Combined Transconjunctival and Transcaruncular Approach for Repair of Large Medial Orbital Wall Fractures

Christopher Seungkyu Lee, MD; Jin Sook Yoon, MD; Sang Yeul Lee, MD

Objectives: To describe the combined transcaruncular and transconjunctival approach in isolated large medial orbital wall fractures and to study the implications of uncorrected posterior orbital volume on postoperative enophthalmos.

Methods: A retrospective medical record review was performed of 23 consecutive patients who underwent reduction surgery for isolated large medial orbital wall fractures using the combined transcaruncular and transconjunctival approach between February 1, 2003, and October 31, 2007. The unaffected contralateral orbital volume was assumed to represent the pretrauma volume of the affected orbit, and the uncorrected posterior orbital volume after reduction was determined using a software program.

Results: The mean (SD) volume of the affected orbit changed from 26.00 (2.01) cm³ to 24.08 (2.06) cm³ after reduction, which was still larger than the contralateral unaffected orbit by 1.48 (0.83) cm³. Despite the uncorrected volume in the most posterior portion of the medial wall, the mean (SD) postoperative enophthalmos measured only 0.17 (0.29) mm using Hertel exophthalmometry at a mean follow-up of 8.5 months.

Conclusions: The combined transconjunctival and transcaruncular approach results in excellent outcomes in terms of prevention of postoperative enophthalmos of the large medial wall fracture without substantial complications. The far posterior medial volume may not contribute significantly to the development of posttraumatic enophthalmos.


Unlike classic blowout fractures of the orbital floor, medial orbital wall fractures have not received much clinical attention. Many patients with a medial orbital wall fracture are asymptomatic, and in some, signs and symptoms may be so subtle that the condition eludes diagnosis. Pearl and Vistnes,1 however, found medial orbital wall fractures in as many as 31% of cadavers studied. Burn et al2 reported that the incidence of isolated medial wall fracture (54.9%) was actually the highest among blowout fractures of the orbit. Enophthalmos, one of the most feared complications of blowout fractures of the orbit, has been thought to be less frequently associated with medial wall fractures, but several recent studies2,3 have reported that medial wall fractures play a major role in traumatic enophthalmos.

The election and timing of surgical repair of medial orbital wall fractures are subjects of continued interest and controversy. In the case of large medial orbital wall fractures, early surgical management is generally indicated to prevent the development of late enophthalmos and to minimize fibrosis and contraction of the prolapsed tissue.4 Although surgical approaches to the orbit have advanced significantly during the past few years, the management of medial wall fractures is still challenging. The traditional Lynch approach with medial transcutaneous incision still remains the major approach to the medial orbit, but the transcaruncular approach is growing in popularity because of fewer complications, including less cutaneous scarring.5 In cases of large medial orbital wall fractures, however, appropriate exposure for tissue reduction and implant placement is often difficult with the transcaruncular approach alone.

We combined an inferior transconjunctival incision with the transcaruncular approach to achieve better exposure and to place a large orbital implant to reconstruct the large medial wall fracture. In large medial orbital wall fractures, complete reduction to the posterior orbit with the implant is often difficult (Figure 1). Fracture in the most posterior portion of

Author Affiliations:
Department of Ophthalmology, Institute of Vision Research, Severance Hospital, Yonsei University College of Medicine, Seoul, Korea.
the medial wall may not be covered by the implant, resulting in orbital expansion. This point is important because the degree of enophthalmos is known to be directly correlated with the volume of the fractured orbit.8-10

Using the combined approach, insertion of the implant and coverage of the defect can be easily accomplished, but the far posterior orbit cannot be adequately covered. The aims of this retrospective study are to describe our experience with the combined transcaruncular and transconjunctival approach in large medial orbital wall fractures and to study the implications of residual posterior orbital volume on postoperative enophthalmos using a software program to calculate orbital volumes.

