Incidence of diplopia after division and reattachment of the inferior oblique muscle during orbital fracture repair

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- Independent Study Project edition for Jeff Tsao, UCSD MS4, Class of 2017
- ISP Chair: Dr. Bobby Korn
- ISP Committee Members: Dr. Don Kikkawa and Dr. Ramzi Alameddine

Generously supported by the Research to Prevent Blindness, New York, NY, and the UCSD Vision Research Center Core Grant P30EY022589. None of the authors have any financial interests to disclose.

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SUMMARY

Background: Wide surgical access to the orbital floor and medial wall is often impaired by the inferior oblique muscle. There is no current consensus on the optimal surgical approach for exposure, and techniques involving inferior oblique disinsertion are generally shunned for concern of possible complications.

Objective: To determine the safety and outcomes of inferior oblique division and reattachment for surgical access to the orbital floor and medial wall.

Methods: This is a retrospective, single-center review of 85 patients that underwent orbital floor, medial wall or combined fracture repair with division and reattachment of the inferior oblique near its origin. Measured characteristics include surgical approach, type of surgery, time to surgery, pre- and post-operative diplopia, enophthalmos, and complications.

Results: Forty-five patients (52.9%) with no pre-operative diplopia were followed up for a mean of six months. Of them, six patients (13.3%) developed post-operative binocular diplopia that resolved in all but one patient (2.2%). No patients developed torsional diplopia. One patient developed a hematoma two years later attributable to capsular contraction around the implant.

Conclusion: Division and reattachment of the inferior oblique muscle is a safe method that allows for panoramic surgical visualization of the inferior and medial orbit.

KEYWORDS: surgical technique, orbital fracture, diplopia, inferior oblique division, disinsertion, reattachment

MANUSCRIPT

INTRODUCTION

Wide surgical access to the inferior or medial orbit is often required in cases of combined orbital fracture repair, large orbital tumor resection, or orbital decompression surgery. A panoramic view of the inferior and medial orbit is reliably obstructed by the inferior oblique muscle as it originates from the maxillary bone to its insertion behind the macula (Riordan-Eva, 2011). Numerous reports in the literature describe different techniques of addressing the inferior oblique to improve surgical visualization, but no consensus currently exists on the optimal approach. The main concern of manipulating the inferior oblique muscle is disruption of function and subsequent complications, such as diplopia. In this study we report the incidence and nature of complications following division and reattachment of the inferior oblique muscle near its origin during orbital fracture repair.

METHODS

We performed a retrospective chart review of 85 patients who underwent orbital floor or combined floor and medial wall fracture repair at a single institution from August 2007 to December 2014. All patients with diplopia prior to fracture repair, history of strabismus, or thyroid eye disease were excluded so that any cases of diplopia could be attributed to surgery.

All cases were performed under general anesthesia. After a lateral canthotomy and inferior cantholysis, an inferior transconjunctival incision was carried inferiorly to the orbital rim in a pre-septal plane. For fractures involving the orbital floor and medial wall, the transconjunctival incision was medially extended in a plane between the caruncle and the plica semilunaris. Dissection was carried medially and posteriorly to the medial wall behind the posterior lacrimal crest. In all cases, the inferior oblique muscle was identified and isolated with a Von Graefe or Green muscle hook (Katena Inc, Denville, NJ), imbricated with a 6-0 Vicryl suture, and divided, leaving a 2-3mm proximal muscle stump near its origin (Figures 1A-1D and Video 1). Following a subperiosteal dissection, a titanium mesh implant embedded with porous polyethylene (Medpor Titan Barrier MTB, Stryker, Kalamazoo, MI) was fashioned and used to cover the defect in all cases. At the conclusion of the fracture repair, the inferior oblique was reinserted at the muscle stump, and the conjunctival incision was closed using a running 6-0 fast-absorbing gut suture.

Measured characteristics include slit lamp examination findings, patient time to surgery, diplopia, and enophthalmos. The incidence and nature of postoperative complications including diplopia was determined in patients who did not have any preoperative diplopia. Surgical dissection was performed on a fresh-frozen cadaveric head supplied by the Department of Anatomy, University of California San Diego. A search of the PubMed database 1966–2015 was conducted using various combinations of the key words orbital fracture, inferior oblique, orbital floor,

medial wall, transcaruncular, and transconjunctival. Articles in all languages were considered, provided that the non-English articles included English abstracts. This study complies with the tenets of the Declaration of Helsinki and Health Insurance Portability and Accountability Act Regulations. An Institutional Review Board approval was obtained for this study (Project Number #161076).

