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Lower eyelid excursion: A functional and cosmetically relevant parameter in the treatment of lower eyelid retraction

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Summary The purpose of this study was to assess and quantify lower lid excursion following repair of lower lid retraction.
In this retrospective cohort study, a case review of patients who had undergone ear cartilage grafting for lower lid retraction was undertaken. Surgical correction involved the placement of autologous cartilage between the tarsal plate and lower lid retractors. Measurements taken preoperatively and postoperatively were the marginal reflex 2 (MRD2) and the lower scleral show (LSS). The lower lid excursion on downgaze (LLE) was measured only postoperatively with a comparison made between operated eyes and control eyes.
Thirteen eyelids of 10 patients were included in the study. Preoperatively, MRD-2 ranged from 4 to 8 mm (6.5 ± 1.5 mm) – mean ± SD. Postoperatively, MRD-2 ranged from 4 to 6 mm (5.1 ± 0.7 mm). The difference in mean MRD2 was statistically significant ($p < 0.05$). Preoperatively, LSS ranged from 0 to 5 mm (2.5 ± 1.6 mm). Postoperatively, LSS ranged from 0–1 mm (0.1 ± 0.3 mm). The difference in mean LSS was statistically significant ($p < 0.01$). Postoperatively, all lower eyelids achieved movement on downgaze. On the operated eyes, the eyelid excursion ranged from 2 to 5 mm (3.1 ± 1.0 mm) on downgaze. On the nonoperated (control) eyes (where the operations were not performed bilaterally), the eyelid excursion ranged from

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1 to 4 mm (2.8 ± 1.2 mm). There was no statistically significant difference in the lid excursion of operated and nonoperated eyes ($p > 0.05$).
It is possible to correct lower lid retraction in both primary and secondary positions of gaze if an appropriate surgical technique is employed.

Introduction

The anatomically and aesthetically appropriate lower lid position is one where the lower lid lies along the globe, skirting the limbus at 6 o'clock.[1,2] Lid retraction may be congenital or acquired[3] and can interrupt the normal relationship between the lower lid and globe. This can have cosmetic and functional implications for the patient.

Techniques that have been described to correct the lid-globe relationship have, to date, focused on restoring the static anatomical relationship in the primary gaze (eyes looking straight ahead), with little or no emphasis on the dynamic relationship between the globe and lid in the secondary position of downgaze. During downgaze, the capsulopalpebral fascia (posterior lamella of lid, inserting into the inferior tarsus border and conjunctiva), displaces the lid inferiorly and thereby keeps the visual axis unobstructed. This is an important parameter to functionally restore as otherwise patients may have to flex their neck to read or climb down stairs due to limited excursion of the lower lid on downgaze.[4]

To the best of our knowledge, the parameter of lower lid excursion following surgery for lid retraction repair has not been formally addressed and quantified in the literature to date. The ideal surgical technique for the correction of lower lid retraction would not only address the lid malposition in primary position, but would also address lower lid excursion in the secondary position.

The aim of this paper is to assess and quantify the lower lid excursion, an additional parameter of the lower lid-globe relationship, following appropriate repair of lower lid retraction. The null hypothesis is that there will be no significant difference observed between the recorded LLEs for the operated eyes and those for the control eyes.

Patients and methods

A retrospective cohort study of consecutive patients that underwent ear cartilage grafting for lower lid retraction, in the 3 years period between October 2006 and October 2009, was undertaken. As this was a case review, institutional ethical approval was not required at the time this study was carried out. All procedures were carried out at the Department of Ophthalmology Norfolk and Norwich University Hospital and all patients who underwent the procedure between 1 October 2006 and 30 September 2009, and who had follow up measurements recorded in their files, were eligible for this study. Of the 10 patients identified, 2 did not have follow-up data and their results were thus excluded from the statistical analyses.

This study was performed in accordance with the tenets of the Declaration of Helsinki, and the results have been reported in conformance to the STROBE guidelines.

All patients had preoperative and postoperative photographs in the primary position and in downgaze. The following measurements were made preoperatively: marginal reflex 2 (MRD2) – the distance between the corneal reflex in the primary position and the lower lid margin – and lower scleral show (LSS) – the distance between the lower limbus and the lower lid margin. Lower lid excursion on downgaze (LLE) – the distance moved by lower lid margin between primary position and down gaze – was measured only postoperatively with a comparison made between operated eyes and control eyes. These measurements were performed on both eyes, enabling the use of the fellow eye as a control in unilateral cases of lid retraction. The preoperative measurements were repeated postoperatively. The same observer (MK) performed all measurements. Details of the aetiology of lid retraction, previous lid surgery, intraoperative and postoperative complications and surgical outcome were also noted.

