.6 mm from 22.7±2.5 mm (range, 17-29 mm) to 20.3±2.3 mm (range, 14-25 mm) (P<.001 [95% confidence interval, 1.8-3.0]). Mean visual acuity improved after surgery (P=.02). One patient (2.1%) developed postoperative primary or downgaze diplopia; he underwent successful eye muscle surgery at a later stage. No complications were associated with orbital decompression.

Conclusions: Minimally invasive orbital decompression surgery with intraconal fat debulking in this group of patients was effective in proptosis reduction; improvement in subjective pressure pain and high patient satisfaction were noticed. Surgery was associated with a low rate (2.1%) of new-onset primary or downgaze diplopia. Proptosis reduction using a graded approach accounting for 4 mm of retrodisplacement was achieved.

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high surgical morbidity. This is greatly reduced with mod-

sis. In the past, orbital decompression was associated with
dislation either by bone or fat removal, thus reducing propto-
gery is to provide additional space for orbital tissue expan-
is reserved for moderate to severe TRO. The goal of sur-
formed in the noninflammatory phase of the disease and


morbidity. This is greatly reduced with modern orbital surgical techniques. Today, up to one third of
patients undergo operations for cosmetic indications to de-
crease disfiguring proptosis.14,15,17

Many of the patients with thyroid orbitopathy often have
a diffuse pressure pain and limitation of eye movements,
which are related to decreased venous outflow and orbital
congestion. These symptoms can be substantially disabling
and may respond well to orbital decompression, improving
venous outflow and relieving or ameliorating the congestive
symptoms.

Orbital decompression is individualized to each patient
according to the desired amount of proptosis reduction.
Bony decompression includes removing portions of the
orbital wall (floor, medial, and lateral walls)15,16,18-26; other
surgeons perform primarily intraconal fat removal.25,27

We have developed a graded approach to decompression that
is customized to the patient. For patients with congestive
orbitopathy and mild to moderate proptosis (2-4 mm of
anticipated retrodisplacement), we use a minimally inva-
sive approach that involves conservative bone expansion
using a sharp curette and removal of intraconal fat using
a suction cutting technique through a small conjunctival
incision. The surgery can be performed using sedation and
local anesthesia on an outpatient basis. The goal of this
study was to review in a retrospective fashion the results of
a consecutive series of surgeries.

Figure 1. The diploic space above the inferior orbital fissure typically widens
to form a large lake of diploe that can be carved out along the edge of the
inferior orbital fissure.

METHODS

This study is a retrospective, interventional case series. Medi-
cal records of all patients who underwent minimally invasive
hand-carved bony orbital and fat decompression for TRO at the
Jules Stein Eye Institute, Los Angeles, Calif, between January
1, 1999, and December 31, 2003, were reviewed. The study com-
plied with the policies of the local institutional review board.
Data regarding visual acuity, exophthalmometry measure-
ments, intraocular pressure (IOP), primary or downgaze stra-
bismus, clinical assessment of ocular motility, and patient sat-
isfaction were recorded and analyzed.

SURGICAL TECHNIQUE

The orbital surface of the zygomatic and maxillary bones was
exposed through an eyelid-crease incision or inferior fornix con-
junctival incision. Using a sharpened curette (2-4 mm in cup
size), cortical bone was removed from the lateral maxillary si-
nus roof and the zygomatic marrow space on the anterior rim
of the inferior orbital fissure (the “basin”19) (Figure 1). The
extent of bone removal was individualized according to the
degree of proptosis. In all patients, intraconal fat located
between the lateral and inferior rectus muscle was bluntly dis-
sected and excised or suctioned using a Frasier tip aspirator;
the volume of excised fat removed ranged from 1.5 to 3 mL3.

The suction technique is performed by gently teasing for-
ward the intraconal fat using Stevens tenotomy scissors in a blunt
spreading technique. Once the fat is released from the septae
of the intraconal space, it flows into the extraconal space. A
10F Frasier tip aspirator is used to suction the fat out of the
orbit, using sharp release of residual fibrous attachments with
the scissors. The suction technique allows gentle and efficient
removal of intraconal fat with decreased need for extensive
dissection. The surgeon excises the fat that flows into the ex-
traconal space, hence reducing the risk of nerve or muscle in-
yury. Bipolar cautery is used to obtain hemostasis.

