Superior Cantholysis for Zygomatic Fracture Repair

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Objective: To determine if performing a superior cantholysis eases the surgical exposure, reduction, and rigid fixation of the zygomaticofrontal suture in the open repair of zygomatic complex (ZMC) fractures.

Patients and Methods: Fifteen superior cantholysis procedures were used in 14 patients who presented with ZMC fractures requiring open reduction and internal fixation. Follow-up ranged from 6 to 18 months. Collected data included patient demographics, cause of fracture, fracture classification, associated facial injuries, methods of fracture exposure and reduction, type and location of fixation, procedure-related complications, and postoperative outcome, including adequacy of fracture reduction.

Results: Superior cantholysis opens a direct surgical route to the zygomaticofrontal suture for exposure, reduction, and rigid fixation. It also expedites exposure and assessment of the sphenozygomatic suture. No postreduction ZMC malunions or malpositions occurred during the study. There were 4 complications, none of which could be attributed to superior cantholysis. The complications related primarily to the transconjunctival and lateral canthotomy incisions.

Conclusions: Superior cantholysis eases the surgical exposure, reduction, and rigid fixation of the zygomaticofrontal suture in the open repair of ZMC fractures. The superior cantholysis added no morbidity in open ZMC fracture repair, and it simplified exposure of the lateral orbital rim, without the need for overzealous tissue retraction.

Arch Facial Plast Surg. 2000;2:181-186

Traditional methods of exposing the zygomaticofrontal (ZF) suture during the repair of zygomatic complex (ZMC) fractures often lead to unsightly scarring or prolonged soft tissue swelling. Approaching the ZF suture by superior cantholysis avoids these problems, while providing superior access to the lateral orbital rim and sphenozygomatic suture.

The ZF suture has traditionally been accessed through a coronal flap, an infrabrow incision, lateral extension of the upper eyelid crease incision, or a lateral canthotomy. Although the coronal approach provides wide exposure of the upper ZMC and the ZF suture, it is best reserved for severely comminuted zygomatic fractures that are combined with midfacial or cranial fractures. The infrabrow incision is a transcutaneous approach for direct exposure of the ZF suture. It is the most convenient and simplest method with which to expose the suture, but it can lead to obvious scarring and contour irregularities in the lateral and infrabrow areas. The lateral extension of the upper eyelid crease (blepharoplasty) incision provides direct access to the ZF suture but has several drawbacks, including a noticeable scar, and a small strip of intervening skin is created between the upper blepharoplasty and lower canthotomy incisions that is prone to scar contracture. In the late 1980s, access to the ZF suture was described via the lateral canthotomy incision alone. To expose the suture and lateral orbital rim, complete mobilization of the lateral canthal ligament (lateral retinaculum), periorbita along the lateral orbital rim, and soft tissues over the lateral orbital rim is required. Although this tissue mobilization avoids an additional skin incision, exposure is more difficult than with a separate skin incision, and “the strong traction and mobilization required result in more postoperative swelling.” Supplementing the lateral canthal incision with superior cantholysis directly exposes the ZF suture, similar to the exposure provided in the upper blepharoplasty incision, but without the added morbidity of an additional skin incision.

Superior cantholysis frees the lateral aspect of the upper eyelid margin to swing superiorly, directly exposing the ZF suture. There is no need for extensive tissue retraction or mobilization of the tissues over the lateral orbital rim. Ac-
PATIENTS, MATERIALS, AND METHODS

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Fifteen superior cantholysis procedures were used in 14 patients who presented with ZMC fractures requiring open reduction and internal fixation. Follow-up ranged from 6 to 18 months. Collected data included patient demographics, cause of fracture, fracture classification, associated facial injuries, methods of fracture exposure and reduction, type and location of fixation, procedure-related complications, and postoperative outcome, including adequacy of fracture reduction. The fractures were classified as follows according to a simplified schema described by Zingg et al: type A1, isolated zygomatic arch fracture; type A2, isolated lateral orbital wall fracture; type A3, isolated infraorbital rim fracture; type B, tetrapod fracture; and type C, multifragmented ZMC fracture.

