Evolution of the surgical approach to the orbitozygomatic fracture: from a subciliary to a transconjunctival and to a novel extended transconjunctival approach without skin incisions

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Summary

*Background***:** Surgical approach to the orbitozygomatic fracture evolved in the last 20 years to limit skin incisions and minimize external scars.

*Methods***:** The approach to the orbitozygomatic fracture was evaluated by a retrospective chart review from 1992 to 2012 and advantages, disadvantages and complications were studied.

Results: Surgical approach to the orbitozygomatic fracture evolved from a subciliary approach to a transconjunctival approach and to a novel extended transconjunctival approach without skin incisions in the last 20 years. **The greatest advantage of using an extended transconjunctival approach is wide exposure of the inferior orbital rim, orbital floor, lateral orbital wall, and the frontozygomatic suture in one unobstructed operative field without any skin incisions.** Precise assessment of the reduction at the sphenozygomatic suture is possible with wide exposure of the lateral orbital wall. **Because the dissection plane in a transconjunctival approach is entirely posterior to the lacrimal apparatus, the medial incision can be placed medially beyond the lacrimal punctum and by combining this approach with the transcaruncular approach, a wide operative field for the medial orbital wall can be obtained, which is the most advantageous point for choosing a transconjunctival approach over a subciliary approach.** Complication rate was comparable to a subciliary approach.

Conclusions: **The author advocates an extended transconjunctival approach for orbitozygomatic fractures to avoid skin incisions and to precisely assess the reduction status.**

Keywords

orbitozygomatic fracture; zygomaticomaxillary complex fracture; extended transconjunctival approach; **extended transcaruncular approach**; frontozygomatic suture; sphenozygomatic suture

Introduction

Although three-point fixation has been the traditional gold standard for zygomaticomaxillary complex (ZMC) fracture fixation, recent trend toward minimally invasive approach has been to limit skin incisions to minimize external scars.[1-3] A transconjunctival approach has been shown to be superior to a lower eyelid approach in terms of postoperative lower lid deformity,[4-6] it has been criticized for poor exposure of the lateral orbital wall and the lateral orbital rim without a lateral canthotomy.[7]

An extended transconjunctival approach has been developed to overcome this limitation of restricted operative field and to enable fixation of the frontozygomatic suture without any skin incisions. This study was carried out to review the evolution of the surgical approach to the orbitozygomatic fracture and to evaluate its advantages, disadvantages, and complications.

Surgical technique

Extended transconjunctival approach

A generous conjunctival incision was made from the lacrimal punctum to the lateral edge of the tarsal plate just inferior to the inferior tarsal margin, which is about 5 mm from the lid margin. Then the dissection is anterior to the orbital septum (preseptal approach) to avoid a prolapse of the intraorbital fat. A periosteal incision was carried out inferior to the arcus marginalis and the lateral periosteal incision is extended superolaterally along the lateral orbital rim and the conjunctival incision is also extended accordingly. By retracting the orbital content medially with a malleable retractor and the soft tissue lateral

to the lateral orbital rim laterally with a Ragnell retractor, the lateral orbital rim appears as a ridge line. The periosteum along the lateral orbital rim will be incised by inserting one blade of scissors under the periosteum and cutting this ridge line until the frontozygomatic suture is reached (Figure **1**). Although the anterior limb of the lateral canthal ligament is not disturbed, the posterior limb of the lateral canthal ligament is either transected or stripped off (Figure **2**) and by subperiosteal dissection the tight attachment of the lateral canthal area is freed from the lateral orbital rim. Further subperiosteal dissection beyond the frontozygomatic suture offers a wide operative field of the lateral orbital wall (Figure 3).

No Frost sutures are placed to support the lower eyelid postoperatively. To prevent postoperative lower eyelid descent, the periosteum is closed at the inferior orbital rim and the lateral orbital rim. If the periosteum is found to be fragile or severely torn and does not support the lower eyelid, the soft tissue around the periosteum of the lower eyelid is sutured to drill holes made at the inferior orbital rim to prevent lower eyelid or cheek sagging. In case postoperative chemosis is anticipated lateral and sometimes medial temporary tarsorrhaphy is placed for several days.

