CLINICAL STUDY

The incidence of diplopia following coronal and translid orbital decompression in Graves' orbitopathy

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Abstract

Purpose **Firstly, to assess the incidence of induced diplopia following orbital decompression in patients with Graves' orbitopathy. Secondly, to assess patient satisfaction after orbital decompression. Thirdly, to determine the factors that contribute to the variable reported incidence of diplopia complicating decompression surgery.**

Methods **We present a retrospective analysis of the alterations of ocular motility in a consecutive series of 81 patients with Graves' orbitopathy who underwent orbital decompression by either a coronal or a translid approach. We assessed patient satisfaction by a telephone survey, and we reviewed the literature.**

Results **Eleven patients underwent decompressive surgery for dysthyroid optic neuropathy (DON); 5 of them had a three-wall coronal decompression, the other 6 had a two-wall translid decompression. One of the 5 (20%) coronal versus 2 of the 6 (33%) translid patients experienced worsening of their existing diplopia. Seventy patients underwent surgery for disfiguring proptosis; 41 of them had a coronal decompression and 29 had a translid decompression. Eight of the 41 coronal patients (20%) and 4 of the 29 translid patients (14%) experienced aggravation of their motility impairment. There was no statistically significant difference between these percentages (chi-squared, $p > 0.05$). Three of 26 coronal patients (12%) without pre-operative motility impairment developed diplopia in all directions. Twenty-five per cent needed strabismus surgery (9% multiple times). High satisfaction scores were noted after both types of orbital decompression. Through a review of the literature, several factors that may add to heterogeneous results were identified, including definition of diplopia, inclusion criteria and type of surgery.**

Conclusions **Induced diplopia is seen after any type of orbital decompression (19% overall), and its incidence is determined by various factors. To facilitate comparative studies between decompression techniques, a standardised protocol for orthoptic evaluation should be developed.**

Key words Graves' orbitopathy, Diplopia, Orbital decompression

Graves' orbitopathy is the commonest cause of both unilateral and bilateral exophthalmos in adulthood, affecting women more frequently than men. The natural history of this orbital disorder, which is closely related to Graves' thyroid disease, is variable. The basic feature of this disfiguring condition is a panorbital infiltration and inflammation of orbital fat and extraocular muscles, which may cause restrictive myopathic strabismus.

Surgical techniques and their indications in the management of Graves' orbitopathy are still evolving. Various ways to enlarge the orbit have been described, including (1) lateral decompression, (2) inferomedial or antral-ethmoidal decompression (translid, transcaruncular and transantral approach), (3) 'three-wall' decompression ((1)+(2), or coronal approach) and (4) 'four-wall' decompression.[1–8] Orbital decompression may be indicated when the optic nerve is compressed or when corneal exposure has led to severe keratopathy. For more than 10 years the operation has also been performed to reduce disfiguring proptosis in the burnt-out stage of Graves' orbitopathy. The most widely used technique today is antral-ethmoidal decompression through a transantral approach. The major disadvantage reported with this method is increased post-operative motility imbalance.[7–11] A lesser incidence of iatrogenic diplopia is observed after coronal or translid orbital decompressions.[1,7] In our clinic, a two-wall orbital decompression is performed through a translid approach, and a three-wall (bilateral) decompression through a coronal approach. Both surgical procedures have been shown to be efficacious, but the coronal technique has been associated with superior cosmesis.[1,2,12]

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The first goal of this paper was to assess the incidence of (increased) ocular motility disturbances following coronal and translid orbital decompression for Graves' orbitopathy. Furthermore, patient satisfaction is considered to be the most important criterion of success, especially for cosmetic surgery. Therefore we evaluated patient satisfaction post-operatively through a telephone survey, with particular attention to side-effects of orbital decompression. A third goal was to determine the factors that contribute to the variable reported incidence of diplopia complicating decompression surgery.

Patients and methods

This retrospective analysis is based on a consecutive series of 81 patients with Graves' orbitopathy who required orbital decompression for either compressive optic neuropathy or disfiguring proptosis. The clinical characteristics of the patients, who underwent the operation between January 1991 and December 1994, are given in Table 1. There was a preponderance of female patients in this study (83%). The male patients all underwent orbital decompression by a translid approach.

Eleven patients (22 orbits) underwent orbital decompression because of bilateral optic nerve compression as shown by a decrease in visual acuity, visual field defects, abnormal visual-evoked potentials (VEPs) and/or optic disc oedema. Seven patients received oral prednisone pre-operatively, whilst 3 were treated with a combination of prednisone and retrobulbar orbital irradiation. One patient received no pre-operative treatment because of the sudden onset of visual deterioration. Five of these patients were treated by coronal decompression, the other 6 by translid decompression.