METHODS

A retrospective medical record and image study review was performed on consecutive patients who underwent reduction surgery by one of us (S.Y.L.) for isolated large medial wall fractures between February 1, 2003, and October 31, 2007, at the Ophthalmology Center of Yonsei University College of Medicine. The following inclusion criteria were used: unilateral isolated large medial wall fracture, opposite orbit uninjured, preoperative and postoperative computed tomography (CT) scans available, a clearly visible reconstructive implant on postoperative and postoperative computed tomography (CT) scans. When further stability was deemed necessary to prevent implant shift or migration, a small bony opening was made using a chisel on the inferior floor just lateral to the neurovascular bundle, and a small central tab made on the implant using Deaver scissors was bent down into the bony opening. To prevent anterior migration, this tab was made on the anterior side of the implant, was bent down into the medial wall fracture, and was rested against the anterior lacrimal crest. Using a Freer elevator and a malleable retractor, herniated orbital tissue was retracted until the margins of the fracture were clearly seen. The fracture was estimated and was covered with a suitably sized silastic sheeting implant. The implant was inserted through the inferior incision and was pushed up against the medial orbit while its other end was pulled through the transcaruncular incision using a skin hook (Figure 2).

After confirming that the implant adequately covered the superior border of the medial orbital defect, a forced duction test was repeated to confirm the complete release of orbital tissues. When further stability was deemed necessary to prevent implant shift or migration, a small bony opening was made using a chisel on the inferior floor just lateral to the neurovascular bundle, and a small central tab made on the implant using Deaver scissors was bent down into the bony opening. To prevent anterior migration, this tab was made on the anterior side of the implant, was bent down into the medial wall fracture, and was rested against the anterior margin of the fracture. In some cases, inferior and medial tabs were used, whereas in others, either an inferior or a medial tab was used. The released inferior ramus of the lateral canthal tendon was anchored to the periosteum of the lateral tarsus. After the inferior periosteum was sutured using a 5-0 Vicryl suture, inferior and medial conjunctival incisions were closed using 6-0 Vicryl interrupted sutures.

VOLUME MEASUREMENT

The imaging variables of CT were 120 kV, 220 mA, and 2.5-mm thickness of continuous sections in coronal and axial planes. A manufacturer’s measuring tool provided with the workstation software (AW suite, version 5.2.13h14a; GE Healthcare, Barrington, Illinois) was used to calculate the or-
bital volume. The sagittal plane images were reformatted from axial and coronal CT scans using this software. The drawing along the orbit boundaries in each spatial plane was guided by an automatic tracing program provided with the software, which uses contrast differences (Figure 3). Orbital volume can then be automatically calculated. The anterior border of the orbital floor was determined as the first CT section containing a visible maxillary sinus and the posterior border as the apex of the orbit.10

RESULTS

Of 118 patients who underwent medial orbital wall reduction procedures, 74 had combined inferior wall or zygomatic bone fractures. Of 44 patients with isolated medial orbital wall fracture reduction, 23 met the inclusion criteria (18 males and 5 females). The mean (SD) pa-

Figure 2. Implant insertion procedure. A, Suitably sized silastic sheeting implant after assessment of medial orbit defect size. B, Silastic implant being inserted through the inferior conjunctival incision at an angle toward the medial wall. C, Further insertion of the silastic sheeting implant into the orbit. D, Implant being pulled through the transcaruncular incision using a skin hook.

Figure 3. Volume calculation using the workstation software. The margins of the orbital walls are drawn (in red) on sagittal (A), axial (B), and coronal (C) computed tomography scans, and the program calculates the orbital volume.
tient age was 32.3 (16.6) years, and the mean (SD) interval between injury and surgery was 16.8 (10.7) days. Twelve of the fractures were on the right side and 11 were on the left side. Patients were followed up for 6 to 17 months (mean, 8.5 months), and enophthalmos was measured at each visit.

The mean (SD) volume of the affected orbit, including the herniated tissue, was 26.00 (2.01) cm³ before surgery, and it changed to 24.08 (2.06) cm³ after reduction surgery (Table). The mean (SD) difference between the affected and the unaffected orbital volume changed from 3.38 (0.90) cm³ to 1.48 (0.83) cm³ after surgery; thus, the mean decrease in volume was 1.92 (0.62) cm³. The mean (SD) postoperative volume (24.08 [2.06] cm³) was still larger than the contralateral unaffected orbit by 1.48 (0.83) cm³, which was assumed to represent the uncorrected posterior orbital volume not covered by the orbital implant, but the mean (SD) postoperative enophthalmos was only 0.17 (0.29) mm at a mean follow-up of 8.5 months.