Surgery was performed by the same surgeon (BB) in all cases, using the same technique. All operations were carried out under general anesthesia. The primary aims of surgery were to achieve symmetry in the lower lid position and to eliminate scleral show. The secondary aim was to achieve lower lid mobility and lid excursion on downgaze.

Postoperatively, patients were placed on guttae. Chloramphenicol 0.5% tds, guttae. Prednisolone 0.5% tds for 2 weeks in the operated eye, and oral co-amoxiclav 375 mgs tds for 1 week. Patients were reviewed at weeks 1 and 6, and then at 6 and 12 months. All measurements were performed by the same author (MK) in order to eliminate inter-observer variability in measurements.

Surgical technique

Donor site

Local anesthetic (2% Xylocaine with 1 in 200,000 Adrenaline) was injected subcutaneously, enabling a cleavage plane between perichondrium and ear cartilage. A 4/0 nylon traction suture, was used to expose the postauricular sulcus. The ear was marked on the reverse with a template taken from the lower lid. A skull-based rectangular skin flap was fashioned to expose cartilage. A Mitchell's trimmer was used to dissect off perichondrium from cartilage. The quantity of cartilage required was estimated such that the lid position would be 1 mm higher than required to allow for postoperative graft shrinkage and gravitational effects. After harvesting, the skin and perichondrium were closed with 6/0-prolene in a single layer. The graft was placed in

Table 1 Summary of preoperative and postoperative measurements.

Parameter		Preoperative	Postoperative	Difference in mean (mm); significance
MRD-2 (mm)	Range	4-8	4-6	1.4; $p < 0.01$
	Mean ± SD	6.5 ± 1.5	5.1 ± 0.7	
LSS (mm)	Range	0-5	0-1	2.3; $p < 0.01$
	Mean ± SD	2.5 ± 1.6	0.1 ± 0.3	
LLE (mm)	Range (OE)	-	2-5	$p > 0.05$
	Range (Control)	-	1-4	
	Mean ± SD (OE)	-	3.1 ± 1.0	
	Mean ± SD (Control)	-	2.8 ± 1.2	

Abbreviations: MRD-2: Marginal reflex distance 2; LSS: Lower scleral show; LLE: Lower lid excursion; OE: Operated Eye.

Gentamicin solution (40 mg/ml), whilst the eyelid dissection was performed. A pressure dressing was placed on the ear for 24 h to prevent postoperative bleeding and hematoma.

Recipient site

A lower-lid sub-ciliary incision was made 2-3 mm below the lash line. The anterior lamella was dissected to the lower border of tarsus enabling the lower lid retractors to be identified. The lower lid retractors were detached and the cartilage graft was fashioned to fit the defect with the lower lid resting at its desired postoperative position. The upper border of the graft was then sutured in place: the upper border of graft to the lower border of the tarsus, and the lower border of graft to the lower lid retractors. 6/0-vicryl was used. Skin closure was achieved with continuous 6/0 nylon.

Statistics

The R program (R – A language and environment for statistical computing, 2009 Vienna, Austria) and Microsoft Excel (2013) – Microsoft, Inc., Redmond, WA – were used to analyze our results. Paired student-*t* test analysis was used examine preoperative and postoperative MRD2 and LSS measurements. Unpaired Student's *t*-test analysis was used examine the LLE post-surgery in operated eyes in comparison with the LLE in the control (nonoperated) eyes. A *p* value less than 0.05 was taken as statistically significant.

Results

Thirteen eyelids of 10 patients were included in the study but data was only available for 10 eyes of 8 patients for final analyses. The mean age (± SD) of the patients was 65 (± 9) years (range 51-81 years). The patient cohort included six women and four men. One woman (two eyes) and one man (one eye) were lost to follow-up. The mean follow-up was 11 months (11 ± 12 months; range: 1-33 months). The most common etiology for lower lid retraction was thyroid eye disease (four patients). Other causes in our cohort included facial nerve palsy (four patients), following basal cell carcinoma excision (two patients) and an anophthalmic socket (one patient).