Orbital decompressions for rehabilitative reasons were not performed until all signs of disease activity (e.g. chemosis and redness of the lids and conjunctiva) had disappeared for at least 6 months. Of the total of 70 patients with disfiguring proptosis, 41 underwent coronal orbital decompression; for the remaining 29 patients a translid approach was used. The majority of patients (78%) underwent a bilateral procedure. All patients in this study were managed and operated on by one surgeon (M.Ph.M.).

Surgical technique

The techniques of both coronal and translid decompression have been described previously.[1,2] The choice of operation technique largely depended on the amount of proptosis, the laterality (unilateral versus bilateral orbitopathy) and the sex of the patient. In brief, the coronal approach involves bilateral stripping down of the frontal skin flap from the scalp to expose the front of each orbit. The periorbita is then freed from the orbital bones, including the trochlea. The temporalis muscle is partially dissected off its origin, after which the lateral wall is removed, leaving the rim intact. The medial wall is removed as far back as the posterior ethmoidal artery, in addition to the medial part of the orbital floor. In the posterior orbit the periorbita is incised in postero-anterior direction and, perpendicular to these cuts, incisions are placed in the anterior periorbita, enabling the orbital contents to herniate in the sinuses. Drains are left in the infratemporal fossae, after suturing the temporalis muscle. The periosteum is closed, as well as the frontal skin flap. Coronal decompression is chiefly reserved for bilaterally affected women with not too high a hairline, since there is a risk of exposure of a coronal scar in men with acquired male-pattern hair loss.

In the translid approach, as utilised in our series, a skin incision through the lower eyelid is made approximately 10 mm below the eyelid margin, bending downwards laterally in a skin fold. The orbicularis muscle is split bluntly until the periosteum is reached. The periosteum and periorbita are dissected free of the orbital floor and medial orbital wall. The orbital floor is removed as far as the posterior wall of the antral cavity, sparing the neurovascular bundle. The nasal orbital wall is removed up to the posterior ethmoidal artery. Finally, the periorbita is incised in a similar way as in the coronal approach. This technique may be combined with a lateral wall decompression, as described previously.[1]

Ophthalmic examination

Measurements of proptosis by Hertel values were obtained pre-operatively and at 2 months after surgery. At these visits we also measured the visual acuity and intraocular pressure, and performed slit lamp examination and fundoscopy. In addition, we assessed the visual fields and VEPs.

Table 1. *Clinical characteristics of 81 patients who underwent orbital decompression for Graves' orbitopathy*

	Coronal decompression				Translid decompression			
		For DON		For disfiguring proptosis		For DON		For disfiguring proptosis
No. of patients		5		41		6		29
Laterality	($n = 5$)	0 unilateral, 5 bilateral	($n = 41$)	0 unilateral, 41 bilateral	($n = 6$)	0 unilateral, 6 bilateral	($n = 29$)	18 unilateral, 11 bilateral
Sex M/F ratio	($n = 5$)	0/5	($n = 41$)	0/41	($n = 6$)	1/2	($n = 29$)	13/16
Age (years) ± SD	($n = 5$)	61 ± 8	($n = 41$)	41 ± 14	($n = 6$)	62 ± 15	($n = 29$)	47 ± 9
Pre-operative Hertel	($n = 10$)	22 ± 2	($n = 82$)	20 ± 3	($n = 12$)	19 ± 2	($n = 40$)	19 ± 3

DON, dysthyroid optic neuropathy.

Orthoptic examination

Orthoptic examination included the assessment of binocular single vision, the cover test (near and distance), the prism cover test (near and distance), the ocular motility, the ocular ductions using the modified hand perimeter,[13] the field of binocular single vision, and the Hess screen test. These investigations were performed pre-operatively (within days before surgery) and 2 months after decompression. A subdivision into three groups was made: (1) no diplopia (−), (2) diplopia at extremes of gaze (±) and (3) diplopia in primary and/or reading position (+).

Telephone survey

Telephone contact was sought with all patients in the post-operative period in June 1995 (between 6 and 54 months after orbital decompression). Each subject was asked to answer a questionnaire. Information was obtained regarding the presence of post-operative hypo/hyperesthesia, frowning and other subjective new complaints. The patients were asked to score their personal satisfaction with regard to the orbital decompression according to a sliding scale from 1 to 10.

