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 4¼ 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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THYROID-RELATED ORBITOPATHY (TRO) is the most frequent extrathyroid manifestation of Graves disease.[1] 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.[1-6]

Most of the patients with Graves disease have mild TRO that tends to improve spontaneously, and only 15% show deterioration of ophthalmopathy.[7] 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 mild proptosis (2-4 mm). In its severe form, optic neuropathy, marked proptosis with exposure keratopathy, eyelid edema, chemosis and conjunctival hyperemia, blurred vision, and diplopia from eye muscle involvement can ensue.[8] Thus, TRO can be disfig-

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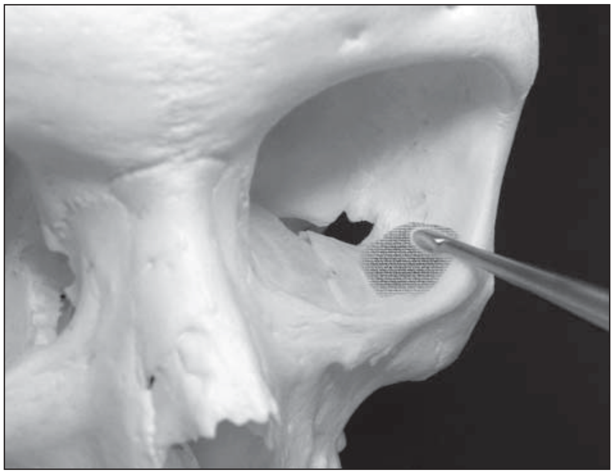

Figure 1. The diploic space above the inferior orbital fissure typically widens to form a large lake of diploe that can be carved out along the edge of the inferior orbital fissure.

uring and quite an invalidating disease that profoundly impairs the quality of life of the affected individuals.[9-11]

Orbital decompression is effective to treat proptosis and congestion associated with TRO.[9,10,12-16] 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.[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 invasive 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.

METHODS

This study is a retrospective, interventional case series. Medical 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 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"[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 dissected and excised or suctioned using a Frasier tip aspirator; the volume of excised fat removed ranged from 1.5 to 3 mL^3.

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.

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 ductions measurements. Pearson bivariate correlation was used to examine the influence of age, visual acuity, IOP, and extent of exophthalmos 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

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.). 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 prominent globes with relative proptosis and no TRO.

After minimally invasive orbital decompression, exophthalmometry measurements decreased a mean ± SD of 2.4 ± 2.6 mm from 22.7 ± 2.5 mm (range, 17-29 mm) preoperatively 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 almost 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. Demographics of Study Population*

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

Abbreviation: NS, not significant.
*The study population consisted of 48 patients undergoing 80 procedures.
†Unless otherwise indicated.
‡Paired-samples *t* test.

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.

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**) (**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 ($P<.001$, paired-samples *t* test).

Four patients underwent 6 minimally invasive orbital decompressions for prominent globes with relative

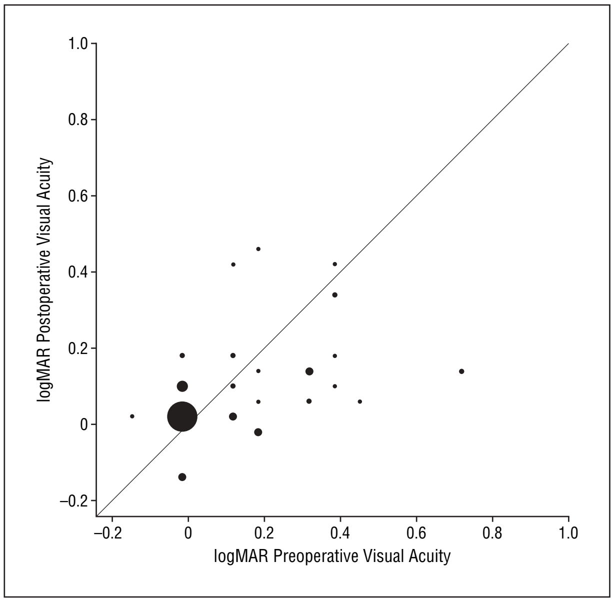

Figure 3. Scattergram of preoperative and postoperative logMAR (logarithm of the minimal angle of resolution) of visual acuity in 48 patients undergoing minimally invasive orbital decompression at the Jules Stein Eye Institute, Los Angeles, Calif, in a 4-year period.

Table 2. Preoperative and Postoperative Primary or Downgaze Diplopia

Group	No. (%) of Patients (N=48)
No preoperative or postoperative diplopia	36 (75)
No preoperative diplopia, postoperative diplopia	1 (2.1)
Preoperative diplopia, no postoperative diplopia	4 (8.3)
Preoperative diplopia and postoperative diplopia	7 (14.6)

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.

COMMENT

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.[1,15,16,18-25,27] These anatomical areas can be approached through various surgical incisions, including

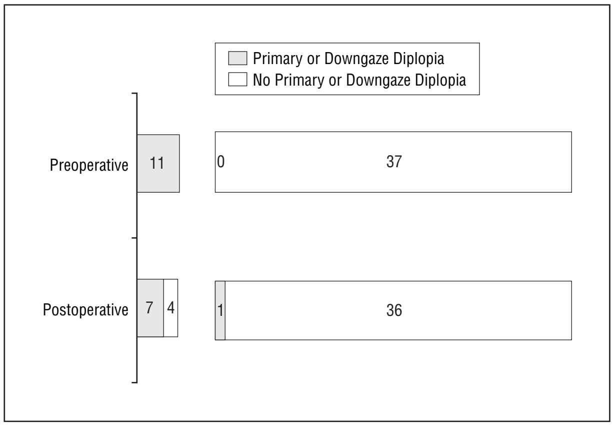

Figure 4. Number of patients with preoperative and postoperative primary or downgaze diplopia.

endonasal.[28] 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.[11,29] 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 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.[30] 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.[9] 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[31] 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[15] 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.[9] 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.[18,21-24,26,31-33] In a recent study,[33] 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.[34] 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.[11] 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,[10] 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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