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Endoscopic Approach to Medial Orbital Wall Fractures

John S. Rhee, MD, MPH[a,b,*], Chien-Tzung Chen, MD[c]

Historically, medial orbital wall fractures have been underappreciated in their incidence and importance. Recent studies have indicated that the incidence of medial orbital wall fractures may be higher than that of the floor [1]. In addition, studies have suggested that enophthalmos may be more significant from nonrepaired medial orbital wall fractures than from blowout fractures of any other orbital wall. Furthermore, because of the underappreciation of this injury, the incidence of delayed enophthalmos may be higher for this type of orbital fracture [2].

Biomechanical studies have suggested that that in the absence of orbital rim or facial skeleton trauma (pure hydraulic mechanism), isolated medial orbital wall fractures cannot occur without trauma to the surrounding bony framework (eg, orbital rim, nasal bone) [3]. These biomechanical findings are corroborated by reports in the clinical medical literature. In a large series of medial orbital fractures, Burm and colleagues [1] reported that nasal fractures were the most common fracture associated with the medial orbital wall fracture, suggesting that the force causing nasal fractures was a very important causative factor of pure medial orbital fractures by means of the buckling mechanism. In the clinical realm, medial orbital fractures may occur by way of the buckling or hydraulic mechanism, with a combination of the two mechanisms the most likely scenario. It is also more common that the medial orbital wall is fractured in conjunction with the orbital floor, necessitating repair of both of these fractured walls.

There are a multitude of approaches that have been used for repair of medial orbital wall fractures, each with their advantages and disadvantages. The medial brow incision has been described for access to the medial orbital wall [4]. This approach is limited to the anterior and superior medial orbital wall and fails to free the entrapped medial rectus muscle from the posterior medial wall fracture because of the close proximity of the optic nerve. A lid crease incision may offer a more cosmetically appealing result, but has the same limitations as the medial brow incision [5].

A direct medial canthal approach can be used to gain access to the medial and inferomedial aspects of the orbit, and this may be extended to the infraorbital rim to explore the floor. Drawbacks to this approach include the obvious external scar, webbing of the skin, and risk of telecanthus from surgical detachment of the medial canthal tendon [6].

[a] Department of Otolaryngology, Medical College of Wisconsin, 9200 W. Wisconsin Avenue, Milwaukee, WI 53226, USA
[b] Zablocki Veteran Affairs Medical Center, 5000 W. National Avenue, Milwaukee, WI 53295, USA
[c] Division of Trauma Plastic Surgery, Department of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital, Number199, Tunghwa Rd., Taipei, Taiwan, Republic of China
* Corresponding author. Department of Otolaryngology, Medical College of Wisconsin, Milwaukee, WI 53226.
E-mail address: jrhee@mcw.edu (J.S. Rhee).

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Indirect approaches to the medial orbital wall include the coronal incision, which usually is reserved for patients with multiple facial fractures. This approach offers wide exposure and reconstruction of the defect with calvarial bone through the same incision. Disadvantages include an external scar, scalp alopecia, significant surgical dissection, overnight hospitalization, and potential injury to cranial nerves VI and VII.

The transcaruncular approach to the medial orbital wall has been described more recently and provides excellent access to the medial wall [6–8]. The main limitation of this approach is that a large graft cannot be placed through the small incision without connecting it to an orbital floor approach. Other potential disadvantages include the risk of injury to the lacrimal apparatus and difficulty assessing the posterior dissection.

Endoscopic-assisted techniques have emerged as the next frontier for repair of medial orbital fractures. Recently, techniques have been described that allow for endoscopic assistance in reduction of the orbital contents and in placement of an alloplast or graft for reconstitution of the medial orbital wall. The two main techniques in which endoscopy has aided in the repair of these fractures have been either through the intranasal (transethmoidal) or the transcaruncular approaches [9,10].

Most endoscopic intranasal techniques involve partial ethmoidectomy and exposure of the fractured lamina papyracea. The herniated orbital contents are reduced, and some type of intranasal splint or packing is placed between the lamina and the middle turbinate for a period of time (approximately 2 months) until healing of the medial wall is completed [11–13]. Alternatively, an intranasal endoscopic approach to assist in placement of an orbital implant by means of a periorbital incision has been described [14].