Results

Visual function

After coronal decompression for dysthyroid optic neuropathy (DON) no deterioration of visual function was noted. After translid decompression for DON the visual function improved in all patients, with the exception of one patient with bilateral choroidal folds. There was no loss of visual function in the patients who underwent orbital decompression for rehabilitative reasons.

Proptosis reduction

The mean proptosis reduction at 2 months after orbital decompression is shown in Fig. 1. There was a significant difference between coronal (three-wall) and translid (two-wall) decompression in terms of proptosis reduction (chi-squared, $p < 0.05$). After coronal decompression for DON the mean proptosis reduction was 4.8 mm, and after translid decompression it was 2.8 mm. After surgery for disfiguring proptosis, these figures were 4.7 mm and 3.2 mm respectively.

Diplopia

The orthoptic data are shown in Table 2, in which, on the vertical axis, a division is made into three groups according to pre-operative assessment: firstly, 38 patients with no pre-operative diplopia; secondly, 24 patients with pre-operative diplopia at extremes of gaze; and thirdly, 19 patients with diplopia in the primary and/or reading position. In Table 2 a division is made according to the surgical technique: coronal ($n = 46$) versus translid

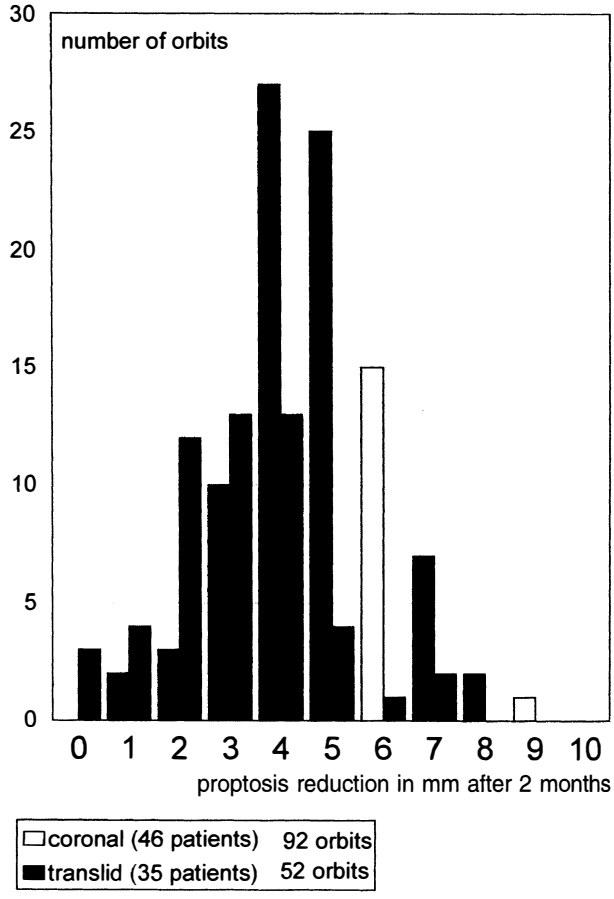

Fig. 1. *Reduction in proptosis (mm) at 2 months after orbital decompression.*

($n = 35$) decompression. Further subdivision is made according to the indication for surgery: optic compression versus disfigurement. The orthoptic data are analysed according to the indication for surgery:
1. *Dysthyroid optic neuropathy.* Five of 11 patients (45%) with DON experienced pre-operative diplopia in primary/reading position, and the other 6 had diplopia at extremes of gaze. *Coronal* decompression resulted in aggravation of strabismus in 1 of 5 patients, causing a post-operative rise in the preoperative incidence of diplopia in 40% (2/5 patients) to 60% (3/5 patients). The other patients showed no change in their ocular imbalance. *Translid* decompression for this indication was followed by worsening of diplopia at extremes of gaze to primary/reading position in 2 of 6 patients; the pre-operative incidence of diplopia in the primary/downgaze position at 50% (3/6 patients) rose to 83% (5/6 patients) following surgery. The group of patients treated for DON was too small for statistical analysis.
2. *Disfiguring proptosis (cosmetic).* Seventy of 81 (86%) patients included in this study underwent orbital decompression for disfiguring proptosis. Thirty-eight of those had no pre-operative diplopia (Table 2). In the group of 41 patients who underwent *coronal* decompression for this indication, increased post-operative muscle imbalance was noted in 8 (20%). The pre-operative incidence of diplopia in primary/downgaze was 12%, rising post-operatively to 29%

Table 2. *Orthoptic status of 81 patients with Graves' orbitopathy prior to and 2 months after orbital decompression*

