Original Investigation

Proptosis Reduction by Clinical vs Radiological Modalities and Medial vs Inferomedial Approaches Comparison Following Endoscopic Transnasal Orbital Decompression in Patients With Dysthyroid Orbitopathy

Suman Thapa, MS; Ashok K. Gupta, MS, MNAMS; Amod Gupta, MS; Vivek Gupta, MD; Pinaki Dutta; Ramandeep S. Virk, MS

IMPORTANCE  Dysthyroid orbitopathy is clinically relevant in 30% to 40% of patients with Graves disease and is sight threatening as related to optic neuropathy, corneal breakdown, or both in 3% to 5%.

OBJECTIVES  To evaluate proptosis reduction using clinical (Hertelexophthalmometry) vs radiological (computed tomography) modalities and using medial vs inferomedial decompressions following the endoscopic orbital sling technique.

DESIGN, SETTING, AND PARTICIPANTS  Prospective study in an academic research setting between July 1, 2011, and December 31, 2012. Participants included 15 patients diagnosed as having dysthyroid orbitopathy with a Clinical Activity Score of at least 3 of 7 and disfigurement who did not respond to medical therapy or with a Clinical Activity Score of less than 3 of 7 and sight-threatening disease.

INTERVENTIONS  All patients underwent endoscopic decompression using an orbital sling technique. Preoperative and postoperative proptosis, visual acuity, perimetry, intraocular pressure, visual evoked potential, and fundus findings were measured by both clinical and radiological modalities and followed up to 3 weeks.

MAIN OUTCOMES AND MEASURES  Trends in proptosis reduction observed using both clinical and radiological modalities and medial and inferomedial approaches.

RESULTS  The mean Clinical Activity Score improved from 3.37 to 0.47 in 3 weeks. Both the visual acuity (4 of 6) and visual field (2 of 3) improved in 67% of patients, respectively. Intraocular pressure was reduced in all patients, without any observable changes in fundus findings, color vision, or visual evoked potential. The mean (SD) proptosis reduction was 3.41 (0.05) mm. Significant proptosis reduction ($P < .005$) was observed in the first and third postoperative weeks using clinical and radiological modalities. The paired $P$ values achieved for proptosis reduction using Hertelexophthalmometry and computed tomography were not significant before or after surgery ($P > .005$). Performed separately, medial and inferomedial decompressions, respectively, achieved 6% (1.4 of 24.8 mm) and 10% (2.6 of 25.4 mm) proptosis reductions during the first week and 7% (1.8 of 24.8 mm) and 19% (4.8 of 24.8 mm) by the end of the third week. The observed paired $P$ values for proptosis reduction by medial and inferomedial approaches were also not significant ($P > .005$). No postoperative complications were identified.

CONCLUSIONS AND RELEVANCE  Proptosis measurements by Hertelexophthalmometry vs computed tomography were comparable and equally effective. The inferomedial approach achieved more effective decomposition than the medial approach alone. Compared with external and combined approaches, the endoscopic approach is a better and safer technique and is associated with low morbidity.

Published online February 5, 2015. Corrected on March 27, 2015.

Copyright 2015 American Medical Association. All rights reserved.
Dysthyroid orbitopathy (DO) is an autoimmune disorder representing the most common and important extrathyroidal manifestation of Graves disease. Approximately 30% to 40% of patients with Graves disease demonstrate clinical signs of DO, of whom 3% to 5% have sight-threatening complications related to optic neuropathy, corneal breakdown, or both. Proptosis can be evaluated clinically using the Clinical Activity Score (CAS), Clinical Severity Score (CSS), and Hertel exophthalmometry (HE) and radiologically by computed tomography (CT) or magnetic resonance imaging. The classic presentations of DO on imaging include bilateral proptosis, extraocular muscle hypertrophy, and increased intraconal or extraconal fat, with bowing of the medial orbital wall producing a coca-cola bottle sign.

Treatment options include medical or surgical interventions. Orbital decompression is necessary in cases of compressive optic neuropathy (CON) and may be performed in patients with cosmetic issues and those refractory to medical therapy.

