Orbital Fat Decompression for Thyroid Eye Disease: Retrospective Case Review and Criteria for Optimal Case Selection

Marta Calsina Prat, M.D.*,†; Alexandra L. Braunstein, M.D.*, Lora R. Dagi Glass, M.D.*, and Michael Kazim, M.D.*

*Department of Ophthalmology, Columbia University Medical Center, New York-Presbyterian Hospital, New York, New York, U.S.A.; and †Oculoplastics and Orbital Surgery Service, Department of Ophthalmology, Hospital del Mar-Esperanza, Parc de Salut Mar, Universitat Autònoma de Barcelona, Barcelona, Spain

The purpose of this study is to identify the subgroups of thyroid eye disease (TED) patients most likely to benefit from orbital fat decompression.

Methods: This retrospective study reviews 217 orbits of 109 patients who underwent orbital fat decompression for proptosis secondary to thyroid eye disease. Charts were reviewed for demographic, radiographic, clinical, and surgical data. Three groups of patients were defined for the purposes of statistical analysis: those with proptosis secondary to expansion of the fat compartment (group I), those with proptosis secondary to enlargement of the extraocular muscles (group II), and those with proptosis secondary to enlargement of both fat and muscle (group III).

Results: Groups I and II, and those patients with greater preoperative proptosis and those with a history of radiation therapy, were most likely to benefit from orbital fat decompression. However, even those in group III or with lesser proptosis appreciated significant benefit.

Conclusions: While orbital fat decompression can and, at times, should be combined with bone decompression to treat proptosis resulting from thyroid eye disease, orbital fat decompression alone is associated with lower rates of surgical morbidity and is especially effective for group I and II patients, those with greater preoperative proptosis, and those with a history of radiation.

all 9 cardinal fields at near and at distance (performed for those patients reporting preoperative diplopia in primary or reading positions), surgical techniques (superior and inferior, inferior, transcutaneous, or transconjunctival approach), quantity of fat removed per orbit (ml) when available, and surgical complications including loss of vision, optic neuropathy, hemorrhage, diplopia, infection, poor wound healing, and reactivation. Fat removed was measured via displacement of saline in a 3-ml syringe. Three groups of patients were defined by qualitative analysis of CT/MRI. Group I demonstrated proptosis due to expansion of the fat compartment, with normal extraocular muscles (Fig. 1). Group II demonstrated exclusive enlargement of the extraocular muscles, defined as at least 3-fold enlargement in at least 3 muscles (Fig. 2). Group III demonstrated enlargement of both muscle and fat compartments, with muscle enlargement defined as at least 2-fold enlargement of at least 1 muscle (Fig. 3). Statistical analysis was performed using bivariate Student t test, one-way analysis of variance, bivariate χ² test, and Pearson correlation.

**Surgical Procedure.** Orbital fat decompression was performed under general anesthesia. Patients received preoperative intravenous antibiotics and corticosteroids, and postoperative intravenous antibiotics for 24 hours. Oral corticosteroids were continued for 5 to 7 days postoperatively to minimize swelling.

A lower eyelid transconjunctival approach was routinely taken, though 7% had a transcutaneous approach. In the rare cases where the lower eyelid was tightly opposed to the globe, a lateral canthotomy and inferior cantholysis were performed to facilitate access to the inferior fornix and the lateral orbital compartment. The conjunctiva and lower eyelid retractors were incised approximately 5 mm below the inferior border of the tarsal plate. The septum was opened with a unipolar needle-tipped cautery, and the underlying fat pads were identified. The intra- and extraconal fat was removed using malleable retractors to protect the lower eyelid and the globe. When hemostasis was assured, the conjunctiva was closed with two absorbable sutures. If a canthotomy and a cantholysis were performed, the canthal structures were repaired. On occasion, a concurrent superior approach was felt to be appropriate based on the presence of prolapsing orbital fat. In this approach, the superonasal fat pad was accessed through a eyelid crease incision limited to the nasal and one-third of the eyelid.