STATISTICAL ANALYSIS

Statistical analysis was performed using a paired-samples t test
to evaluate preoperative and postoperative data such as visual
acuity, exophthalmometry measurements, IOP, and ocular duc-
tions measurements. Pearson bivariate correlation was used to
examine the influence of age, visual acuity, IOP, and extent of
exophthalmos on treatment outcome. A nonparametric Wil-
coxon Mann-Whitney U 2 independent-samples test was used to
compare different variables in patients with TRO and pa-
tients with prominent globes and no TRO undergoing mini-
mally invasive orbital decompression.

RESULTS

Eighty minimally invasive orbital decompression sur-
geries were performed on 48 patients (6 male, 42 fe-
male); all surgeries were performed by 1 of us (R.A.G.).
Data regarding patient demographics are summarized in
Table 1. Seventy-four surgeries were performed on pa-
tients with TRO and 6 surgeries (4 patients) on patients
with prominent globes with relative proptosis and no TRO.

After minimally invasive orbital decompression, exoph-
thalmometry measurements decreased a mean±SD of
2.4±2.6 mm from 22.7±2.5 mm (range, 17-29 mm) pre-
operatively to 20.3±2.3 mm (range, 14-25 mm) at the end of
follow-up ($P<$<.001 [95% confidence interval, 1.8-3.0]).

Postoperative medical record notes indicated that al-
most all patients reported improvement in pressure pain
and ocular discomfort after surgery. Although no specific
quality of life questionnaire was used, our anecdotal ex-

Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>TRO (n=74)</th>
<th>Prominent Globes (n=6)</th>
<th>Prominent Globes and TRO (n=2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>49±7</td>
<td>49±8</td>
<td>42±9</td>
</tr>
<tr>
<td>Gender</td>
<td>36 (53%)</td>
<td>4 (67%)</td>
<td>2 (100%)</td>
</tr>
<tr>
<td>Visual Acuity (LogMAR)</td>
<td>0.8±0.5</td>
<td>0.8±0.5</td>
<td>0.8±0.5</td>
</tr>
<tr>
<td>IOP (mm Hg)</td>
<td>14±3</td>
<td>14±3</td>
<td>14±3</td>
</tr>
<tr>
<td>Exophthalmometry Measurements</td>
<td>21.5±2.5</td>
<td>21.5±2.5</td>
<td>21.5±2.5</td>
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Experience is that patients were happy with surgical results and noticed functional as well as aesthetic improvement after minimally invasive decompression (Figure 2).

Mean visual acuity improved after surgery \( (P = .02) \) (Figure 3); IOP decreased a mean±SD of 0.6±3.1 mm Hg. Older patients had higher preoperative IOP in primary and upgaze diplopia \( (r = 0.7; P = .006 \text{ and } r = 0.9; P = .001, \text{ respectively, Pearson bivariate correlation}) \).

Eleven patients (23%) had preoperative primary or downgaze diplopia. Postoperatively, 7 patients (14.6%) had persistence of double vision and 4 patients (8.3%) had improvement in double vision to the point that single binocular vision was present in primary or downgaze diplopia. Only 1 patient without preoperative primary or downgaze diplopia developed new-onset primary or downgaze diplopia postoperatively (Table 2) (Figure 4). He underwent successful eye muscle surgery at a later stage.

Limitations in ocular ductions in all positions of gaze did not change significantly postoperatively; limitations in upgaze were most common. No correlation was found between degree of exophthalmos correction to change in extraocular motility after surgery. Field of binocular single vision increased postoperatively in upgaze and downgaze diplopia \( (P < .001, \text{ paired-samples } t \text{ test}) \).

Four patients underwent 6 minimally invasive orbital decompressions for prominent globes with relative proptosis; these patients were not diagnosed with TRO. These patients were older as compared with patients with TRO (mean±SD, 55±7 years vs 44±11.7 years; \( P = .01, \text{ Wilcoxon Mann-Whitney } U \text{ test} \) and showed no extraocular muscle motility disturbances prior to surgery \( (P = .005, \text{ Wilcoxon Mann-Whitney } U \text{ test}) \). They achieved similar exophthalmos reduction with surgery.