Patients and methods

All orbitozygomatic fractures treated by the Department of Plastic and Reconstructive Surgery at Okinawa Chubu Hospital, Uruma City, Japan were evaluated by a retrospective chart review. Institutional review board approval was obtained. All facial fracture cases were extracted from the prospectively maintained operating room database from 1992 to 2012 with keywords of ‘facial fracture’ or ‘orbital fracture’. Three hundred and thirty-nine cases were found excluding an isolated nasal fracture. Of these 339 cases, a retrospective chart review was carried out and fracture sites, fixation sites, operative approaches, mechanism of injury, follow-up period, complications, and outcome were input

into a FileMaker Pro 12 database, FileMaker, Inc. CA, USA. Fractures involving ZMC, orbital floor, medial orbital wall accounted for 275 cases, with 195 ZMCs, 139 orbital floors, and 32 medial orbital walls. Of these 275 cases, 15 secondary reconstruction cases were excluded, leaving 260 cases of acute orbitozygomatic fractures. One case with excessive bleeding for which transarterial embolization was carried out and an open reduction and internal fixation of only the lateral buttresses was carried out without orbitozygomatic exploration was excluded. Two cases with minimally displaced ZMC that did not require orbitozygomatic exploration were excluded. Excluding these three cases left 257 cases which underwent orbitozygomatic exploration. Of these 257 cases, no out-patient record were available in six cases and the follow-up period was less than 30 days in 47 cases. These 53 cases were excluded leaving 204 orbitozygomatic fracture cases for detailed evaluation. All evaluated cases involved surgical approach to the orbit. There were 170 male and 34 female patients with ages ranging from 12 to 74 years with the average age of 36.1. Follow-up period ranged from 45 to 2,493 days with the average of 401 days. Statistical analysis was carried out by chi-square test.

Results

Surgical approaches

All orbitozygomatic fractures

These 204 orbitozygomatic fractures involved 145 ZMCs, 111 orbital floors, 25 medial orbital walls, 22 naso-orbito-ethmoids (NOE), 17 maxillas without Le Fort fractures, 28 Le Fort fractures, 8 split palates, 2 sphenoids, 4 superior orbital rims, 7 frontal bones, and 18 mandibles. Some overlaps of the fractures existed, e.g. 60 cases of ZMC fractures with orbital floor fractures.

There were 87 right side fractures and 99 left side fractures with 18 bilateral fractures. For detailed evaluation of the surgical approach and the outcome, each side was treated

as an individual fracture and the evaluation was made based on fracture sides, not on fracture cases. This converts 204 orbitozygomatic fracture cases to 105 right sides and 117 left sides with a total of 222 orbitozygomatic fractures.

These 222 fractures were approached by 29 subciliary approaches (right 16, left 13) and by 179 transconjunctival approaches (right 80, left 99), which included **11** extended transconjunctival approaches (right 4, left **7**) introduced in 2009 (Figure **4**). The remaining 14 fractures were approached by lacerations in 11 fractures, by a laceration combined with an upper eyelid incision and a lateral canthotomy in one fracture, and by lateral upper blepharoplasty incisions in two fractures for fixation of the frontozygomatic suture.

ZMC fractures

Of these 204 orbitozygomatic fractures, ZMC fractures accounted for 145 cases (right 65, left 75, bilateral 5, total 150 sides). This converts 145 ZMC fracture cases to 70 right sides and 80 left sides with a total of 150 ZMC fractures.

These 150 ZMC fractures were approached by 24 subciliary approaches (right 10, left 10, bilateral 2) and by 117 transconjunctival approaches (right 50, left 61, bilateral 3), which included **11** extended transconjunctival approaches (right 3, left **6**, bilateral 1).

The frontozygomatic suture was fixated in 118 fractures out of 150 ZMC fractures (78.7%), the inferior orbital rim was fixated in 135 fractures (90.0%), and the lateral buttress was fixated in 138 fractures (92.0%) **through a gingivobuccal sulcus incision**.