To measure the volume of fat removed, the specimen was placed in a 3-ml syringe partially filled with normal saline, and the volume of fat excised was estimated by the displacement of the saline. The volume of fat removed was routinely within 0.5 ml of symmetry bilaterally.

**RESULTS**

A total of 217 orbits of 109 patients with TED who underwent solely orbital fat decompression were reviewed.

One hundred eighty-four orbits (85%) were female and 33 (15%) were male. The average age was 44 years (range 15–73). Sixteen orbits of 154 patients with documented smoking patterns had a history of tobacco use (10%).

One hundred twenty-nine orbits (59%) were included in group I (fat expansion), 12 orbits (6%) in group II (muscle expansion), and 76 patients (35%) in group III (fat and muscle expansion).

Fifty-one patients had preoperative diplopia and therefore underwent formal motility measurements prior to surgery (47%).

Eighty-one orbits (37%) underwent 2-compartment orbital fat decompression (superior and inferior) and 136 (63%) underwent inferior orbital fat decompression alone.

Twenty-seven orbits (12%) received fractionated orbital radiotherapy to treat active TED prior to the stabilization of TED and ultimate surgery; these patients were equally divided between groups I, II, and III.

When the results were analyzed based on the preoperative assessment of soft-tissue expansion, the largest proptosis reduction was appreciated in group I (fat compartment expansion) and group III (both muscle and fat expansion) patients (mean 3.27 mm and 3.47 mm proptosis reduction, respectively). Less proptosis reduction was achieved in group II patients (enlargement of the extraocular muscles; mean 2.83 mm). See Table for preoperative and postoperative measurements according to group. One-way analysis of variance testing found no statistically significant differences between groups regarding proptosis reduction in millimeters.
Proptosis was reduced by an average of 3.1 mm in patients who underwent inferior decompression alone. In comparison, proptosis was reduced by an average of 3.63 mm in patients who underwent combined superior and inferior decompression. This difference was statistically significant ($p < 0.001$).

Positive Pearson correlation ($r = 0.51$, $p < 0.001$) was found between preoperative degree of proptosis and postoperative proptosis reduction (Fig. 4). It is notable that there was an approximately 1:1 ratio of fat removal (mean 3.2 ml) to difference in pre- and postoperative Hertel measurements (mean 3.3 mm) in the 35 patients in whom the amount of fat removed was quantified ($r = 0.42$, $p < 0.015$).

A history of smoking did not affect the amount of proptosis reduction ($p = 0.6$). However, a history prior to radiation therapy did appear to be of import; those with no history of radiation had an average of 3.23 mm ± 1.54 mm reduction, whereas those with a history of radiation had an average of 3.95 mm ± 0.78 mm reduction ($p = 0.046$).

None of the study patients suffered surgically induced optic neuropathy. An improvement in diplopia and motility was observed in 15 of 51 patients (29%) with formal pre- and postoperative orthoptics measurements. Ocular motility worsened temporarily in 2 of the 51 patients (4%), but improved spontaneously to the preoperative level. There were no cases of new onset diplopia, loss of vision, hemorrhage, optic neuropathy, reactivation, poor wound healing, or infection postoperatively.

**DISCUSSION**

After retrospectively examining the preoperative indications and postoperative outcomes of patients in practice undergoing orbital fat decompression technique, the authors found that patients with fat or both fat and muscle expansion, as well as greater amounts of proptosis, were more likely to enjoy greater reduction in proptosis postoperatively, independent of their smoking history. However, even those with muscle expansion or smaller amounts of proptosis appreciated significant benefit. A history of radiation therapy was not detrimental, and was perhaps even of benefit.