No severe complications of minimally invasive orbital decompression, such as vision loss, occurred.

Minimally invasive orbital decompression with intraconal fat debulking was associated with subjective improvement in pressure pain and congestive orbitopathy in the study group. Moderate reduction in proptosis was achieved and no severe complications occurred; only 1 patient (2.1%) developed new-onset primary or downgaze diplopia postoperatively.

There are many surgical options for orbital decompression. Multiple anatomical surfaces (medial, floor, and lateral wall) could be used with or without intraconal fat debulking.1,13,16,18,25,27 These anatomical areas can be approached through various surgical incisions, including...

### Table 1. Demographics of Study Population

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean ± SD (Range)†</th>
<th>( P ) Value‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, No. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>6 (12.5)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>42 (87.5)</td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>44.8 ± 11.8 (21-78)</td>
<td></td>
</tr>
<tr>
<td>Follow-up, mo</td>
<td>8.3 ± 5.2 (6-26)</td>
<td></td>
</tr>
<tr>
<td>Visual acuity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative, mean (range)</td>
<td>20/27 (20/15-20/800)</td>
<td>.02</td>
</tr>
<tr>
<td>Postoperative, mean (range)</td>
<td>20/25 (20/15-20/50)</td>
<td>.64</td>
</tr>
<tr>
<td>Intraocular pressure, mm Hg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>19.8 ± 4.3 (16-30)</td>
<td>.64</td>
</tr>
<tr>
<td>Postoperative</td>
<td>16.5 ± 3.5 (10-22)</td>
<td>.64</td>
</tr>
<tr>
<td>Proptosis, mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>22.7 ± 2.5 (17-29)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Postoperative</td>
<td>20.3 ± 2.3 (14-23)</td>
<td>.64</td>
</tr>
</tbody>
</table>

Abbreviation: NS, not significant.

*The study population consisted of 48 patients undergoing 80 procedures.
†Unless otherwise indicated.
‡Paired-samples \( t \) test.

### Table 2. Preoperative and Postoperative Primary or Downgaze Diplopia

<table>
<thead>
<tr>
<th>Group</th>
<th>No. (%) of Patients (N=48)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No preoperative or postoperative diplopia</td>
<td>36 (75)</td>
</tr>
<tr>
<td>No preoperative diplopia, postoperative diplopia</td>
<td>1 (2.1)</td>
</tr>
<tr>
<td>Preoperative diplopia, no postoperative diplopia</td>
<td>4 (8.3)</td>
</tr>
<tr>
<td>Preoperative diplopia and postoperative diplopia</td>
<td>7 (14.6)</td>
</tr>
</tbody>
</table>

Figure 2. A 54-year-old woman preoperatively (A and C) and 6 months postoperatively (B and D) after minimally invasive orbital decompression with correction of upper eyelid retraction.

Figure 3. Scattergram of preoperative and postoperative logMAR (logarithm of the minimal angle of resolution) of visual acuity in 48 patients undergoing minimally invasive orbital decompression at the Jules Stein Eye Institute, Los Angeles, Calif, in a 4-year period.

Figure 4. Log-probability graph of preoperative and postoperative logMAR visual acuity in 48 patients undergoing minimally invasive orbital decompression at the Jules Stein Eye Institute, Los Angeles, Calif, in a 4-year period.
endonasal. Surgery should always be individualized to the patient’s specific needs, and in cases where there is a choice of surgeries, the least invasive approach should be selected to reduce complications (which can include death, stroke, intracranial injury, vision loss, numbness, and paresthesia.) Variables that affect surgical decision making include the amount of desired proptosis reduction, bony and sinus anatomy, risk factors for surgical complications (including advancing age), and aesthetic goals based on facial configuration.

This series of patients did not have severe proptosis. However, proptosis is not the only problem associated with the orbital soft-tissue volume expansion that characterizes Graves ophthalmopathy. The increased soft-tissue volume leads to congestion of the orbit, producing symptoms such as vague pressure pain around the eye and temple and ocular discomfort even without frank proptosis or exposure keratopathy. From an aesthetic standpoint, there can be fullness of orbital fat, congestive edema, and increased suborbicularis oculli fat volume.