The approach to the frontozygomatic suture was by lateral brow incisions in 4 fractures (3.4%), by lateral upper blepharoplasty incisions in 21 fractures (18%), by lateral canthotomies in 44 fractures (37%), by extended transconjunctival approaches in **11** fractures (**9.3**%), by coronal incisions in **11** fractures (**9.3**%), and by lacerations in the remaining **27** fractures (22%) (Figure **5**).

Coronal incisions were used in **15** cases out of 145 cases (**10**%), or **18** fractures out of 150 fractures (**12**%, **12** unilateral and 3 bilateral ZMCs) mainly for reduction and fixation of the zygomatic arch and NOE fractures (zygomatic arch and NOE fixation in 6 cases, zygomatic arch fixation in 4 cases, NOE fixation in 2 cases, superior orbital rim fixation in 1 case, **superior orbital rim and zygomatic arch fixation in 1 case,** and calvarial bone graft for medial orbital wall fracture in 1 case). After introduction of an extended transconjunctival approach in 2009, **only one** coronal **incision was** used **for fixation of the zygomatic arch and the superior orbital rim**.

Orbital floor/medial orbital wall fractures

Of these 204 orbitozygomatic fractures, 120 orbital floor and/or medial orbital wall fractures were found. ZMC fractures, NOE fractures, maxillary fractures, and Le Fort fractures were excluded from these 120 fractures leaving 48 cases with pure orbital floor and/or medial orbital wall fracture for evaluation. There were 19 right orbital floor/medial orbital wall fractures and 29 left orbital floor/medial orbital wall fractures and no bilateral cases were found. Orbital floor fractures accounted for 40 cases and medial orbital wall fracture 15 cases with 7 combined orbital floor and medial orbital wall fractures. Forty-seven cases were approached by a transconjunctival approach and one case was approached by a subciliary approach. Calvarial bone graft was carried out in 32 cases, rib graft was done in one case, hydroxyapatite implant was used in five cases and in 10 cases no graft material was used.

Complications

Fifty-three cases of complications were detected in the all 222 orbitozygomatic fractures. From these 53 cases, 34 complications not related to the surgical approach were excluded. These 34 cases overlapped and were not exclusive, which included 9

infectious complications, 7 cases of posttraumatic enophthalmos, 4 cases of facial deformity from original injury, e.g. lower lid avulsion, 4 cases of ocular motility disorders, 3 cases of exposed hardware, 3 nasolacrimal drainage obstructions from the original injury, 2 cases of abnormal tooth sensation, one case each of tooth injury during anesthetic induction, carotid-cavernous sinus fistula from the original traumatic event, postoperative hematoma, loosened intermaxillary fixation, malposition of intraorbital calvarial bone graft, malunited ZMC fracture, cheek sagging, posttraumatic eyelid ptosis, and inflammatory intraorbital mass adjacent to hydroxyapatite orbital floor implant. Excluding these 34 complications left 19 complications directly related to the surgical approach.

Two cases of transient scleral show and ectropion were detected in the 29 subciliary approaches (6.9%). In the 179 transconjunctival approaches, including **11** extended transconjunctival approaches, 3 symblepharons were detected (1.7%). Two of three symblepharons were released under local anesthesia as an office procedure. Six cases of entropion, one case of ectropion, and two cases of trichiasis occurred after transconjunctival approach (3.4%, 0.6%, and 1.1%). Two lacrimal canaliculus avulsion were detected after transconjunctival approach (1.1%), both of which were repaired intraoperatively under microscope without long term sequelae. Four conjunctival granulations were detected after transconjunctival approach (2.2%), three of them disappeared spontaneously and the other one was excised under local anesthesia as an office procedure. One lateral canthotomy out of fifty-three after transconjunctival approach caused granulation formation at the lateral canthal area with lateral ectropion, which required lateral canthal revisional surgery (0.19%). In summary, complications resulting in lower lid deformity was 6.9% after subciliary approach, all of which was transient ectropion and 4.5% after transconjunctival approach ($p = 0.921$), namely 6 entropions (3.4%) and one each case (0.6%) of lateral canthal malposition and ectropion.