Traditionally, orbital decompression has been performed by various external approaches (transantral, external ethmoidectomy, or an anterior craniotomy approach). These techniques were not popular because of their unacceptable morbidity and high incidence of postoperative complications (cutaneous scar, hypoglobus, diplopia, antral pain, facial swelling, paresthesia of the cheek, injury to the nasolacrimal duct, dental problems, and oroantral fistulas). With the advent of Hopkins rod-lens telescopes, Kennedy et al and Michel et al reported a series of intranasal endoscopic decompressions in 1990 and 1991, respectively. Several groups then began to focus on the need for a more balanced (concurrent medial and lateral) decompression to reduce the incidence of new-onset or worsening diplopia. The techniques to reduce the incidence of diplopia included preserving an inferomedial bony strut or creating a fascial sling in the region of the medial rectus. To our knowledge, no studies have compared proptosis changes measured simultaneously using different modalities (clinical vs radiological) and various approaches (medial vs inferomedial decompression). Therefore, this study was conducted to compare proptosis changes following the widely used endoscopic orbital sling technique.

Methods

Institutional review board approval was obtained from the Postgraduate Institute Thesis Board. Written informed consent was obtained from the patients. Fifteen patients with diagnosed DO (based on clinical, biochemical, and radiological variables, irrespective of age and sex) were included who were seen at the Departments of Otolaryngology, Ophthalmology, and Endocrinology, Postgraduate Institute of Medical Education and Research, Chandigarh, India, between July 1, 2011, and December 31, 2012. Participants included 15 patients (1) with a CAS of at least 3 of 7 and disfigurement with proptosis who did not respond to medical therapy or (2) with a treatment-naive CAS of less than 3 of 7 and a sight-threatening DO grade, including CON and exposure keratopathy. Patient workup included the relevant history, clinical examination with routine tests (hematological, biochemical, and coagulation) and specific tests (thyroid function and immunological), and ophthalmological testing (visual acuity [VA], fundus findings, intraocular pressure [IOP], visual evoked potential, and HE). Computed tomography of the orbit and paranasal sinus was performed to measure the exophthalmos, starting from the interzygomatic line up to the globe apex (Figure 1). Any case with less than one-third of the globe lying posterior to the interzygomatic line, an HE index of at least 22 mm, or any asymmetry of more than 2 mm between the eyes was considered pathological.

All patients underwent clinical photography and imaging before and after surgery (the first and third weeks). The operative procedure included bilateral simultaneous endoscopic orbital decompression, with an additional optic nerve decompression in a patient with CON.

Following induction of general anesthesia, adrenaline-soaked lidocaine hydrochloride, 4%, wicks were applied topically to the nose. The eyes were maintained within the surgical field and were protected with a sterile gown. Local injection of lidocaine hydrochloride, 2% (available in India), with 1:200 000 epinephrine was administered at the axilla and along the maxillary line. With the aid of 0°- and 45°-angled endoscopes (Karl Storz), a wide middle meatal antrostomy was performed using a ronguer forceps (Kerrison) and microdebrider (Medtronic) (Figure 1 in the Supplement). The bulla ethmoidalis was then opened, taking care with its lateral attachment. Removal of anterior and posterior ethmoid air cells and sphenoïdotomy were performed. The medial orbital wall was skeletonized by elevating the lamina papyracea and preserving the underlying periorbitalis using a Freer periosteal elevator (15; Hu-Friedy). An orbital window (2 × 3 cm) was created to extend from the ethmoidal roof to the orbital floor and 2 mm short of the sphenoid face posteriorly to the maxillary line in front (Figure 2 in the Supplement). Two horizontal periorbital incisions were made using a sickle knife (N2909; Bausch & Lomb) extending from the posterior to the anterior end of the nasal cavity along the superior and inferior margins of the...
medial rectus (eFigure 3 in the Supplement). A generous amount of fat prolapsing into the ethmoids could then be seen retained by an orbital strip (Figure 2).

Inferior decompression then began by preserving a small inferomedial bony strut and removing the portion of the orbital floor lying medial to the infraorbital nerve. Orbital floor mucosa and bone were removed using the Freer periosteal elevator and ronguer forceps to visualize the orbital fat prolapsing into the maxillary sinus. On completion, nasal Merocel packing (Medtronic) was placed. The nasal packing was removed on the third day, and patients maintained a tapering oral corticosteroid regimen for 3 weeks. They were advised to follow up at the end of the first and third weeks after decompression. At every visit, clinical assessment (CAS, CSS, and ophthalmological testing), photography, and imaging were performed to compare trends in proptosis reduction and to evaluate the final cosmetic appearances. Data were collected and analyzed using the Statistical Package for Social Sciences (IBM), with the significance level (P value) set at α = .05.

Results

Demographics of the Study Sample
The mean patient age was 43 years, and there was a preponderance of women (sex ratio, 0.9). The mean (SD) body mass index (calculated as weight in kilograms divided by height in meters squared) was 24.9 (3.3), with mean values of 24.8 for women and 25.0 for men. The mean number of pack-years smoked for men was 13.7.