Seven patients had a mild preoperative abduction deficit with diplopia at lateral gaze, all of which completely returned to normal at a mean (SD) follow-up of 4.9 (1.6) months. Two patients had preoperative limitation of ocular motility (LOM) at upward gaze with diplopia, which completely returned to normal 3 months after surgery for 1 patient. For the other patient with preoperative upward LOM, LOM and diplopia were significantly improved after surgery without causing any discomfort for the patient, but slight upward LOM and associated diplopia remained at his last follow-up visit (6 months after surgery). No newly developed LOM after surgery was noted in any patients.

One of the commonly used approaches to medial orbital wall repair is the Lynch incision. The Lynch incision is made directly over the superomedial orbital rim and provides excellent exposure; however, it can result in severe scarring or webbing, and it carries a risk of lacrimal system injury. More recently, the transcaruncular approach has gained popularity because it leaves no cutaneous scars and preserves the integrity of the lacrimal system while providing as much exposure to the medial orbit as the Lynch approach.7,11

Ophthalmic sequelae of the transcaruncular approach reported in the literature are minimal. Perry et al12 reported no transcaruncular technique–related complications in their series of 26 patients with orbital decompression. Baumann and Ewers13 used the transcaruncular approach for repair in 5 patients with medial wall fracture. Four of these patients had concomitant orbital floor fracture, and the authors extended their caruncle incision accordingly superiorly and inferiorly into the fornices. They reported no complications involving the lacrimal system, the conjunctiva, or the medial canthus. Graham et al14 described 49 patients who underwent a transcaruncular approach, including 26 for medial orbital decompression. The authors reported a single case of medial fornix scarring causing diplopia as the only

### Table. Changes in Orbital Volume and Enophthalmos Before and After Reduction Surgery for Isolated Large Medial Orbital Wall Fractures

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Before Surgery</th>
<th>After Surgery</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Affected Orbit, cm³</td>
<td>Unaffected Orbit, cm³</td>
</tr>
<tr>
<td>1</td>
<td>25.12</td>
<td>20.16</td>
</tr>
<tr>
<td>2</td>
<td>30.61</td>
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<tr>
<td>Mean (SD)</td>
<td>26.00 (2.01)</td>
<td>22.62 (2.17)</td>
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</table>

Abbreviation: En, enophthalmos.
complication, which required a revision procedure with subsequent resolution of diplopia. Shorr et al.7 reviewed their series of 10 medial orbital fracture repairs and 24 orbital decompressions using the transcaruncular approach and reported no complications. In 10 cases using the transcaruncular approach, Oh et al.13 reported a single case of linear corneal abrasion, which healed after topical antibiotic drug treatment. In the present study, no complications attributable to the combined transcaruncular and transconjunctival approach were noted in any of the 23 patients.

In the management of large medial wall fractures, the combined transcaruncular and transconjunctival approach poses several benefits. Large medial orbital wall fractures require placement of a large orbital implant. Without adequate exposure, insertion and placement of the large orbital implant over the fracture may be limited and difficult. Another benefit of combining the transcaruncular and transconjunctival incision is that the inferior platform, on which the orbital implant is placed, can be visually confirmed during the operation. Through the transcaruncular incision, adequate coverage of the upper margin of the defect by the orbital implant can also be visually confirmed, and improved postoperative results can be expected.

We used the combined transcaruncular and transconjunctival approach for large medial wall fractures. The inferior incision makes the initial insertion of the large orbital implant possible from the inferior side under the periorbita toward the medial wall. When the tip of the implant is seen through the transcaruncular incision, the implant can easily be lifted using instruments such as skin hooks while visually confirming adequate coverage of the upper margin of the medial wall.

Despite the ample exposure, it was difficult to extend the implant to the far posterior site to completely cover the medial orbital defect, but no postoperative enophthalmos occurred. All the cases included in this study were of large medial defects, in which late significant enophthalmos was deemed inevitable. Mean (SD) preoperative enophthalmos was 1.24 (0.75) mm, but during the early period after trauma, enophthalmos may be masked because of the associated periorbita or intraorbital edema or hemorrhage. We tried to minimize this masking effect by measuring patients’ preoperative enophthalmos right before surgery, but the true value of enophthalmos still may have been underestimated because most procedures were performed within approximately 2 weeks of the inciting trauma (mean [SD], 16.83 [10.74] days). Only 1 observer (J.S.Y.) measured preoperative and postoperative enophthalmos to avoid possible interobserver error.