Preoperative and postoperative results are summarized in Table 1. The difference in mean MRD2 was 1.4 mm, which was statistically significant ($p < 0.01$). The difference in mean LSS was 2.3 mm, which was statistically significant ($p < 0.01$). Postoperatively, all eyes achieved movement in downgaze. The operated eyes showed a mean lid excursion of 3.1 mm (SD = 1.0) on downgaze, range 2-5 mm. The fellow (nonoperated) eyes had a mean lid excursion of 2.8 mm (SD = 1.2) and ranged from 1to 4 mm. There was no statistically significant difference in the lid excursion between operated and non-operated eyes ($p > 0.05$).

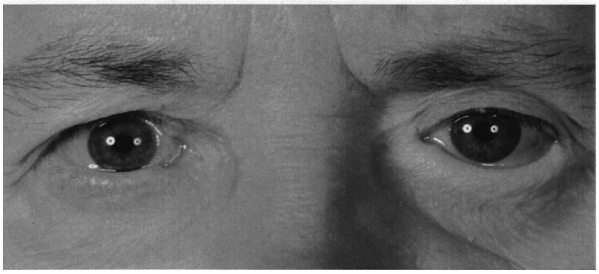

Figure 1 Primary gaze preoperatively with left lower lid retraction.

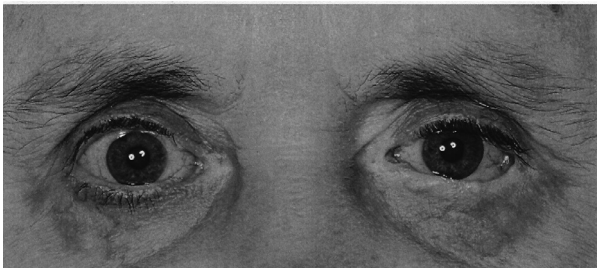

Figure 2 Primary gaze postoperatively showing a normal position for the left lower lid.

There were no intraoperative complications. The raw data for the participants of this study is in Table 2. All patients were subjectively satisfied with their postoperative appearance and eyelid movement. The visible contour of the lower lid was normal in all eyes. Minimal irregularity of the graft was noted on palpation subcutaneously in three patients. See Figures 1-3 for an example of pre- and postsurgical results.

Discussion

The capsulopalpebral fascia inserts into the inferior margin of the tarsal plate and is responsible for the dynamic

Table 2 Raw data for the participants of this study.

Case No.	Sex	Eye	Age	Date of Operation	Diagnosis	Pre-op MRD2 (RE)	Pre-op MRD2 (LE)	Pre-op Scleral show (RE)	Pre-op scleral show (LE)	Previous History	Post-op MRD2 (RE)	Post op MRD2 (LE)	Post-op scleral show (RE)	Post-op scleral show (LE)	Lid Excursion Downgaze (RE)	Lid Excursion Downgaze (LE)	F/Up (months)
Case 1	F	Bil	58	16.07.2008	TED	***5***	***5***	***0***	***1***	2 wall decomp-2001	***5***	***4***	***0***	***0***	***2***	***3***	12
Case 2	F	left	72	03.07.2009	LL cicatricial ectropion sec to BCC	7	***8***	0	***1***	BCC under plastics1998	5	***5***	0	***0***	4	***4***	1
Case 3	F	Bil	51	12.11.2008	TED	***8***	***8***	***2***	***2***	2 wall decomp	***6***	***6***	***0***	***0***	***3***	***4***	8
Case 4	F	Right	65	24.04.2007	7th nerve palsy	***7***	5	***3***	0	7th nerve palsy	***5***	5	***0***	0	***2***	2	27
Case 5	M	left	62	2.10.2006	Anophthalmic socket	4	***6***	0	***3***	left enucleation with pri implant 97	4	***4***	0	***1***	1	***5***	33
Case 6	M	Right	66	26.05.2009	7th nerve palsy	***6***	2	***5***	0	7n palsy post acoustic neuroma 1987	***5***	4	***0***	0	***3***	3	2
Case 8	F	Right	81	27.05.09	R LL retraction sec to inner canthal BCC	***4***	4	***5***	0	BCC with tenzel- May 08	***5***	5	***0***	0	***2.5***	2.5	2
Case 9	M	Right	62	17.04.09	7th nerve palsy sec to ac neuroma - 1990	***8***	6	***3***	1	gold wt-94,facial sling - 94	***6***	6	***0***	1	***2***	4	3

Footnote: ***Results for the operated eyes are in bold-italics***. Results for un-operated (control) eyes are in grey.