Clinical Characteristics
Twenty-eight eyes (in 15 patients) underwent decompression. Two eyes were used as controls, with the contralateral eye subjected to medial or inferomedial decompression alone. Of 15 patients, 11 had undergone bilateral simultaneous (ipsilateral medial and contralateral inferomedial) decompression. The other 2 patients (in whom the contralateral eye was used as a control) underwent bilateral medial decompression. The mean CAS (of a total score of 7) significantly improved from 3.37 to 0.47 during 3 weeks (eFigure 4 in the Supplement). The paired weekly mean CAS reductions were significant (P < .005). One patient with CON had a CSS of severe, while the other patients had a CSS that was mild to moderate. Two-fifths (6 of 15) of patients had reduced VA, with 67% (4 of 6) improving after surgery. The mean (SD) VA improved from 0.206 (0.539) before surgery to 0.153 (0.364) and 0.073 (0.115) after the first and third weeks of follow-up, respectively. The weekly VA changes were not significant (eFigure 5 in the Supplement). One patient with right CON and preoperative light perception underwent immediate decompression of the right optic nerve and orbit, resulting in a dramatic recovery of vision as measured by Snellen chart. Visual acuity improved from preoperative light perception to counting fingers, ultimately reaching 6/12 after the third week of decompression. Visual acuity did not worsen in any of our patients. Despite normal preoperative IOPs, reductions of 1.5 and 4 mm were observed after the first and third weeks of decompression, respectively (eFigure 6 in the Supplement).

Among one-third (5 of 15) of patients with reduced visual field, 67% (2 of 3) improved after surgery. Fundus findings and visual evoked potential were normal in all our patients before and after surgery, including the patient with CON.

The mean (SD) proptosis reduction achieved in our study was 3.41 (0.05) mm. No complications, new-onset diplopia, cerebrospinal fluid leak, sinusitis, epiphora, or infraorbital hypesthesia were observed. Table 1 lists the weekly proptosis changes observed using HE and CT simultaneously. Proptosis decreased by a mean of 3.41 and 3.28 mm during 3 follow-up weeks as measured by HE and CT, respectively. Significant proptosis reduction was observed weekly using both modalities (Table 2). The decompressive trends in proptosis measured with both modalities in each eye are shown in Figure 3. However, the paired P values for proptosis reduction measured by HE and CT were not significant at all weekly intervals.

Overall, 34% (1.00 of 2.90 mm) and 55% (2.30 of 4.20 mm) proptosis reductions were observed 1 week after medial and inferomedial decompressions, respectively, using the other eye as a control (Figure 4). The total decompressions achieved via medial and inferomedial approaches were 2.0 and 4.8 mm, respectively (eFigure 7 in the Supplement). No significant dif-
Our observed sex ratios of 2.0 and 3.3 in the literature.22,23 Our observed sex ratio (0.9) may be attributed to the inclusion of fewer patients with an erratic distribution of the disease, resulting in an incomplete picture of DO. Our mean (SD) patient body mass index of 24.9 (3.3) was comparable to the 24.8 (3.7) in a study of patients with Graves disease by Ozata et al.24 Smokers experience more severe DO than nonsmokers.25,26 The mean number of 13.7 pack-years smoked among male smokers herein was similar to the 15 pack-years smoked in a study of orbital compression by Jernfors et al.27

The mean CAS improved significantly from 3.37 to 0.47 during 3 weeks, as similarly reported by Le Moli et al28 (eFigure 4 in the Supplement). Visual acuity is an important indicator of quality of life in patients with reduced vision. The mean (SD) VA improved from 0.206 (0.539) before surgery to 0.153 (0.364) after surgery and to 0.073 (0.115) after 3 weeks (eFigure 5 in the Supplement). She et al29 reported similar VA improvement 1 and 3 months after decompression; however, the weekly VA changes noted in our study were not significant. As similarly reported by Koh and Dhong,30 our study showed eventual postoperative VA improvement in a patient with CON. Significant weekly IOP reduction was observed, reaching up to one-fourth (4.50 of 17.50 mm) of patients by the end of the third week (eFigure 6 in the Supplement). An overall mean (SD) reduction in IOP of 4.53 (0.72) mm observed after 3 weeks was comparable to the results by She et al,30 who demonstrated mean (SD) reductions of 4.40 (0.72) and 4.38 (0.80) mm after 1 and 3 months, respectively. Fundus findings were normal in all our patients, including the patient with CON, whereas Hossein and Dabirmoghaddam31 reported abnormal fundoscopy results in a patient with CON. The endoscopic technique of preserving the orbital sling, combined with preservation of the inferomedial bony strut, has proved to be a safer and better alternative to external and combined approaches.20,22 Although endoscopic approaches achieved a wider range (1-12 mm) of proptosis reduction than external and combined approaches (3-10 mm), the overall mean reduction was greater with the external and combined approaches.14,23