SURGICAL TECHNIQUES

Anatomy

Zygomatic complex fractures involve at least 4 skeletal disruptions, including the sphenozygomatic suture, inferior orbital rim and floor, ZF suture, and zygomaticomaxillary suture. To perform the superior canthal approaches in a safe manner and to mobilize the lateral retinaculum, a thorough understanding of the relevant anatomy is essential for maximizing surgical exposure, while minimizing the risk of injury to adjacent structures. An appreciation of the surface anatomy regarding the relationship of the inferior and superior lateral eyelid margins is critical. The configuration of the palpebral slit gives the illusion that the canthi are on different levels with respect to the true axial plane. However, the canthi and the insertions of the canthal ligaments should be on the same plane, falling directly on a true horizontal line extending across the nasion (Figure 1). The lateral aspect of the lower eyelid should gently slope upward toward its lateral insertion, and the eyelid margin should appear to fold under the lateral aspect of the upper eyelid margin (Figure 2). The lateral palpebral ligament includes superficial and deep limbs that course from the orbital septum and lateral tarsal borders to the lateral orbital rim. The superficial component is thin and ill defined, inserting into the fascia over the superficial aspect of the lateral orbital rim. The deep limbs are distinct fascial bands that originate at the lateral borders of the superior and inferior tarsal plates and insert onto the medial aspect of the lateral orbital rim at Whitnall tubercle. Whitnall tubercle is located approximately 4 mm deep to the lateral orbital rim and 9 mm inferior to the ZF suture.

Transconjunctival Approach With Lateral Canthotomy

A corneal shield (crescent-shaped plastic or metal conforming cup) was placed and later supplanted by pulling the inferiorly based conjunctivocapsulopalpebral flap over the corneal surface using traction sutures. Loop magnification was helpful to accurately identify the layers of the lower eyelid. By dissecting anterior to the orbital septum (preseptal approach) after traversing the capsulopalpebral fascia, prolapse of orbital fat into the wound was avoided. Avoidance of orbital fat was helpful to maximize the surgical exposure and to prevent inadvertent injury to the inferior oblique muscle, which may be obscured by prolapsing fat.

Table

The study included 12 male and 2 female patients (median age, 35 years). Treatment date, patient age and sex, fracture classification, surgical approaches, treatment of the orbital floor, complications, cause of fracture, parity, and associated facial injuries are shown in the Table. All the fractures were rigidly fixed with 1.7 miniplates over the ZF suture using at least 2 screws on each side of the fracture line. The inferior orbital rim was fixed by either wire osteosynthesis (patient 9) or a 1.3 miniplate using at least 2 screws on either side of the fracture line. Gel film was placed over the orbital floor in all but 3 pa-
In preparation for the preseptal approach to the orbital floor, the surgeon stood at the head of the operating table and everted the patient’s lower eyelid to view the inner aspect of the inferior tarsus. A horizontal incision was made inferior to the tarsus (approximately 5 mm below the eyelid margin or 1 mm inferior to the tarsus), extending just lateral to the orifice of the inferior canaliculus. Bleeding was minimized by the use of a sharp-tipped electrocautery device for the incision and subsequent dissection. The incision was deepened through the capsulopalpebral fascia, above the divergence of the fascial layers that enclose the orbital fat (capsulopalpebral fascia and orbital septum). The orbicularis oculi muscle was visualized anteriorly, and the dissection plane between the muscle and orbital septum was developed by a combination of blunt and sharp dissection. The orbital rim was encountered, and the dissection continued over the rim approximately 1 mm before sharply dividing the periosteum anterior to the inferior arcus marginalis. A subperiosteal plane was entered and widened posteriorly over the bony orbital floor and anteriorly over the inferior orbital rim. This exposure allowed evaluation and repair of fractures involving the orbital floor and inferior orbital rim. To improve the exposure of the orbital floor and rim, a lateral canthotomy and an inferior cantholysis were performed. The skin incision extended no more than 1 cm beyond the lateral palpebral slit, slightly offset from the underlying canthotomy (Figure 3).

**Superior Cantholysis**

The deep limb of the superior canthal tendon was located by grasping the lateral eyelid margin and strumming the tendon with a fine forceps (Figure 4). Distal and proximal to the midportion of the exposed tendon, 4-0 nonabsorbable sutures were passed and held away with hemostats, and the tendon was cut between the sutures (Figure 5). The upper eyelid was lifted away from the lateral orbital rim, exposing the periosteum over the ZF suture. A few millimeters above the insertion of the lateral canthal tendon, the periosteum of the lateral orbital rim was sharply incised vertically and peeled away from the underlying ZF suture. Adequate periosteal stripping was done to accommodate a miniplate with 2 proximal and 2 distal screw holes. To aid in fracture reduction and fixation, both the inferior orbital rim fracture and the ZF suture could be visualized simultaneously (Figure 6).

