Endoscopic and transcaruncular medial wall decompression in unilateral graves' orbitopathy: a multicenter randomized study

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Background
Thyroid eye disease is the most common orbital inflammatory disorder causing unilateral or bilateral proptosis in an adult. Infiltrative orbitopathy thyroid disease characterized by the deposition of immune complexes and inflammatory cells with subsequent fibrosis can severely affect vision and damage the optic nerve. In this study, we compare the safety and efficacy of transcaruncular versus endoscopic orbital decompression in the management of patients with unilateral Graves' orbitopathy.

Patients and methods
This is a retrospective comparative, center-based randomization which included 36 eyes of 36 different patients with Graves' orbitopathy and axial proptosis ranging between 20 and 26 mm. Complete ophthalmic examination included visual acuity, color vision, intraocular pressure, fundus examination and visual field assessment. Proptosis was measured by Hertel exophthalmometry and computed tomography orbit for all the cases preoperatively and 1.6 months postoperatively. There were follow-ups at day 1 postoperative, and at 1, 3, 6 months. All patients were photographed by the same camera. Patients were divided and were randomized on center based, distributed into two groups: the endoscopic group (18 eyes) were operated on through nasal endoscopic approach and the transcaruncular group (18 eyes) were operated on through the transcaruncular approach.

Result
There was significant reduction in proptosis in each group after surgery ($P<0.001$). The mean reduction of proptosis was more pronounced and statistically significant in the transcaruncular group (4.78±0.17 mm) as compared with the endoscopic group (3.61±0.18 mm) ($P<0.001$). The bony decompressed volume estimated by the serial computed tomography image was 0.75±0.23 cm^3 in the transcaruncular group and 0.80±0.29 cm^3 in the endoscopic group. There significant improvement in vision from 20/45 to 20/30 in both groups ($P<0.001$). Visual field defects have improved in 14 (77.8%) cases of the transcaruncular group, as compared with 15 (83.3%) cases of the endoscopic group with complete resolution of corneal staining in both groups within 1 month, postoperatively.

Conclusion
The transcaruncular technique showed better results because it has significantly better proptosis reduction, has 50% less residual proptosis, higher expanded compressed volume area and better improvement of visual acuity, although statistically nonsignificant.

Keywords:
endoscopic decompression, grave's orbitopathy, orbital decompression, proptosis

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Introduction

Thyroid eye disease is the most common orbital inflammatory disorder causing proptosis in adults. Infiltrative orbitopathy thyroid diseases are characterized by deposition of immune complexes and inflammatory cells infiltrating the orbital fat, muscles and subsequent fibrosis, which can severely affect vision and damage the optic nerve [1].

Surgical decompression for thyroid eye disease may require urgent management of compressive optic neuropathy (CON) to improve the vision and the esthetic appearance of patients [2]. The esthetic deformity caused by thyroid eye disease can be a devastating psychological experience to the patient, especially in unilateral proptosis, so the use of orbital decompression can improve the appearance [3].

Considerable progress in surgical techniques has enabled surgeons to achieve both functional and cosmetic benefits in these patients. A variety of surgical techniques, ranging

from minimally invasive orbital decompression up to two-wall or three-wall decompression with orbital fat excision are used [4] through different approaches such as transcutaneous, trasantral, endoscopic, and transcaruncular approaches [5].

In this study, we compare the safety and efficacy of the transcaruncular approach with the endoscopic approach of orbital decompression in Graves' orbitopathy.

Patients and methods

Informed consent was obtained from all individual participants included in the study. All data were collected with protocols approved by Ain Shams University Hospitals. We have carried out an retrospective study, which has included 36 eyes of 36 patients with unilateral Graves' orbitopathy, to compare with normal eye, from the ophthalmology clinic, and the ear, nose, and throat clinic of Ain Shams University hospitals, Cairo, Egypt, from 2013 to 2015, about 16 case per year. Exclusion criteria included patients with bilateral proptosis, glaucoma, severe optic nerve compression with color vision defect, uncontrolled coagulation profile, and uncontrolled thyroid status. Preoperatively, patients received full endocrine assessment of thyroid status and complete ophthalmic examination including best-corrected visual acuity, intraocular pressure, color vision, fundus examination, corneal staining by fluorescent stain, proptosis measurement by Hertel exophthalmometry, visual field assessment, and computed tomography (CT) orbit preoperatively and at 1-month and 6-month postoperatively.