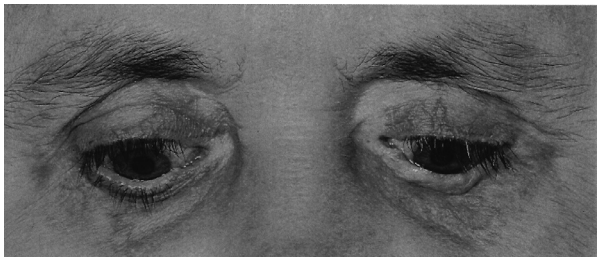

Figure 3 Downgaze postoperatively showing lower lid creases indicating retractor actions for both the normal right eye and operated left eye.

relationship between the lower lid and globe. In the primary position (eyes directed forward), the lower lid touches the limbus at the 6 o'clock position. In the secondary position of downgaze, the fascia retracts the lower lid, ensuring the visual axis remains unobstructed. In the secondary position, the retractors physiologically create and/or accentuate the lower lid crease in some individuals.

Lower lid retraction may be congenital (hypoplastic orbital syndromes[4]) or acquired.[3] Acquired causes include aging,[5] due to tissue volume loss and deflation. Acquired pathological states include thyroid eye disease[6-8] and following cranial nerve VII palsy (paralytic ectropion)[3,7,9,10]; chronic progressive external ophthalmoplegia[6,7]; high myopia[7]; increased sympathetic tone[8]; idiopathic.[7] Iatrogenic causes include postsurgical (skin or septum contracture) postblepharoplasty/ postorbital surgery/anophthalmic socket/maxillectomy, poststrabismus surgery(inferior rectus)[1,3,6-8,10-13]; and burns contracture.[10]

Lid retraction results in scleral show and possible rounding of the canthal angle[9], with frank ectropion sometimes resulting if the retraction is severe. This may be unilateral, or bilateral and asymmetrical, depending up on the underlying pathology. Regardless of the underlying etiology, the patient may complain of ocular discomfort[2] and exhibit signs of exposure keratopathy.[6,11,12] The effect on cosmesis and functionality are undesirable.[1]

A variety of surgical techniques have been described to correct the lower lid-globe relationship. The underlying etiology of lid retraction involves contracture of one or more of the three layers of the lower lid. Broadly speaking, techniques can be divided into those that make use of spacers and those that do not. Those that make use of spacers vary in their use of spacer material and spacer placement. Options for donor material include autologous and synthetic types. Donor sclera (cadaveric) has been used in the past[2] but has fallen out of favor due to the risk of transmissible diseases.[14] In addition, there is a risk of absorption and recurrence.[15] Synthetic materials include polytetrafluoroethylene (Gore-Tex),[16] porcine acellular dermal matrix (Enduragen)[17] and porous polyethylene (Medpor).[18] Synthetic materials vary in their effectiveness, permanence and tissue tolerance.[15] Complications include infection, extrusion and lack of mobility.[15] Autologous materials include conchal or nasal cartilage, hard palate mucosa, eyelid tarsal-conjunctiva, dermis and pericranium.[11,14,15] Alternatives to the use of spacers include lysis of middle lamellar scar tissue and retractors[9,13]; suspension of orbicularis to zygomatic bone[4]; and full thickness skin grafts (suitable where anterior lamella scarring is responsible for lower lid retraction).[4]

In the literature, these techniques have focused on re-establishing the static, anatomical, relationship between globe and lid in the primary position. Assessment of a given technique's utility in the secondary position of downgaze has been limited to noting that patients had to flex their necks to read or climb down stairs, due to limited excursion of the lower lid on downgaze in some case series.[4,10] We suggest that the technique selected should aim to achieve lower lid excursion as an additional aim of surgery as this is both functionally and cosmetically desirable for the patient. To the best of our knowledge, the parameter of lower lid excursion has not been addressed and quantified in the literature to date.

With lower lid excursion as an aim, in addition to lid elevation, the technique selected would have to utilize the lower lid retractors. To this extent, a spacer will provide vertical lengthening and a platform that can be interposed between the tarsal plate and retractors. Attachment of the lower lid retractors will invoke a downward force vector simultaneously with globe movement inferiorly on downgaze, as in the case of the natural movement of the lid.