Discussion

The criticism against a transconjunctival approach which is a limited operative field for the lateral orbital wall and the lateral orbital rim was overcome by adding a lateral canthotomy.[4, 5, 8] Figure **5** shows evolution of the approach to the frontozygomatic suture for ZMC fractures. For the fixation of the frontozygomatic suture, a lateral brow incision is still popular in Japan. However, this leaves sometimes an unsightly scar **in** Oriental patients and this approach was used only in four patients during the early period of this study. Combined with a transconjunctival approach, a lateral canthotomy had been used extensively for the purpose of approaching the frontozygomatic suture until 1998, when a lateral upper blepharoplasty incision was first used. A lateral upper blepharoplasty incision is located directly over the frontozygomatic suture and heals very well with a barely noticeable scar.[8-10] After using a lateral upper blepharoplasty incision, utilization of a lateral canthotomy decreased but was not eliminated entirely. The problem of using a lateral upper blepharoplasty incision was that the operative field is separated into two narrow fields; one for the inferior orbital rim and the orbital floor and the other for the frontozygomatic suture and the lateral orbital wall, and one has to move from one field to the other back and forth. The lateral orbital wall contains the sphenozygomatic suture, one of the most important reference structures for reduction,[11-14] and direct wide exposure of the lateral orbital wall is necessary for precise reduction of the ZMCs especially when other reference structures are comminuted. Because of a small operative field and a tangential approaching angle, exposure of the lateral orbital wall is significantly limited from a lateral upper blepharoplasty incision and accurate assessment of the reduction is difficult. This had been the main reason to remain choosing a lateral canthotomy over a lateral upper blepharoplasty incision to approach the lateral orbital wall when accurate assessment of the sphenozygomatic suture was required.

In 2009 an extended transconjunctival approach was first utilized for **a** displaced ZMC fracture of a 12-year-old girl and three-point fixation was feasible without any skin incisions (Figures **6**, **Figure 13 top left,** see Supplementary Video Content). Since this experience, this extended transconjunctival approach has been increasingly applied and practically replaced a lateral canthotomy and a lateral upper blepharoplasty incision.

The advantage of using an extended transconjunctival approach is wide exposure of the inferior orbital rim, orbital floor, lateral orbital wall, and the frontozygomatic suture in one unobstructed operative field. In selected cases, plate fixation of the sphenozygomatic suture is possible, which is very useful when other fixation point is comminuted and the facial projection is lost with laterally displaced zygomatic arch and a coronal approach would otherwise be required.[11-15] By using this sphenozygomatic suture as a three-dimensional reference structure and a fixation point,[16] an extended transconjunctival approach **reduced** the need for a coronal approach (Figures **7, 8**).

Because the dissection plane in a transconjunctival approach is entirely posterior to the lacrimal apparatus, the medial incision can be placed medially beyond the lacrimal punctum and **by combining this approach with a transcaruncular approach,** a wide operative field for the medial orbital wall can be obtained, which is the most advantageous point for choosing a transconjunctival approach over a subciliary approach.

Currently we are extending the transcaruncular approach further superiorly and the frontomaxillary suture can be approached without skin incisions. We started using this *extended transcaruncular approach* for fixation of single-segment type I naso-orbito-ethmoid (NOE) fracture[17] in December 2012 and have utilized this approach for six cases as of the end of 2014. Combination of this *extended transcaruncular approach* and the extended transconjunctival approach offers a very wide operative field extending from the frontomaxillary suture, medial orbital

wall, orbital floor, lateral orbital wall, and to the frontozygomatic suture without any skin incisions (Figure 9-12).