In all cases, the patients signed an informed consent and agreed to use the photographs for scientific purposes. All surgical approaches were done by the same surgeon and same camera (Lumix DMC-FZ60; Panasonic Inc., Osaka, Japan) program IA with aperture value 4.

Surgical methods

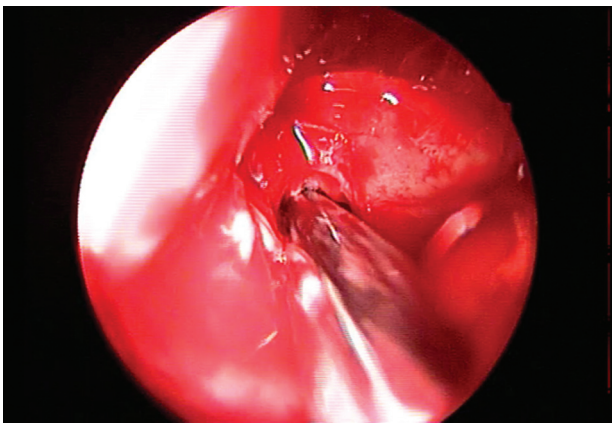
Endoscopic approach

All procedures were performed under general anesthesia with an external infiltration of the supraorbital, supratrochlear, and tamponade of the nasal fossa by a nasal pack containing 0.05% oxymetazoline solution (Novartis Pharma, Cairo, Egypt), then it was removed after 10 min. Dissection of the ethmoid, anterior and posterior ethmoidal air cells were started by using the 30° video, 4 mm endoscopic lens (STORZ Company, Tuttlingen, Germany) (Fig. 1). Using the Freer dissector and a Blakesley forceps, a middle meatal antrostomy was performed and a large sphenoidotomy was created to join the lateral wall of the sphenoid sinus with lamina papyracea. The medial wall was resected up to the sphenoethmoidal union. Horizontal incision in the periorbita was created with a light massage on the globe, the adipose tissue that partially occupied the dissected ethmoid with partial lipectomy using Blakesley forceps. Nasal packing was not required unless postoperative bleeding was present.

Transcaruncular approach

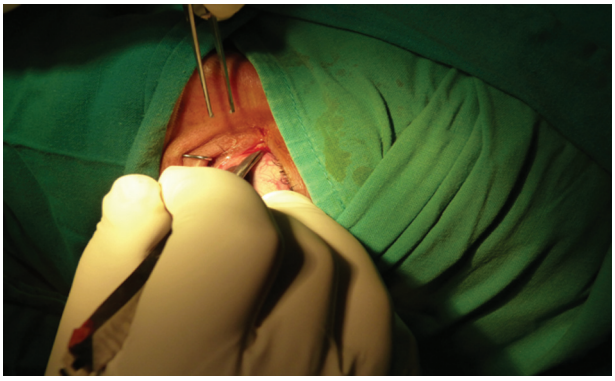
All procedures were performed under general anesthesia with local anesthesia at the conjunctiva of the medial canthus. A vertical incision was made through the caruncle (Fig. 2) with dissection posteriorly through the conjunctival tissue and the periosteum was incised at the posterior lacrimal crest and the periorbita was horizontally incised and reflected. The lamina papyracea was fractured with the bone, from lacrimal crest to the orbital apex. A total ethmoidectomy was performed; the periorbita was

Figure 1



Endoscopic approach.

Figure 2



Transcaruncular approach.

incised and globe retropulsion was performed gently to facilitate orbital fat herniation into the ethmoid sinus, periodically checking the pupil and the degree of residual proptosis. Wounds of the caruncle and conjunctiva healed without sutures.

Estimation of the decompressed volume of the orbital wall on computed tomography orbit images

CT imaging (bone window, 3-mm collimation) of all patients was performed on both axial and coronal planes. Orbital volume expansion after surgery was calculated using ImageJ software (National Institutes of Health, Bethesda, Maryland, USA). The expanded area in each orbital slice was marked from the bone edge in the preoperative wall border to the decompressed bony edge in comparison between two groups. The sum of all areas (cm^3) multiplied by 0.3 cm was considered the expanded orbital volume (cm^3) [6].

Statistical analysis

Statistical analysis was performed using the statistical package for the social sciences (SPSS, version 19.0.1; SPSS Inc., Chicago, Illinois, USA).

Numerical variables were presented as mean±SD and intergroup differences were compared using the independent-samples *t*-test. Within-group comparison of numerical variables was done using the paired-samples *t*-test.