			Coronal decompression ($n = 46$)		Translid decompression ($n = 35$)		
	Pre-operative	Post-operative	For DON	For disfiguring proptosis	For DON	For disfiguring proptosis	Total
No pre-operative diplopia	−	−	0	22	0	9	31
($n = 38$)	−	±	0	1	0	3	4
	−	+	0	3	0	0	3
Pre-operative diplopia at	±	−	0	1	0	1	2
extremes of gaze ($n = 38$)	±	±	2	5	1	6	14
	±	+	1	4	2	1	8
Pre-operative diplopia in	+	−	0	0	0	0	0
primary position ($n = 19$)	+	±	0	0	0	1	1
	+	+	2	5	3	8	18
Total			5	41	6	29	81

−, no diplopia; ±, diplopia at extreme(s) of gaze; +, diplopia in primary and reading position.

(Table 2). Three individuals without pre-operative strabismus experienced diplopia in primary and/or reading position after the operation. We calculated a 14% incidence (4/29 patients) of post-operative increased muscle imbalance following the *translid* technique; the incidence of pre- *and* post-operative diplopia in primary/downgaze position in this group was similar at 31% (Table 2). Orthoptic improvement was seen in 1 of 41 patients (2%) after coronal surgery, and in 2 of 29 patients (7%) after translid decompression.

There was no statistically significant difference in iatrogenic diplopia between the two techniques employed in this study (chi-squared, $p > 0.05$).

The predominant feature of postoperative strabismus after both coronal and inferomedial decompression was a bilateral restriction of abduction and/or elevation, which frequently was less marked before decompression.

Management of strabismus

In the 6 months after orbital decompression, the patients were assessed by an orthoptist a 2-monthly intervals. Prism glasses were prescribed for disturbing strabismus in individual cases. After 6 months a treatment plan was made for the patients who had experienced no spontaneous improvement and required strabismus surgery. From the total group of patients, 3 individuals suffering from post-operative diplopia at extremes of gaze and 19 patients (25%) with diplopia in the primary and reading position underwent a strabismus operation. In 7 patients (9%) two or three procedures were necessary to restore single binocular vision.

Patient satisfaction

Sixty-seven (83%) patients responded to the telephone questionnaire. The following division into four arbitrary groups was made: dissatisfied (< 6, on a sliding scale from 1 to 10), moderately satisfied (6–7), satisfied (7–8), very satisfied (> 8). Sixty-five per cent of the patients who underwent coronal decompression were very satisfied (≥ 8) compared with 59% after translid decompression. Eighteen per cent were satisfied (7–8) after coronal decompression and 15% after a translid approach. Eighteen per cent were moderately satisfied after coronal decompression, versus 19% after translid decompression. Finally, no dissatisfaction was noted following coronal decompression, whilst 2 of 27 (7%) patients who underwent translid decompression were dissatisfied. The mean satisfaction score was 8.2 for the category of coronal decompression and 7.9 for the category of translid decompression.

The chief complaints after both techniques of orbital decompression were hypoesthesia and paraesthesia in the lower lid, cheek, upper lip and nose; foreign body feeling; dry eye; red eye; diplopia; and torticollis. The majority of these side-effects were temporary. In addition, the following complaints were experienced after coronal decompression: hypoesthesia/paraesthesia and swelling of the forehead skin, 'helmet' feeling, disturbed frowning and blinking, itching of the coronal scar, post-operative epistaxis and post-operative difficulty with chewing.

Discussion

It has been widely recognised that orbital decompression for Graves' orbitopathy is frequently complicated by ocular motility problems. Various factors may influence the incidence and severity of post-operative strabismus. One factor is the pre-operative myopathic status,[7,10,14–17] which depends on the amount of fibrosis of both the ocular muscles and the surrounding orbital tissues and the formation of fibrotic bands with the extraocular muscles.[7] Another factor is the degree of 'apical crowding', which may result from a tight orbital apex and/or severe posterior enlargement of extraocular muscles.[7] Asymmetrical herniation of orbital contents after orbital decompression may further add to post-operative motility problems.[15] Furthermore, there is a variety of surgical techniques for orbital decompression. Several authors[1,2,7,10,17] reported a lower incidence of induced diplopia following either a translid or a transconjunctival orbital decompression, as compared with the high frequency of motility disorders after transantral decompression, both in patients who underwent surgery for disfiguring proptosis and in those with DON.[7–9,16] In addition, there is a notable difference