One of the most concerned aspects of applying this extended transconjunctival approach is disruption the posterior limb of the lateral canthal ligament from the Whitnall's tubercle. Paul Manson, et al. stated that canthal reattachment is not required in acute fracture treatment[8]. The differentiating factors that require canthal reattachment are the presence of soft tissue scarring and the use of a coronal incision which frees the periorbita along the roof of the orbit. All the patients who underwent the extended transconjunctival approach did not undergo a coronal incision and no soft tissue scarring was present around the lateral canthal area. They also stated that the anterior limb of the lateral canthal ligament is a thickening of the orbicularis fascia and is continuous with the temporal fascia and galea aponeurotica. The diffuse connections of this limb facilitate proper position of the lateral canthus after mobilization of the posterior limb. The author agrees and by closing the periorbita after the extended transconjunctival approach, the anterior limb of the lateral canthal ligament is repositioned properly and no canthal malposition ensued. Figure 13 showed eight consecutive patients with this approach without reattachment of the lateral canthal ligament. None of the patients showed lateral canthal malposition six to twelve months postoperatively.

For the purpose of sparing skin incisions to approach the frontozygomatic suture, upper lid transconjunctival approach has been reported.[18, 19] Although this approach obviates the need for lateral canthotomy incision, it suffers the same limitation as a lateral upper blepharoplasty incision that the operative field is separated into two narrow fields.

As to the complications, a transconjunctival approach was associated with lower complication rate of lower lid deformity as compared to a subciliary approach (4.5% vs 6.9%), which is in accordance with the previous reported series[4-6] but did not reach

statistical significance (p = 0.921). However, all the complications from a subciliary approach were transient ectropions and scleral shows and did not require surgical intervention. On the other hand, in a transconjunctival approach, two lacrimal canaliculus transection required immediate intraoperative repairs and two symblepharons and one conjunctival granulation required office procedures under local anesthesia. Three out of six entropions were treated by palatal mucosal graft under general anesthesia. In total there were eight complications requiring surgical interventions or office procedures in 179 transconjunctival approaches (4.5%) as compared to 0% in the 29 subciliary approaches (p=0.522). Despite no statistical significance, this fact is not overlooked and should be kept in mind that the complications resulting from a transconjunctival approach tended to require more surgical interventions than after a subciliary approach.

These high complication rate might have occurred from too much traction for difficult reduction of displaced ZMC fractures, and a separate analysis between ZMC fractures and pure orbital floor/medial orbital wall fractures was undertaken. If all the complications were included, 18 complications (6 entropions, 1 lateral canthal malposition, 1 ectropion, 2 lacrimal canaliculus transections, 3 symblepharons, 1 trichiasis, and 4 granulations) were noted in 117 ZMC fractures (15.4%), as compared to 2 complications (one each of trichiasis and granulation) in 47 pure orbital floor/medial orbital wall fractures (4.3%). Although statistical significance was not reached (p=0.088), there clearly was a trend of increasing complications in ZMC fractures. Every attention should be paid to avoid excessive traction.

Conclusions

The greatest advantage of using an extended transconjunctival approach is wide exposure of the inferior orbital rim, orbital floor, lateral orbital wall, and the frontozygomatic suture in one unobstructed operative field without any skin

incisions. It can be combined with a transcaruncular approach to further extend the operative field to include the medial orbital wall and frontomaxillary suture for fixation of a single-segment type I NOE fracture.

Conflict of interest

None.

Funding

None.

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Figure legends

Figure 1

Intraoperative view showing that the periosteal incision is being extended superolaterally by inserting one blade of scissors under the periosteum and cutting the ridge line toward the frontozygomatic suture.

Figure 2

Schematic diagram of the dissection plane of an extended transconjunctival approach. The posterior limb of the lateral canthal ligament is either transected or stripped off (red dashed arrow).

Figure 3

A wide operative field obtained by an extended transconjunctival approach. The frontozygomatic suture and the sphenozygomatic suture are widely exposed in one unobstructed operative field. **Ragnell retractor lateral to the lateral orbital rim is retracting the periosteum dissected from the lateral orbital rim and the anterior limb of the lateral canthal ligament is not disrupted, only to be retracted over the periosteum.**

Figure 4

Approach to the orbit. The approach to the orbit evolved from a subciliary approach to a transconjunctival approach and then to an extended transconjunctival approach. The transition occurred in 1995 and in 2009.