Categorical variables were presented as number (%) and between-group differences were compared using the Pearson χ^2 test.

Partial correlation analysis was used to compare decompression volume with exophthalmos reduction between two groups.

All statistical tests were two-sided and significance was targeted at the 95% confidence level, that is, a *P* value less than 0.05 was considered statistically significant.

Results

Thirty-six eyes of 36 patients with Graves' orbital exophthalmos were included. The study population comprised 21 women and 15 men randomized, distributed in each group. The mean age was 31.44 years in the endoscopic group versus 35.11 years in the transcaruncular group. Demographic distribution of cases in both groups is shown in Table 1 with insignificant difference between them.

The proptosis showed significant improvement after surgery in each group ($P<0.001$). The mean reduction of proptosis was significantly more in the transcaruncular group as compared with the endoscopic group (4.78±0.17 vs. 3.61±0.18 mm) ($P<0.001$), respectively, as shown in Table 2. The proptosis has resolved completely in 77.78% of cases in the endoscopic group and 88.89% in the transcaruncular group. Four cases of the endoscopic group and two cases of the transcaruncular group showed residual proptosis, which was surgically managed by lateral orbitotomy.

The bony decompressed volume estimated by the serial CT image was 0.75±0.23 cm^3 in the transcaruncular

Table 1 Patient demographics

	Transcaruncular group	Endoscopic group
Age (mean±SD) (years)	35.11±7.21	31.44±6.65
Sex [*N* (%)]		
Men	12 (66.7)	3 (16.7)
Women	6 (33.3)	15 (83.3)
Preoperative vision (mean±SD)	0.41±0.143 (20/40)	0.44±0.136 (20/45)
Preoperative proptosis (mean±SD)	23.61±0.849	23.66±1.32
Visual field [*N* (%)]		
No defect	0	2 (11.1)
Mild defects	14 (78.8)	12 (66.7)
Moderate defects	4 (22.2)	4 (22.2)
Positive corneal staining [*N* (%)]	6 (33.3)	2 (11.1)

Table 2 The preoperative and postoperative mean proptosis, decompression volumes and vision in both groups

	Transcaruncular group (mean±SD)			Endoscopic group (mean±SD)		
	Preoperative	Postoperative	*P* value	Preoperative	Postoperative	*P* value
Proptosis	23.67±1.33	20.06±1.47	<0.001	23.61±0.84	18.83±1.2	<0.001
Volume (cm^3)	–	0.68±0.23	<0.002	–	0.80±0.29	<0.011
Vision	0.44±0.14	0.67±0.12	<0.001	0.41±0.11	0.67±0.15	<0.001

group and 0.80±0.29 cm^3 in the endoscopic group. In the partial correlation analysis, orbital volume expansion in both groups was significantly correlated with exophthalmos reduction after surgery (P=0.002 and 0.011, respectively) and partial R was higher in the transcaruncular group (R=0.466) than in the endoscopic group (R=0.402) which means that the expanded, compressed volume area is higher in the transcaruncular group than in the endoscopic group.

The vision also showed significant improvement from 20/45 to 20/30 in both groups (P<0.001) as shown in Table 2. The mean change of vision was 1.78 lines improvement in the transcaruncular group versus 1.39 lines. But this difference was not statistically significant (P=0.53).

In the transcaruncular group, 14 (77.8%) cases had mild visual field defect and four (22.2%) cases had moderate field defects. One month following surgery, the visual field findings improved completely in 14 (77.8%) cases except four (22.2%) eyes, which had mild field defects and after 6 months the same changes are present, while in the endoscopic group, 12 of 18 (66.7%) cases had mild visual field defect and four (22.2%) cases had moderate field defects. One month after surgery, the visual field findings improved completely in 15 (83.3%) cases except for three (16.7%) eyes, which had mild field defects and after 6 months the same changes are present.

Corneal staining was seen preoperatively in 33.3% (6/18 cases) in the transcaruncular group as compared with 11.1% (2/18 cases) in the endoscopic group and completely disappeared postoperatively in both groups.

Visual field and corneal staining are statistical analysis by cross-tabulation and χ^2 tests.

One case of the transcaruncular group showed diplopia caused by medial rectus muscle injury during the surgery, which was treated by squint surgery after 1 month from decompression operation.