A review of 613 patients undergoing endoscopic decompression showed a mean (SD) proptosis reduction of 3.50 (0.51) mm, which is comparable to our mean (SD) result of 3.41 (0.05) mm.25 To date, Metson and Samaha22 have endoscopically achieved the highest proptosis reduction (mean [SD], 5.1 [1.1] mm). Using the same endoscopic approach, other studies14,16,21,31 have achieved either greater (4.6 and 3.8 mm)

### Table 2. Comparative Proptosis Reduction Using Hertel Exophthalmometry (HE) vs Computed Tomography (CT)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean Reduction, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HE</td>
</tr>
<tr>
<td>Preoperative to week 1</td>
<td>1.83</td>
</tr>
<tr>
<td>Week 1 to week 3</td>
<td>1.58</td>
</tr>
<tr>
<td>Preoperative to week 3</td>
<td>3.41</td>
</tr>
<tr>
<td></td>
<td>CT</td>
</tr>
<tr>
<td>Preoperative to week 1</td>
<td>1.80</td>
</tr>
<tr>
<td>Week 1 to week 3</td>
<td>1.48</td>
</tr>
<tr>
<td>Preoperative to week 3</td>
<td>3.28</td>
</tr>
</tbody>
</table>

* P < .001 for all comparisons.

### Figure 3. Reduction Trends in Proptosis by Computed Tomography (CT) vs Hertel Exophthalmometry (HE)

### Figure 4. Medial Decompression and Inferomedial Decompression Using the Other Eye as a Control

- **A** Right Eye
- **B** Left Eye

Discussion

The mean age herein for both sexes was 43 years, which was identical to the mean age in the study of outcomes following surgical decompression by Leong et al.23 Graves disease herein followed the trend of female preponderance, with sex ratios of 2.0 and 3.3 in the literature.22,23 Our observed ratio (0.9) may be attributed to the inclusion of fewer patients with an erratic distribution of the disease, resulting in an incomplete picture of DO. Our mean (SD) patient body mass index of 24.9 (3.3) was comparable to the 24.8 (3.7) in a study of patients with Graves disease by Ozata et al.24 Smokers experience more severe DO than nonsmokers.25,26 The mean number of 13.7 pack-years smoked among male smokers herein was similar to the 15 pack-years smoked in a study of orbital compression by Jernfors et al.27

The mean CAS improved significantly from 3.37 to 0.47 during 3 weeks, as similarly reported by Le Moli et al28 (eFigure 4 in the Supplement). Visual acuity is an important indicator of quality of life in patients with reduced vision. The mean (SD) VA improved from 0.206 (0.539) before surgery to 0.153 (0.364) after surgery and to 0.073 (0.115) after 3 weeks (eFigure 5 in the Supplement). She et al29 reported similar VA improvement 1 and 3 months after decompression; however, the weekly VA changes noted in our study were not significant. As similarly reported by Koh and Dhong,30 our study showed eventual postoperative VA improvement in a patient with CON. Significant weekly IOP reduction was observed, reaching up to one-fourth (4.50 of 17.50 mm) of patients by the end of the third week (eFigure 6 in the Supplement). An overall mean (SD) reduction in IOP of 4.53 (0.72) mm observed after 3 weeks was comparable to the results by She et al,30 who demonstrated mean (SD) reductions of 4.40 (0.72) and 4.38 (0.80) mm after 1 and 3 months, respectively. Fundus findings were normal in all our patients, including the patient with CON, whereas Hossein and Dabirmoghaddam31 reported abnormal fundoscopy results in a patient with CON. The endoscopic technique of preserving the orbital sling, combined with preservation of the inferomedial bony strut, has proved to be a safer and better alternative to external and combined approaches.20,22 Although endoscopic approaches achieved a wider range (1-12 mm) of proptosis reduction than external and combined approaches (3-10 mm), the overall mean reduction was greater with the external and combined approaches.14,23