RESULTS

Forty-five patients (52.9%) that did not have pre-operative diplopia were followed up for a mean of six months (range 2–60 months). In this group, average age was 39 years (range 11–73 years). Thirteen patients (28.9%) were female and 32 (71.1%) were male. Twenty-six patients (57.8%) had an orbital floor fracture, while 19 (42.2%) had a combined orbital floor and medial wall fracture. One patient had previous fracture repair performed elsewhere. The median time interval between fracture incident and surgical intervention was 60 days (range 1-360 days). Mean preoperative relative enophthalmos was -2.2 ±0.8 mm, and improved postoperatively to -0.4 ±0.53 mm. Six patients (13.3%) complained of new-onset postoperative binocular diplopia, that resolved in all but one patient. Average time to resolution was three months (range 2-6 months). One patient (2.2%) developed persistent binocular vertical diplopia with upgaze, but was lost to follow-up after the second postoperative month. All patients were orthotropic in primary gaze, two patients had mild supraduction deficit, and no patients developed persistent torsional diplopia. One patient (2.2%) developed proptosis from a hematoma within the implant capsule two years postoperatively owing to recent institution of clopidogrel. The hemorrhage was drained and the patient's proptosis resolved without development of diplopia.

DISCUSSION

Surgical access to the medial orbit remains technically challenging. The transcaruncular approach, first described by Garcia, allows for direct visualization and a cosmetically suitable incision (Garcia et al, 1998). It can be combined with the inferior transconjunctival approach to provide open access to the inferior and medial orbit (Edgin et al, 2007; Su and Harris, 2006). A panoramic view can be obtained by disinserting the inferior oblique muscle that crosses the field as it stems out from its maxillary bone origin. The wide surgical access and visualization also allows for the insertion of large orbital implants.

Various techniques have been described on handling the inferior oblique muscle, but there is no current consensus on the optimal approach. Earlier case reports advocated for disinserting the muscle from its periosteal attachment, allowing it to spontaneously reattach postoperatively (Edgin et al, 2007; Cho and Davies, 2013; Shorr et al, 2000)). Other variations include suturing the periorbita to the inferior orbital rim at the end of procedure (Shorr et al, 2000; Malhotra et al, 2007; Scolozzi, 2011). Rodriguez described a similar technique to the one we present, that involves dividing the inferior oblique muscle, while leaving a small

muscle cuff at its origin to suture it back into at the conclusion of surgery (Rodriguez et al, 2009).

Few papers report on the long term sequelae of using these techniques. The most relevant complication is a disruption of function secondary to inferior oblique manipulation, causing underaction or even torsional binocular diplopia. Diplopia has been previously reported mostly in cases where the inferior oblique muscle was left to passively re-adhere after disinsertion (Tiedemann et al, 2014; Cho and Davies, 2013; Malhotra et al, 2007; de Haller R et al, 2012). Although most of these cases of diplopia were transient and likely secondary to muscle paresis (de Haller R et al, 2012), Tiedemann demonstrated persistent postoperative binocular diplopia with hypotropia and incyclotropia secondary to failure of inferior oblique reattachment. They hypothesized that a postoperative hematoma, seen on computed tomography imaging, hindered the reattachment of the muscle that was found to be flaccid on surgical exploration (Tiedemann et al, 2014). Similarly, studies on orbital decompression surgeries implicated the inferior oblique disinsertion without reattachment as a risk factor for postoperative torsional diplopia (Serafino et al, 2010).

In this study, we report on the safety of inferior oblique division and reattachment in cases of large orbital floor or combined floor and medial wall fractures. No patients developed persistent postoperative torsional diplopia. Six patients (13.3%) had postoperative binocular diplopia that was transient in all but one patient (2.2%) that was lost to follow up at two months postoperatively. The patient had improving binocular vertical diplopia, likely secondary to inferior rectus temporary paresis or postoperative hematoma.

We believe the division of the inferior oblique muscle distal to its origin allows for preservation of the periosteal attachment and prevents inadvertent damage to the medially located lacrimal sac. Also, identification and reflection of the inferior oblique from the operative field protects the muscle from manipulations and possible damage, especially in trauma cases where the anatomy is disrupted and periosteal integrity is compromised. Reattaching the muscle to its origin results in anatomic reduction of tissues, which avoids muscle paresis secondary to periosteal malunion (Tiedemann et al, 2014), or rarely fat adherence syndrome (Kushner, 2007).