Although local eye symptoms and ocular discomfort may somewhat improve with topical treatment and with time, many patients experience vague pressure pain and headache that persists even after disease inactivity. The pressure pain is sometimes associated with eye movements or tasks requiring prolonged visual concentration. Patients with congestive orbitopathy, pressure pain, and periocular swelling can be substantially bothered by these symptoms. Many of these patients do not have severe proptosis. In these cases, the goal of surgery is directed toward reduction in orbital congestion and minimal reduction in proptosis (for example, 1-3 mm). Surgery for this group of patients should be designed to open the orbital fat septae and conservatively remove bone and fat to improve the congestive orbitopathy without excessive globe retrodisplacement. The techniques of hand-carved bony removal, combined with intraconal fat decompartmentalization and debulking, can accomplish these goals with a minimally invasive procedure often performed under sedation anesthesia. Interestingly, 4 patients in our study did not have TRO but had mild corneal exposure secondary to relative proptosis; these patients had similar improvement in ocular discomfort and in proptosis reduction.

In cases of severe TRO and optic neuropathy, orbital decompression is found to be an effective treatment. Orbital decompression frequently improves visual function and individual patients are satisfied with the long-term results. In mild to moderate disease, patient satisfaction may be more subjective and was found to be associated with young age and with surgeries performed mainly for cosmetic purposes. Relatively low mean age (44 years) may have contributed to high patient satisfaction in our study.

However, when surgery is performed primarily for cosmetic reasons, as in all cases of aesthetic surgery, patients may be less tolerant of adverse effects and complications of orbital decompression. Fatourechi et al reported a high rate (73%) of postoperative diplopia in patients who underwent transantral decompression for cosmetic purposes. A substantial percentage of the patients in their study underwent eye muscle surgery for symptomatic diplopia and eyelid retraction correction. A possible explanation for the high percentage of postoperative complications could be attributed to transantral decompression as a major orbital surgical undertaking. In addition, patients in the earlier mentioned study had more advanced TRO (proptosis had decreased a mean of 5.2 mm compared with only 2.4 mm in our study). Lyons and Rootman reported new-onset diplopia in 18% of patients who underwent orbital decompression for cosmetic indications. The minimally invasive technique presented in the current study achieves less decrease in proptosis (mean, 2.4 mm) and therefore less chance of developing new-onset diplopia. Postoperative new-onset symptomatic diplopia may occur in 0% to 70% of cases, depending on surgical approach and the amount of retrodisplacement of the globe. In a recent study, we found that patients who developed new-onset primary or downgaze diplopia after deep lateral-wall decompression achieved a greater decrease in proptosis (6 mm vs 3.1 mm) as compared with patients with no new-onset diplopia.

We recognize that a staged surgical rehabilitation for TRO reduces the total number of procedures needed. Some patients in our study underwent eyelid retraction surgery at the time of orbital decompression. Patients are counseled that additional stages of eyelid repositioning may be needed, but during follow-up, none of the patients who underwent concomitant eyelid surgery required additional eyelid repositioning surgery.

The major limitation of our study stems from using subjective measurements for evaluating patient satisfaction. Recently, a Graves ophthalmopathy quality of life questionnaire was developed in the Netherlands and has been proven to be an effective tool in evaluating the clinical importance of different treatment modalities in patients with TRO. However, we suggest that minimally invasive decompression was effective in treating pressure pain of congestive orbitopathy, and proptosis reduction of up to 4 mm can be achieved. A prospective study comparing different treatment modalities along with different decompression surgeries and using a more powerful tool, such as the Graves ophthalmopathy quality of life questionnaire, is required to accurately estimate the effectiveness of various surgical techniques. Treatment...
studies should take into account the individualized nature of surgical planning; not all patients with Graves disease are alike, and a “one size fits all” surgical approach should be discouraged.

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REFERENCES


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This paper reviewed the modern ideas on the subject and considered the toxins produced by intestinal decomposition; the relationship to certain diseases of the cornea, sclera, and uvea; the possible relationship to amblyopia and retrobulbar neuritis, acute and chronic.