Enophthalmos is known to be correlated with orbital volume change. We quantified orbital volume change from CT using a software program. The mean (SD) decrease in orbital volume after orbital reconstruction in our patients was 1.92 (0.62) cm³, and the mean (SD) correction of enophthalmos was 1.07 (0.74) mm, resulting in a final mean (SD) postoperative enophthalmos of 0.17 (0.29) mm. Although negligible, postoperative enophthalmos remained after orbital volume restoration, and postoperative CT showed uncorrected posterior orbital volumes. To calculate this residual posterior orbital volume, one needs to know the pretrauma volume of the affected orbit. Because pretrauma CTs were not available, the orbital volume of the unaffected contralateral eye was assumed to represent the pretrauma volume of the affected orbit in each case. Forbes et al.16 in their study of 42 orbits, noted that the mean difference in orbital volumes in the same person was 0.43 cm³. We measured the orbital volumes of 10 healthy individuals who underwent CT at the emergency department for the evaluation of orbital trauma and showed no sign of orbital wall defects. The mean (SD) volume difference between orbits in the same person was 0.48 (0.37) cm³. In terms of percentages, intrapatient volume difference varied from 0.5% to 3.6%. Although some degree of intrinsic limitation is unavoidable in calculating true uncorrected orbital volume using contralateral controls, this uncorrected volume is clearly visible on CT (Figure 1). Unless pretrauma volumetric data of the affected orbit are provided, using a contralateral control seems to be the most reliable method for determining these data.

Although complete reduction of the posterior orbit was not achieved using this surgical method, but gave on average 1.48 cm³ of orbital volume expansion, significant postoperative enophthalmos did not occur. The degree of enophthalmos is highly correlated with the increase in volume of the fractured orbit. According to several studies, each cubic centimeter increase in volume causes an increase in enophthalmos ranging from 0.47 mm³ to 0.89 mm³ and even 1.2 mm.10 Possible explanations for the absence of significant enophthalmos despite a 1.48-cm³ increase in orbital volume may lie in the anatomy of the orbit. The anatomical configuration of the junction between the medial wall and the floor in the posterior third of the orbit is of particular importance. The orbital floor, just posterior to the globe, gradually slopes upward at an angle of approximately 30° and, with the medial orbital wall, forms the narrow end of the orbit. Travelling from lateral to medial, the orbital floor also rises approximately 45°, thus making the inferomedial bulge where the orbital floor meets the medial wall. This prominence is important in maintaining the forward projection of the globe, and if not adequately reconstructed, posterior globe displacement may develop even from small fractures.17 18 This characteristic region lies approximately in the posterior one-third of the orbit. In our patients, successful coverage with silicone sheeting of up to one-third of the posterior orbit was seen on CT. The far posterior medial orbit past this region may not significantly contribute to sinking of the globe.

The presence of the orbital implant may have reduced the orbital volume. The silicone sheeting used in these patients has a thickness of 1.5 mm. We used thick silicone sheeting because we thought it could offer more structural stability for large orbital defects and prevent implant shift or migration while being elastic enough to stay bent in the orbit. No implant shift was noted in the postoperative CT taken 1 day after surgery in any of the 23 patients. The mean size of the implant measured from CT was 33.0 × 18.0 × 1.5 mm (volume, approximately 0.94 cm³). Although the orbital implant was used mainly to restore the structural integrity of the orbit, this sec-
ondary effect of volume reduction by 0.94 cm³ may have compensated for the posterior orbital volume expansion and lessened postoperative enophthalmos.

In conclusion, the combined transconjunctival and transcarnucular approach resulted in excellent outcomes in the prevention of postoperative enophthalmos of large medial wall fractures. There were no complications involving the conjunctiva, extraocular muscles, elevator aponeurosis, or nasolacrimal drainage system. The far posterior volume may not contribute significantly to the development of posttraumatic enophthalmos. The combined transcarnucular and transconjunctival approach deserves consideration as a surgical option in patients with a large medial wall fracture.

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REFERENCES


When there has been an old iridocyclitis with atrophic iris, and the pupil is sequestered or occluded, one operation, intracapsular extraction, usually with iridectomy, is generally conceded to be the operation of choice. In the past, preliminary iridectomy followed by extracapsular extraction has been advocated and we have been cautioned to remove the anterior capsule by twisting to tear it with toothed forceps in order to avoid traction on the ciliary processes. In this type of case the zonule is usually exceedingly friable, and, when the anterior capsule is grasped with toothed forceps, the lens often dislocates and can easily be removed in its capsule.