Limitations of this paper include the retrospective nature of the study and small sample size. While future studies can further elucidate the incidence and nature of the underreported and overlooked early postoperative diplopia, the results of this study suggest that inferior oblique disinsertion and reattachment can be safely performed during large orbital floor and combined floor and medial wall fracture repair.

ACKNOWLEDGMENTS & CONFLICT OF INTEREST

Contributors

- Jeffrey Tsao: Interpretation of data, drafting of manuscript, revisions
- Ramzi Alameddine: Design of study, acquisition, analysis and interpretation of data; drafting of macuscript, revisions
- Audrey Ko: Interpretation of data, revisions of manuscript
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- Don Kikkawa: Conception and design of study, revisions of manuscript
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All authors have approved the final article.
Study has been approved by the University of California, San Diego Institutional Review Board and informed consent obtained from all patients.
Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
Conflicts of interest: None.

Table 1. Literature review.

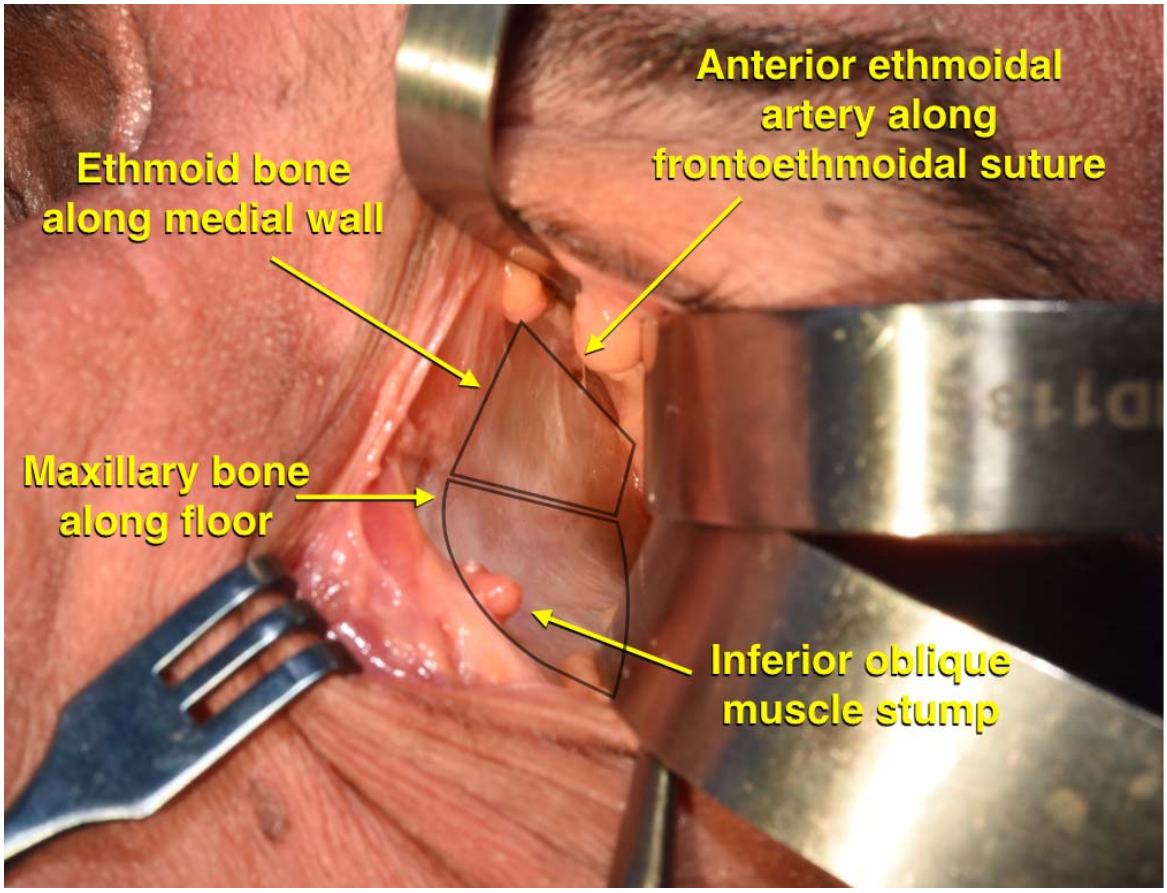
Publication	Number of patients	Orbital fracture	Access	IO technique	Diplopia
Transcaruncular approach to the medial orbit and orbital apex (Shorr et al. 2000)	10	Medial + inferior wall	Inferior fornix-transcaruncular	disinserted + reposited (6), disinserted + sutured (2), left intact (2)	none developed post-op diplopia, fat adherence syndrome uncommon
The transcaruncular approach in repair of orbital fractures: a retrospective study (Garcia, Goldberg, Shorr 1998)	8	Medial + inferior wall	Inferior fornix-transcaruncular		persistent IO underaction (1), also extensive cicatrization (1)
Combined orbital floor and medial wall fractures involving the inferomedial strut: repair technique and case series using preshaped porous polyethylene/titanium implants (Cho & Davies 2013)	17	Medial + inferior wall	Transcaruncular-transconjunctival	disinserted with periosteal elevator	no persistent new or worsened diplopia post-op, some mild vertical/torsional diplopia that resolved within 1-2 weeks
Inferior oblique underaction: a transient complication related to inferior orbital wall fracture in childhood (Lee et al. 2013)	137	Inferior wall	Transconjunctival	not specified, likely elevated with periosteum	IO underaction in 3 pre-op and 9 post-op, but all resolved by 2 months
A combined transcaruncular transconjunctival approach to orbital medial wall fractures (Scolozzi 2010)	10	Severe medial wall or combined medial+inferior wall	Transcaruncular-transconjunctival	divided at insertion with scissors at medial part of inferior orbital rim, periorbita sutured to periosteum with running 5-0 Vicryl	IO underaction compensated by SO seen in all cases, no persistent diplopia