**Reduction, Fixation, and Closure**

Reduction and rigid fixation were accomplished by methods well described in the literature. Plates or wires were used to fixate the lateral and inferior orbital rim fractures (Figure 7). The superior canthal tendon was approximated by tying the distal and proximal marking sutures together, precisely repositioning the lateral upper eyelid. The inferior canthal tendon was carefully sutured (nonabsorbable suture) above and slightly behind its original attachment at Whitnall tubercle. The orientation of the lower eyelid with respect to the upper eyelid in this area was visually confirmed so that the lower eyelid curved gently superiorly to fall just behind the lateral extent of the upper eyelid. The lateral canthotomy was closed in layers. The conjunctival incision required no suturing, and the lower eyelid was pulled superiorly using a Frost suture or tape to avoid any overlapping of the wound edges that could lead to vertical shortening of the lower eyelid and ectropion.
ophthalmic drops (patient 13). The second complication involved cicatrical inferior displacement of the lower eyelid along the entire extent of the transconjunctival incision (patient 5) due to overlapping of the capsulopalpebral flap with the transconjunctival incision. Treatment consisted of re-creation of the transconjunctival incision and temporary inferior eyelid suspension with a Frost suture. The third complication involved a technical error in suturing the lateral canthus too anteriorly, causing a slight separation of the lateral eyelid margin from the globe and accumulation of granulation tissue (patient 14). Patient 14 required revision surgery to restore the normal orientation of the lower eyelid with respect to the globe and lateral upper eyelid area. The fourth complication involved a patient complaint of faint discomfort over the inferior orbital rim that corresponded to the location of a 1.3-mm titanium plate (patient 11). The plate was removed through the transconjunctival route, and the symptoms completely resolved. A floating fragment of bone at the medial aspect of the inferior orbital rim was detected on a radiograph in patient 9 in the recovery room. He was immediately returned to the operating room, and the fragment was wired in place through a Lynch incision; he recovered uneventfully.

Superior cantholysis opens a direct surgical route to the ZF suture for exposure, reduction, and rigid fixation. It also expedites exposure and assessment of the sphenozygomatic suture. By avoiding excessive tissue traction and additional skin incisions, tissue damage and scarring are minimized, while the ease of dissection is greatly facilitated. Our patients experienced no adverse sequelae as a result of the procedure. The complications related primarily to the transconjunctival and lateral canthotomy incisions. According to our findings, superior cantholysis is a safe and effective procedure. Most of the complications are avoidable by technical improvements in approximating the lower lateral canthal tendon and the conjunctival incisions.

Modern methods of surgical exposure for the repair of facial fractures are based on craniofacial techniques that were developed during the last half of the 20th century in a variety of disciplines, including otolaryngology–head and neck surgery, plastic surgery, maxillofacial surgery, and neurosurgery. Before these developments, exposure of facial fractures consisted of making several small incisions over fracture sites, with little concern given to visible scars or sensorimotor deficits. Although limited surgical access is often all that is required for selected simple facial fractures, complex or comminuted fractures demand more extensive exposure for accurate reduction and fixation. The modern approach to complex facial fractures (which represent most facial fractures) is wide surgical exposure that facilitates a 3-dimensional assessment of fracture displacement and application of rigid internal fixation appliances and bone grafts.7 These surgical approaches
emphasize minimally invasive techniques that spare neurosensory structures, while maximizing exposure of the facial skeleton. Craniofacial incisions are hidden in such areas as behind the hairline, within the oral cavity, in the conjunctiva, or under the eyelid. The transconjunctival approach to the orbital rim and floor has proved to be superior to previous methods of orbital rim and floor exposure (eg, the subciliary approach) in the avoidance of postoperative lower eyelid malposition.5 Nevertheless, complications may be encountered, as demonstrated in our series of patients. Patients 5 and 14 developed lower eyelid malpositions as a result of technical errors, including poor anatomical repositioning of the lower lateral canthal tendon and overlap of the free edges of the capsulopalpebral flap, which led to cicatrical ectropion. To avoid these complications, the deep limb of the lower lateral canthal tendon should be sutured slightly behind and above its original attachment at Whitnall tubercle. The lateral palpebral commissure should be on the same horizontal plane as the medial commissure and well apposed to the globe surface. At the conclusion of the operation, the lower eyelid should be pulled superiorly to eliminate overlap of the capsulopalpebral flap and the transconjunctival incision. It is helpful to use a Frost suture or inferior eyelid taping for 48 hours to prevent poor appositional healing and cicatrical ectropion.