between studies in evaluating, defining and classifying ocular muscle imbalance and diplopia. The time interval between orbital decompression and post-operative orthoptic assessment[18] varies between studies, or is not mentioned. Therefore we suggest the use of clearly defined criteria of orthoptic assessment, as in this study. In an attempt to draw significant conclusions and to estimate the frequency of complications following decompression surgery in the United States, McCord[7] reported a survey to which about 25 orbital surgeons contributed. However, such studies are hampered by differences in surgical technique, patient selection and pre- and post-operative evaluation. Patient selection is important since patients with DON have a higher incidence of pre- and post-operative strabismus, and should be evaluated separately from those who require the operation for cosmetic rehabilitation. All these factors contribute to heterogeneity amongst studies on this topic[12] and should be considered when estimating the real frequency of post-decompression motility disorders. Theoretically, a case–control prospective study would be ideal to study the complications of various surgical decompression techniques, but this is precluded by the fact that the varying natural course of Graves' orbitopathy requires individualised management.

Because of the considerations stated above, only a few reported studies on diplopia following orbital decompression for cosmetic rehabilitation are suitable for comparison with our data. In our analysis of 70 patients with cosmetically disfiguring proptosis, we noted iatrogenic worsening of ocular motility in 14% of patients who underwent inferomedial decompression, and in 20% of patients after coronal decompression. A selection bias was observed towards more unilateral disease and pre-operative motility disturbances in the subgroup of 29 patients who underwent an inferomedial orbital decompression for cosmetic rehabilitation. There was no higher incidence of diplopia in primary/downgaze position following the inferomedial technique. Coronal decompression was complicated by a 17% incidence of newly induced diplopia. This is lower than the figure of 50% observed after transantral decompression (for cosmetic purpose) by Fatourechi *et al.*,[8] although other authors employing the transantral technique for disfiguring proptosis,[19,20] reported an incidence of only 13%. Kalmann *et al.*[2] recently reported a 9% incidence of induced diplopia in their coronal decompression series. This lower percentage may be explained by chance alone (chi-squared analysis, $p > 0.05$), or by one of the factors discussed above.

Analysis of our 11 patients with DON revealed a 33% incidence of orthoptic worsening (and newly induced diplopia) after translid decompression, and a 20% incidence following the coronal technique, whilst the pre-operative diplopia rates were high at 50% and 40% respectively. High rates were also observed after transantral decompression,[7,9] suggesting that factors other than surgical technique play a dominant role in DON patients.

To date, there has been no study, including ours, that has indicated a relationship between the number of bony orbital walls removed and the frequency of post-operative aggravation of strabismus. This is in contrast to a reported comment on coronal decompression by Fells,[21] who speculated that incising the periorbita in all four quadrants may result in a more symmetrical herniation of orbital tissues and therefore in less muscle imbalance. The lack of difference in outcome between unilateral and bilateral orbital decompression as found in this study, is in agreement with recent work by Leatherbarrow *et al.*[12]

The transantral technique, which has the advantage of not causing visible scars, is notorious for causing iatrogenic diplopia. McCord[7] explained that this may result from the removal of posterior ethmoids and posterior floor, which normally provide support to the contents of the posterior orbit. Using the coronal or translid approach the posterior support is maintained, which results in a lower incidence of ocular motility problems. For this reason, he considered the transantral technique as the surgical treatment of choice for DON, whilst he thought the other techniques should be employed for restoration of cosmesis.

The predominant feature of post-operative strabismus after both coronal and inferomedial decompression was a bilateral restriction of abduction and/or elevation, which frequently was less marked before decompression. The torsional diplopia and A-pattern esotropia that have been observed after transantral orbital decompression (and previous strabismus surgery)[22,23] were not seen in our group of patients. These complications reflect an increased superior oblique action or decreased action of the inferior oblique muscle after retroplacement of the eye.[17]

Especially when orbital decompression is performed to restore cosmesis, the patient's acceptance of side-effects may be different from that of a patient whose sight is threatened. This study showed high satisfaction scores after both translid and coronal decompression, despite frequently encountered side-effects as mentioned above. In a previous analysis of the results of transantral orbital decompression,[8] 69% of patients was satisfied with the appearance of their eyes, whilst 31% found it acceptable, despite the high rate of post-operative symptomatic diplopia. The latter, however, had been reduced to 6.9% at the time of the follow-up questionnaire. A similar satisfaction score was found in another study on transantral decompression.[17]

In conclusion, we note that induced diplopia is seen after any type of orbital decompression, and its incidence is determined by various factors, the most important of which probably is the pre-operative myopathic status. To facilitate comparative studies between decompression techniques, a standardised protocol for orthoptic evaluation should be developed.

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