Minimally Invasive Orbital Decompression

Local Anesthesia and Hand-Carved Bone

Guy J. Ben Simon, MD; Robert M. Schwarcz, MD; Ahmad M. Mansury, BS; Lillian Wang, BS; John D. McCann, MD, PhD; Robert A. Goldberg, MD

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 4.4 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.

Arch Ophthalmol. 2005;123:1671-1675

HYROID-RELATED ORBITOPATHY (TRO) is the most frequent extrathyroid manifestation of Graves disease. It is believed to be an autoimmune disorder, caused by autoreactive CD4 T lymphocytes recognizing a similar antigen to thyroid and orbital tissue, that infiltrates the orbital tissue and the perimysium of extraocular muscles. This immune-mediated inflammation causes increased production of glycosaminoglycans in the orbital tissue, edematous expansion of the extraocular muscles, and increased volume of the orbital tissue. In a later phase, cicatricial formation may occur, leading to irreversible changes in orbital connective tissue and extraocular muscles. Most of the patients with Graves disease have mild TRO that tends to improve spontaneously, and only 15% show deterioration of ophthalmopathy. Clinical manifestation includes a wide variety of signs and symptoms including subclinical involvement demonstrated only by computed tomographic scans or magnetic resonance images, mild pain or discomfort, eyelid retraction, and increased volume of the orbital tissue. In severe disease, optic neuropathy, marked proptosis with exposure keratopathy, eyelid edema, chemosis and conjunctival hyperemia, blurred vision, and diplopia from eye muscle involvement can ensue. Thus, TRO can be disfig-
Orbital decompression is effective to treat proptosis and congestion associated with TRO. It is usually performed in the noninflammatory phase of the disease and is reserved for moderate to severe TRO. The goal of surgery is to provide additional space for orbital tissue expansion either by bone or fat removal, thus reducing proptosis. In the past, orbital decompression was associated with high surgical morbidity. This is greatly reduced with modern orbital surgical techniques. Today, up to one third of patients undergo operations for cosmetic indications to decrease disfiguring proptosis.

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) to form a large lake of diploe that can be carved out along the edge of the inferior orbital fissure. The suction technique is performed by gently teasing for- 

**METHODS**

Data regarding patient demographics are summarized in Table 1. Seventy-four surgeries were performed on patients with TRO and 6 surgeries (4 patients) on patients with TRO undergoing minimally invasive orbital decompression. Eighty minimally invasive orbital decompression surgeries were performed on 48 patients (6 male, 42 female); all surgeries were performed by 1 of us (R.A.G.).

**STATUTORY 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 ductions measurements. Pearson bivariate correlation was used to examine the influence of age, visual acuity, IOP, and extent of exophtalmos on treatment outcome. A nonparametric Wilcoxon Mann-Whitney U 2 independent-samples test was used to compare different variables in patients with TRO and patients with prominent globes and no TRO undergoing minimally invasive orbital decompression.

**RESULTS**

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 complied with the policies of the local institutional review board. Data regarding visual acuity, exophthalmometry measurements, intraocular pressure (IOP), primary or downgaze strabismus, clinical assessment of ocular motility, and patient satisfaction 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 conjunctival incision. Using a sharpened curette (2-4 mm in cup size), cortical bone was removed from the lateral maxillary sinus roof and the zygomatic marrow space on the anterior rim of the inferior orbital fissure (the “basin”)(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 dissected and excised or suctioned using a Frasier tip aspirator; the volume of excised fat removed ranged from 1.5 to 3 mL.

The suction technique is performed by gently teasing forward 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 extraconal space, hence reducing the risk of nerve or muscle injury. Bipolar cautery is used to obtain hemostasis.
perience 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 and r = 0.9; P = .001, 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). 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 /H11021 .001, paired-samples t 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, Wilcoxon Mann-Whitney U test) and showed no extraocular muscle motility disturbances prior to surgery (P = .005, Wilcoxon Mann-Whitney U 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 intracranal 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 intracranal 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>
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<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>19.8 ± 4.3 (16-30)</td>
<td>.001</td>
</tr>
<tr>
<td>Preoperative</td>
<td>16.5 ± 3.5 (10-22)</td>
<td></td>
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<tr>
<td>Postoperative</td>
<td>22.7 ± 2.5 (17-29)</td>
<td></td>
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<tr>
<td>Proptosis, mm</td>
<td>20.3 ± 2.3 (14-23)</td>
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</tbody>
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Abbreviation: NS, not significant.
*The study population consisted of 48 patients undergoing 80 procedures.
†Unless otherwise indicated.
‡Paired-samples t test.
and ocular discomfort even without frank proptosis or symptoms such as vague pressure pain around the eye and temple. 

This series of patients did not have severe proptosis. However, proptosis is not the only problem associated with 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 oculi 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 intracanal 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. 

Figure 4. Number of patients with preoperative and postoperative primary or downgaze diplopia.

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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.

Submitted for Publication: September 8, 2004; final revision received December 22, 2004; accepted January 25, 2005.

Correspondence: Guy J. Ben Simon, MD, Jules Stein Eye Institute, 100 Stein Plaza, Los Angeles, CA 90095-7006 (guybensimon@gmail.com).

Financial Disclosure: None.

REFERENCES


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his 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.


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