Surgical access to the ZF suture is important in the treatment of unstable ZMC fractures, since it serves as an excellent site for rigid fixation. Also, just posterolateral to the ZF suture is the sphenozygomatic suture. Three-dimensional alignment of the sphenozygomatic suture serves as a useful indicator of successful reduction, especially in cases of severely displaced or comminuted ZMC fractures.2 Exposure of the ZF suture can be difficult with the traditional surgical approaches unless a skin incision is made over the suture itself or in the inferolateral brow. However, scarring in these areas tends to be obvious. Exposure and plating of the ZF suture via a lateral canthotomy have been described, but the dissection is difficult and involves extensive disruption of the superficial lateral retinaculum and rigorous skin retraction.3 Superior cantholysis releases the upper eyelid and frees the medial aspect of the lateral canthotomy incision, minimizing the amount of skin retraction and lateral orbital soft tissue dissection required for exposure of the ZF suture. It facilitates exposure of the sphenozygomatic suture, confirmation of adequate reduction, and application of hardware. In our initial experience with superior cantholysis, a gingenbuccal incision for evaluation of the zygomaticomaxillary suture was used to assess the adequacy of reduction. However, this incision was abandoned in favor of the sphenozygomatic suture because of the significantly improved visualization of the lateral orbit with superior cantholysis.

### Table: Patient Demographics, Fracture Characteristics, and Treatment

<table>
<thead>
<tr>
<th>Patient No./ Age, y/Sex</th>
<th>Class†</th>
<th>Inferior Orbital Approaches‡</th>
<th>Treatment of Orbital Floor</th>
<th>Complication</th>
<th>Cause</th>
<th>Side</th>
<th>Associated Facial Injuries</th>
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<tbody>
<tr>
<td>1/33/M</td>
<td>B</td>
<td>TC, LC, GB, and SC</td>
<td>Gel film</td>
<td>None</td>
<td>MVC</td>
<td>R</td>
<td>None</td>
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<tr>
<td>2/53/M</td>
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<td>Gel film</td>
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<td>MVC</td>
<td>L</td>
<td>None</td>
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<tr>
<td>3/31/F</td>
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<td>TC, LC, GB, and SC</td>
<td>Gel film</td>
<td>None</td>
<td>MVC</td>
<td>L</td>
<td>Lefort II</td>
</tr>
<tr>
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<td>Gel film</td>
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<td>A</td>
<td>L</td>
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</tr>
<tr>
<td>5/41/F</td>
<td>B</td>
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<td>L</td>
<td>None</td>
</tr>
<tr>
<td>6/42/M</td>
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<td>SubC, LC, and SC</td>
<td>Gel film</td>
<td>None</td>
<td>A</td>
<td>R</td>
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<tr>
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<td>A</td>
<td>L</td>
<td>Retinal tear; nasal fracture</td>
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<td>8/57/M</td>
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<td>L</td>
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<tr>
<td>9/43/M</td>
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<td>Reoperation for missing fragment</td>
<td>MVC</td>
<td>L</td>
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<tr>
<td>10/22/M</td>
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<td>TC, LC, and SC</td>
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<td>None</td>
<td>A</td>
<td>L</td>
<td>None</td>
</tr>
<tr>
<td>11/21/M</td>
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<td>TC, LC, and SC</td>
<td>None</td>
<td>Delayed plate removal</td>
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<td>R</td>
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<tr>
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<td>A</td>
<td>L</td>
<td>Mandible fracture</td>
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<td>14/15/M</td>
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<td>TC, LC, and SC</td>
<td>Biodegradable sheeting</td>
<td>Lower eyelid malposition</td>
<td>A</td>
<td>R</td>
<td>Orbital blowout</td>
</tr>
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</table>

*TC indicates transconjunctival; LC, lateral cantholysis; GB, gingenbuccal; SC, superior cantholysis; SubC, subciliary; MVC, motor vehicle crash; ellipses, not applicable; A, assault; R, right; and L, left.
†See the “Patients and Materials” subsection of the “Patients, Materials, and Methods” section for the definition of the classes.
‡Other approaches and procedures included a Gillies operation (patient 1), a suborbicularis oculi fat suspension (patient 6), and a Lynch incision (patient 9).
Although we routinely performed an inferior cantholysis, this step could be eliminated in favor of a superior cantholysis alone through a lateral canthotomy incision. A superior cantholysis alone should allow adequate inferior orbital rim and ZF suture exposure without the added potential morbidity of an inferior cantholysis. We have also inserted an endoscope into the lateral orbit to visualize the sphenozygomatic suture line, which provided a magnified image and further minimized soft tissue dissection. Our experience with this technique is preliminary and was not used in the present series of patients.

CONCLUSIONS

Superior cantholysis eases the surgical exposure, reduction, and rigid fixation of the ZF suture in the open repair of ZMC fractures. The superior cantholysis adds no morbidity in open ZMC fracture repair and simplifies exposure of the lateral orbital rim, without the need for overzealous tissue retraction. With some additional dissection along the lateral orbital wall, the sphenozygomatic suture is also exposed, providing a 3-dimensional confirmation of fracture reduction.

Accepted for publication May 15, 2000.

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REFERENCES