In our case series, conchal cartilage was interposed between the margin of the tarsal plate and capsulopalpebral fascia. This allowed restoration of the anatomical and functional relationship between the lower lid and the globe in both primary and secondary positions of gaze. In the primary position of gaze, the relevant parameter was the LSS. This was reduced from a mean of 2.5 mm preoperatively to 0.1 mm postoperatively. In the secondary position of gaze, the relevant parameter was lower lid excursion, and all patients achieved a downward movement of the lower lid with infraduction of the globe. On the measurement of lower lid excursion, our results showed that there was no significant difference between the operated and nonoperated eyelids in downgaze. These results imply that both anatomical position and functionality were restored. Patients were subjectively satisfied with their outcome. Our series did not have any donor or recipient site complications during the mean follow-up time of 11 months.

Autologous conchal cartilage was our preferred material as it has a high likelihood of acceptance at the recipient site, provides a satisfactory lower lid contour, a natural lid position and normal lid mobility. Risks of complications such as rejection, extrusion and infection are low. Other possible problems include soft-tissue reaction, graft shrinkage, and fibroblastic activity that can all affect the cosmesis of the final eyelid contour. It has the advantage of being relatively easy to harvest and is associated with minimal morbidity to the donor site. Infection or extrusion complications of this graft material have not been reported in the literature.[4,10,19] In our small series, with a mean of 11 months follow-up, we did not have any such problems.

Criticisms of cartilage include the following: its greater thickness and stiffness relative to tarsus; its greater difficulty in contouring; and unpredictable re-epitehlialization.[1] Krastinova et al.,[4] cited a lack of mobility of the eyelid as a drawback. In that study, the authors placed the cartilage between the tarsus and orbital rim, in between the orbicularis and septal plane. In their case series of 20

patients, some patients had to flex their necks to read or climb down stairs due to limited excursion of the lower lid on downgaze. Hashikawa et al.,[10] note similar concerns. In this latter study, the authors described suspension of the cartilage graft from the medial canthal tendon to the lateral orbital rim. Marks et al.,[19] treated lid retraction with conchal cartilage and composite grafts in 33 patients. In cases of middle lamella shortage, the graft was placed anterior to the lower tarsus and inferior orbital rim. These cases showed stiffness of the lid in downgaze.

In the three studies mentioned above, the graft was positioned in nonphysiological locations that do not make use of the lower lid retractors. It is unsurprising therefore that they report a fixed lower lid and corresponding visual field disturbance in downgaze as a drawback of the procedure. Placement of the graft between the tarsus and the retractors is a physiologic location for graft placement that maintains lower lid excursion, as is shown with our results. As an alternative to cartilage, hard palate grafts resemble tarsus in consistency and stiffness, and provide a mucosal surface[1] and are also associated with good cosmetic results[19] in primary gaze (satisfactory appearance in 85% of patients in one case series by Wearne et al.[7]). The main complication was noted to be donor site hemorrhage (10%). Postoperative contraction has been reported at 16% in one cases series.[20]

The main limitation of our study is the small patient numbers which limits the generalizability of our results. However, we feel that a large case series is not necessary to prove the efficacy of this technique in restoring lower lid mobility. Another limitation of this study is the very small distances measured in the assessment of LLE, because even small errors of measurement could result in significant effects on the results. A third limitation is that wounds continue to contract beyond the year-long average follow up period in our study and longer follow-up times are necessary to ascertain whether the measured improvement in LLE is maintained.

In conclusion, in this retrospective cohort study, patients in whom autologous conchal cartilage (surgically placed between the tarsal plate and lower lid retractors) was used to correct lower lid retraction, had satisfactory functional and cosmetic outcomes in both primary and secondary positions of gaze.

Patients who require correction of lower lid retraction can have correction in both primary and secondary positions of gaze if an appropriate surgical technique is employed. Previous studies have reported good results with autologous and synthetic material in the treatment of the cosmetic aspect of lid retraction in primary gaze, but no study in the literature has reported or quantified lid excursion in downgaze. Lower lid excursion is an important parameter in any lower lid reconstruction technique and it is relatively straightforward to address. Autologous conchal cartilage, placed between the tarsal plate and lower lid retractors, gives patients satisfactory functional and cosmetic outcomes in both primary and secondary positions of gaze.

Future studies should be larger, prospective studies with significantly longer follow-up times, which may help to better elucidate the risks and complications associated with, as well as the efficacy of, the technique. Future studies should also measure the parameter of lid excursion as an indicator of a successful surgical outcome, both functionally and cosmetically.

Conflict of interest statement

None.

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