A review of 613 patients undergoing endoscopic decompression showed a mean (SD) proptosis reduction of 3.50 (0.51) mm, which is comparable to our mean (SD) result of 3.41 (0.05) mm.25 To date, Metson and Samaha22 have endoscopically achieved the highest proptosis reduction (mean [SD], 5.1 [1.1] mm). Using the same endoscopic approach, other studies14,16,21,31 have achieved either greater (4.6 and 3.8 mm)

### Table 2. Comparative Proptosis Reduction Using Hertel Exophthalmometry (HE) vs Computed Tomography (CT)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean Reduction, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HE</td>
</tr>
<tr>
<td>Preoperative to week 1</td>
<td>1.83</td>
</tr>
<tr>
<td>Week 1 to week 3</td>
<td>1.58</td>
</tr>
<tr>
<td>Preoperative to week 3</td>
<td>3.41</td>
</tr>
<tr>
<td></td>
<td>CT</td>
</tr>
<tr>
<td>Preoperative to week 1</td>
<td>1.80</td>
</tr>
<tr>
<td>Week 1 to week 3</td>
<td>1.48</td>
</tr>
<tr>
<td>Preoperative to week 3</td>
<td>3.28</td>
</tr>
</tbody>
</table>

* P < .001 for all comparisons.
or lesser (3.3 and 2.1 mm) amounts of globe recession compared with our study. The mean (SD) proptosis reductions of 1.83 (0.22) and 3.41 (0.05) mm herein were observed after 1 and 3 weeks, respectively (Table 2). In contrast, She et al29 observed lesser mean (SD) reductions of 1.93 (0.25) and 2.07 (0.29) mm after 1 and 3 months, respectively.

No studies to date have compared proptosis changes measured simultaneously using both clinical and radiological modalities and medial and inferomedial approaches. Imaging modality was a more reliable means of measuring proptosis herein compared with the clinical results. However, the observed mean proptosis reductions using both modalities in our study were comparable. Significant proptosis reduction was observed weekly (Tables 1 and 2). Computed tomography measurements followed an exponential pattern of proptosis reduction with time (Figure 3). It was questionable whether CT would be a more useful and reliable modality than HE in measuring proptosis. However, no significant differences were observed in proptosis measurements by the modalities (Table 2). Although CT appeared to be more precise and stringent, either means of measuring proptosis was equally effective in our study.

The decompressive curve was much steeper with the inferomedial approach than with the medial approach (Figure 4). This outcome suggested that the inferomedial approach is more effective in reducing proptosis than medial decompression alone. Using the inferomedial approach, Yuen et al32 achieved a slightly higher proptosis reduction (4.6 mm), while Kochetov et al33 reported a lower figure (2.5 mm) compared with our results (4.1 mm). Most proptosis was reduced within the first week, followed by gradual reduction over the next 2 weeks (eFigure 7 in the Supplement). The underlying observed trends in proptosis reduction were identical (2-2.5 mm) with bilateral medial decompression of the orbit. However, the paired P values of medial vs inferomedial decompression techniques were not significant.

New-onset or worsening diplopia is a major complication in 15% to 63% of patients after decompression.16,19,20,23 For new-onset diplopia, the endoscopic approach has a range of occurrence (0%-71%) comparable to that of external and combined approaches (19%-66%).11,21-23,31,33,34 However, the endoscopic-assisted diplopia rates have fallen because of the practice of combining both techniques (preservation of the inferomedial bony strut and orbital sling).20,22,31 The highest new-onset diplopia rates reached 70% in the study by Hossein and Dabirmoghaddam,31 and the findings by Lund et al21 may be attributed to their lack of adopting both techniques. Similar to the study by Metson and Samaha,22 no cases of new-onset diplopia were observed in our study. Associated complications are dependent on the approach used. Pure endoscopic approaches avoid facial scars, infraorbital nerve injury, trauma to the nasolacrimal duct system, and dental problems, reducing the overall morbidity.25,23,29,32 The overall complication rate reported by Leong et al33 was 5.2%, while no complications were observed in our study.

Figure 5. A Female Patient Before and After Surgery
Conclusions

Overall disease activity, severity, and IOP were reduced following endoscopic decompression using an orbital sling technique in our study, and VA and visual field were improved along with optimal globe recession devoid of complications. The final clinical picture was one of patient satisfaction and confidence (Figure 10 in the Supplement and Figure 5). Because our study sample was small, the use of this technique in more patients will provide greater perspective. However, the decompression technique shows promise and demonstrated better results compared with external and combined approaches.

REFERENCES