Orbital fat decompression has traditionally been accomplished through a variety of surgical approaches; the 2 most commonly employed are transconjunctival (with upper or lower eyelid) or transcutaneous subciliary incisions. Inferiorly, the largest volume of orbital fat is removed from the nasal and temporal quadrants, as removal of the central fat pad has minimal effect on orbital volume, and aggressive resection in this zone can result in a hollowed appearance of the eyelid with accentuation of residual proptosis. Superiorly, the largest volume of orbital fat is removed from the nasal quadrant, although this tends to be less effective than inferonasal fat pad resection, and the authors reserve surgery in this quadrant to those patients with significant prolapsing fat. While superolateral fat removal has been described, these attempts risk damaging the lacrimal gland itself or its neurovascular supply. The authors therefore avoid the superotemporal quadrant in their surgical technique, as do Adenis et al.¹³ In cases in which there is an asymmetry of greater than 2 mm in preoperative Hertel measurements, the authors achieve additional decompression via bone thinning or removal in the more proptotic orbit, rather than attempting an asymmetric fat decompression. It is of note that while the definition of intra- and extracranal fat would seem anatomically clear, in their experience, the separation between these 2 areas is blurred, with absolute knowledge of intracranal fat removal defined by direct visualization of the extraocular muscles. Given the redistribution of fat occurs both intra- and postoperatively after decompression, the authors find that the conceptual distinction between intra- and extracranal fat removal may not be of practical significance.

This study has several limitations. Ideally, surgical success would be related to pre-TED Hertel measurements, rather than preoperative Hertel measurements. Pre-TED Hertel measurements are not routinely available and in the authors’ practice are only estimated by inspection of premorbid photographs. It is possible that the degree of preoperative proptosis influenced the surgeon’s choice as to how much fat was removed, such that those with greater proptosis would have more fat removed. However, the authors remove as much fat as considered safe in all patients, rather than basing the amount of fat removed on the amount of preoperative proptosis. Moreover, using this approach they have not produced an overcorrection in any patient.

The authors did not anticipate the 29% objective improvement in preoperative diplopia as a result of the surgery. In their practice, orthoptics measurements are only routinely obtained in patients who complain of diplopia. As a consequence, orthoptics were recorded in 51 of 109 cases. Though limited by the retrospective nature of this study and lack of quality of life surveys postoperatively, this result suggests that the effect of orbital fat decompression goes beyond reduction in proptosis. The authors speculate that attendant to the mobilization and removal of orbital fat is the lysis of pathologically fibrosed intramuscular septations, described by Koornneef,¹⁴ which in turn is responsible for improvement in ocular rotations. While they did examine muscle balance by orthoptics measurement in a subset of patients, it would be of interest to obtain the same measurements in all cases and to more carefully assess the effect of orbital fat decompression surgery on ocular rotations.

The authors did not quantify the volume of muscle enlargement or fat enlargement on preoperative imaging; rather they used a qualitative assessment of fat expansion, muscle expansion, or a combination thereof to guide the placement of patients into group I, II, or III. In addition, because of the nature of largely

<table>
<thead>
<tr>
<th>Group</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>23.5</td>
<td>20.3</td>
<td>3.3 (1.5)</td>
</tr>
<tr>
<td>Group II</td>
<td>23.1</td>
<td>20.2</td>
<td>2.8 (1.5)</td>
</tr>
<tr>
<td>Group III</td>
<td>23.9</td>
<td>20.4</td>
<td>3.5 (1.6)</td>
</tr>
</tbody>
</table>

Results are divided according to group. SD, standard deviation.

![FIG. 4. Correlation between preoperative degree of proptosis and postoperative reduction in proptosis. Positive Pearson correlation was found.](image-url)
referral-based practice, imaging did not have consistent slice thickness. This correlates with everyday practice. The authors hope that this relatively efficient qualitative analysis will serve as a general framework when examining TED patients.

Finally, this study is limited by the nature of the authors’ practice, a university-based tertiary referral that sees more severe TED than average. It is of note that in the most severe cases, fat decompression alone would not generally be considered.

In summary, while fat decompression can and, at times, ought to be combined with bone decompression, fat decompression in and of itself results in reliable proptosis reduction in the properly selected patients, reduced surgical morbidity, and occasionally improvement in diplopia in patients with restrictive strabismus.

REFERENCES