Pseudo-Brown syndrome: A potential ophthalmologic sequela after a transcaruncular-transconjunctival approach for orbital fracture repair (deHaller, Imholz, Scolozzi 2012)	14	Medial wall (8), combined medial-inferior wall (6)	Transcaruncular-transconjunctival	“ “	IO underaction with diplopia limited to extreme upgaze in adduction that didn’t interfere with daily activity (7), pre-operative diplopia limited to extreme upgaze in abduction (4)
Extended transcaruncular approach using detachment and repositioning of the inferior oblique muscle for the traumatic repair of the medial orbital wall (Rodriguez et al. 2009)	10	Medial wall (3), medial+inferior wall (6), orbital apex syndrome (1)	Transcaruncular-transconjunctival	marked with suture, detached from origin, restored with suture (5)	diplopia corrected in all but one pt with an injured inferior rectus
The transcaruncular approach to orbital fracture repair: ophthalmic sequelae (Malhotra et al. 2007)	12	Medial wall (5), medial+inferior wall (8)	Transcaruncular-transconjunctival	disinserted with periosteal elevator	IO underaction (1), improved diplopia post-op (6), persistent in upgaze (3)
Combined inferior and medial surgical approaches and overlapping thin implants for orbital floor and medial wall fractures (Su and Harris 2006)	18	medial+inferior orbital wall fracture	extended transcaruncular	not specified, likely elevated with periosteum, “may require disengaging the origin of the inferior oblique muscle”	no new-onset diplopia
Iatrogenic inferior oblique palsy: intentional disinsertion during transcaruncular approach to orbital fracture repair (Tiedemann 2014)	1	orbital blowout (medial wall, orbital floor, orbital strut)	Transcaruncular-transconjunctival	stripped from origin, left to passively re-adhere	Hypotropia and incyclotorsion

Table 2. Summary of cases.

Total Cases Reviewed	Pre-operative Diplopia	Age (Mean)	Sex	Fracture Type	Mean Pre-operative Enophthalmos	Mean Post-operative Enophthalmos	Follow up period	New-onset post operative Diplopia	Complications
85 Patients	40 Patients with diplopia (47.1%) 45 Patients without diplopia (52.9%)	39 years (Range 11-73)	32 Male (71.1%) 13 Female (28.9%)	Orbital floor 26 Patients (57.8%) Combined floor and medial wall 19 Patients (42.2%)	-2.2 mm (±0.8 mm)	-0.4mm (±0.53 mm)	6 months (Range 2-60)	6 Patients with transient diplopia (13.3%) 1 Patient lost to follow up with improving diplopia at 2 months postop	1 Patient with orbital hematoma 2 years post operatively

Figure 1. Cadaveric dissection demonstrating the ample exposure of the medial wall and floor of the orbit afforded by division of the inferior oblique.



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