Discussion

Graves' orbitopathy is an autoimmune disease characterized by the deposition of antithyroglobulin immune complexes in the extraocular muscles. These complexes induce an inflammatory response through stimulating lymphocytes, and mast cells, leading to edema and fibrosis later on, with thickening of the extraocular muscles – especially the inferior and middle rectus muscles and orbital fat. Moreover, there is a stimulation of the myogenic activity of the fibroblast, which leads to an increase in the orbital volume leading to proptosis and CON [6,7].

Orbital decompression for thyroid eye disease aims to prevent increases in the intraorbital pressure, thus reducing proptosis and CON [4].

There are different surgical techniques for orbital decompression. In our study, we compared two surgical techniques, endoscopic versus transcaruncular, which improved vision from 20/45 to 20/30. The transcaruncular technique improved vision by 1.78 lines which was better than the endoscopic technique (1.39 lines) and this matched with that reported by Liao *et al.* [8].

In the transcaruncular approach, proptosis has significantly improved with mean reduction 4.78± 0.17 mm as Liao *et al.* [8] have reported a global retroreplacement of 3.7 mm and Hill *et al.* [9] reported a reduction of proptosis 2.3 mm. This is due to the excellent anatomical exposure through this approach.

In the endoscopic approach proptosis has improved significantly, with a mean reduction of 3.61±0.18 mm, the same as reported by Schaefer *et al.* [10], but less than what Metson and Samaha [11] have reported (mean of 5 mm). Yuen *et al.* [12] have reported a higher mean reduction of proptosis by 4.6 mm as this technique has additional advantage of good access to the posterior medial wall of orbital decompression.

CT-based measurement of decompressed orbital volume at the medial wall produces lower values in the transcaruncular approach than the endoscopic approach. Volume-adjusted correlations in the partial correlation analysis (partial R) between exophthalmos reduction and expanded, decompressed volume were higher in the transcaruncular approach than in the endoscopic approach. This is due to good visualization and ease of access to the medial wall. Alsuhaibani *et al.* [13] have performed volumetric studies using CT scans with balanced orbital decompression. They showed that the medial wall decompression has more effect than the lateral wall decompression, but one difference was that the authors focused on the orbital volume and the eye position changes. Our study exclusively represents the analysis of the decompression volume with exophthalmic reduction and these are powerful criteria in this study.

Other orbital decompression techniques were reported to demonstrate slightly higher reduction effects on the globe. Balanced orbital decompression by removing the medial and the lateral walls has been reported to result in a reduction of proptosis by 4.1 mm and three wall decompression by 5.3 mm [14,15]. Ünal *et al.* [16] have reported a mean reduction of proptosis to 6.9 mm. It is important to remember that the reduction of proptosis is not only dependent on the surgical technique used or the number of walls resected, but also it depends largely on the degree of fibrosis and infiltration of the orbit's soft tissues [17].

The visual field has improved in both approaches, as no visual field defects were detected in 29 (80.56%) patients. Only four cases of the transcaruncular group and three cases of the endoscopic group demonstrated mild visual field defects 1 month postoperatively. The corneal staining completely resolved postoperatively in all patients and that coincided with the reduction of exophthalmos and adequate closure of the eye lids. These findings are consistent with that reported by Perry *et al.* [18] that Humphrey visual field testing improved post-operatively in each case.Residual proptosis was present in four cases (3 mm in three patients and 4 mm in one patient) in the endoscopic approach and two cases (3 mm in one patient and 4.2 mm in another patient) in the transcaruncular approach. Lateral wall decompression was performed with complete improvement in all patients.

Diplopia is a common complication in orbital decompressions [11]; different techniques were proposed to reduce its incidence. Some authors proposed 'balanced' orbital decompression of the medial and lateral walls [19]. In our study only one case of diplopia appeared in the transcaruncular decompression, this low incidence of new onset diplopia was a result of the preservation of the anterior maxilloethmoidal strut, allowing low risk of globe dystopia [20]. Muscle realignment was performed after 3 months and the diplopia has improved.

Both endoscopic and transcaruncular approaches are effective techniques for orbital decompression, but the transcaruncular technique has better outcomes in reducing mild to moderate proptosis (2–5 mm) than the endoscopic technique with nearly equal visual improvement in both techniques. This is a result of the good anatomical exposure of the transcaruncular approach, making it more beneficial for patients with Graves's orbitopathy.

Conclusion

The transcaruncular technique has better results because it showed significantly better reduction of proptosis, has 50% less residual proptosis, higher expanded, compressed volume area, and better improvement of visual acuity, although statistically nonsignificant.

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Conflicts of interest

There are no conflicts of interest.

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