Figure 5

Approach to the frontozygomatic suture for ZMC fractures. The approach to the frontozygomatic suture evolved from a lateral brow incision, a lateral canthotomy, and to a lateral upper blepharoplasty incision, and then to an extended transconjunctival approach.

Figure **6**

A 12-year-old girl with a posteriorly displaced left ZMC fracture. Three-point fixation through an extended transconjunctival approach and a gingivobuccal sulcus incision without skin incisions.

(above) preoperative CT. (below) postoperative CT.

See also Supplementary Video Content.

Figure 7

A 17-year-old boy with a left ZMC fracture.

(above) Preoperative CT: The left ZMC was posteriorly displaced (blue arrows) with comminution of the lateral buttress and inferior orbital rim. There was only an incomplete greenstick fracture at the left lateral orbital wall, which resisted every attempt at reduction, and the left zygomatic arch was overly bowed (blue arrowheads) with a fracture at the base of the zygomatic process of the temporal bone.

(below) Postoperative 3D CT: Note the gap at the sphenozygomatic suture was maintained with sphenozygomatic fixation (yellow circle) with proper facial projection re-established without fixation of the zygomatic arch, which otherwise would have been required. Fixation of the comminuted lateral buttress was spared (red circle), which would have required extensive subperiosteal dissection and could have resulted in segmentalization of the lateral buttress.

Figure 8

The same case as in Figure 7.

Every attempt to reduce the posteriorly displaced left zygoma failed and **osteotomies** of the left frontozygomatic suture and sphenozygomatic suture **were** required. After the sphenozygomatic osteotomy through an extended transconjunctival approach, the displaced zygoma was pulled forward (yellow arrow) and was fixated at the sphenozygomatic suture with a square-shaped micro three-dimensional titanium plate. Wide exposure offered by the extended transconjunctival approach enabled accurate reduction and fixation.

Figure 9

A 53-year-old male with a single-segment type I left NOE fracture.

(above) Preoperative CT: The fractured medial maxillary segment was displaced posteriorly (yellow arrowheads) with separation of the frontomaxillary suture (yellow arrow).

(below) Postoperative CT: Three-point fixation of the NOE fracture was carried out through an extended transcaruncular approach combined with a transconjunctival approach. The medial buttress was plated through a gingivobuccal sulcus incision. No skin incisions were made.

Figure 10

The same case as in Figure 9.

Intraoperative photograph of the plate fixation for the NOE fracture. The dissection plane was posterior to the posterior lacrimal crest and superior to the medial canthal ligament. The operative field was just sufficient for three-hole plate fixation.

Figure 11

The same case as in Figure 9.

6-month postoperative photograph. No eyelid deformity, nor cutaneous scar were present with good restoration of the naso-orbital valley.

Figure 12

Schematic drawing of an extended transconjunctival approach and extended transcaruncular approach.

A periosteal incision will be extended superolaterally beyond the frontozygomatic suture (yellow arrow: extended transconjunctival approach) and superomedially beyond the frontomaxillary suture (green arrow: extended transcaruncular approach). The area shaded by pink color is a very wide operative field obtained by combined extended transconjunctival and extended transcaruncular approach.

Figure 13

Eight consecutive patients after open reduction and internal fixation of the ZMC fracture utilizing an extended transconjunctival approach without skin incisions. Posterior limb of the lateral canthal ligament was stripped off without canthal reattachment in all cases. No patient showed lateral canthal malposition postoperatively. Stars indicate the operated side.

(left from top to bottom) a 12-year-old girl with a left ZMC fracture, 6-month postoperative photograph, the same patient as in Figure 6 and in the Supplemental Video Content, a 17-year-old male with a left ZMC fracture, 1-year postoperative photograph, a 24-year-old male with a left ZMC fracture, 6-month postoperative photograph, an 18-year-old male with a left ZC fracture, 7-month postoperative photograph

(right from top to bottom) a 17-year-old female with a left ZMC fracture, 6-month postoperative photograph, a 59-year-old male with a right ZMC fracture, 9-month postoperative photograph, a 25-year-old male with a right ZMC fracture, 6-month postoperative photograph, a 28-year-old male with a right ZMC fracture, 7-month postoperative photograph