This article describes different endoscopic-assisted approaches—transcaruncular and intranasal—which have been used to successfully repair medial orbital wall fractures.

Preoperative evaluation

Medial orbital fractures, unlike blow-out fractures of the orbital floor, may be overlooked, because they present with clinical symptoms and signs in only a few instances, especially in the early acute trauma setting. The possible clinical symptoms and signs include:

- Epistaxis
- Eyelid emphysema, especially in the medial canthus
- Periorbital edema
- Narrowing of the palpebral fissure
- Nasal subconjunctival hemorrhage
- Horizontal diplopia
- Restriction of abduction
- Retraction syndrome
- Progressive enophthalmos
- Positive forced duction test [5,15–18]

Associated ocular injuries commonly occur in patients with midfacial trauma, which may result in decrease in visual acuity, or even complete vision loss, if early diagnosis and management are not initiated properly. The incidence of severe ocular disorders associated with an orbital blow-out fracture has been reported to be as high as 16.7% [19]. Therefore, early ophthalmology consultation routinely is sought in patients with suspected orbital fractures. The ocular examination should include an assessment of visual acuity, visual field, papillary function, extraocular muscle function, and slit lamp examination to rule out a corneal perforation or hyphema. A forced duction test is conducted if restriction of ocular movement is detected. The presence of diplopia may be associated with limitation of extraocular muscle movement. One must differentiate the causes of diplopia that may result from cranial nerve-induced injury, orbital soft tissue or muscle entrapment, mal-position of the globe, or intraorbital edema secondary to acute trauma.

Imaging studies including CT scanning are essential before forming a surgical plan. Recently, the development of the helical CT scan has changed the type of studies needed to diagnose and evaluate orbital trauma. The helical CT scan allows for continuous acquisition of volumes of tissue, which permits multi-planar reconstructions of additional image planes. This technique reduces the number of examinations and radiation exposure of the patient and improves the quality of the image [20]. These fine-cut CT scan images are taken in coronal and axial planes, with soft tissue and bone windows. The reformatted sagittal sections that connect the midpoint of the globe and the apex of the orbit are particularly helpful to assess the concomitant orbital floor fractures. Three-dimensional CT images allow for a quick overview of the facial bone fractures, but they are seldom of value in the internal portion of the orbit. Occasionally, MRI can be used to differentiate the herniated muscle and orbital fat, and this may serve as a complement to CT scanning [5,21].

Indications

There is some debate regarding the surgical treatment of an isolated orbital medial wall fracture. When a medial orbital wall fracture presents minimal displacement with no signs of herniation of the orbital content and minimal enophthalmos, conservative treatment is chosen. Surgical exploration and repair, however, are indicated if there is

- Persistent symptomatic diplopia
- Pain during horizontal eye movement,
- A positive forced duction test with clear evidence of medial rectus muscle entrapment on a CT scan,
- Early enophthalmos more than 2 mm preoperatively
- A large defect likely causing secondary enophthalmos [5,21,22]

Both endoscopic-assisted techniques, through either the intranasal or transcaruncular approaches, can be applied to repair the variable sizes of the medial orbital wall fractures. The endoscopic techniques are especially valuable for those fractures involving the superior and posterior medial orbits, which are difficult to dissect and visualize through a lower eyelid approach. In general, these endoscopic techniques are used for primary repair of the medial orbital wall fractures. Recently, the transcaruncular endoscopic approach has been expanded in its use to correct late enophthalmos caused by uncorrected displacement of medial wall or previously inadequate reconstruction of medial wall defects [10]. One may use the coronal incision or existing lacerations to repair these fractures directly without the use of endoscopic approaches, however, if the medial orbital wall fracture is accompanied by periorbital fractures such as nasoethmoid, orbital roof, or supraorbital rim fractures.

Surgical techniques

Endoscopic transcaruncular approach

The surgery is performed under general anesthesia. An injection of 1:100,000 epinephrine solution is placed in the medial conjunctiva using a fine needle. The cornea is protected with a scleral shield during the procedure. Two parallel traction sutures using 4-0 silk are placed in the medial conjunctiva posterior to the caruncle to facilitate the conjunctival incision. A slight curvilinear incision approximately 1 cm in length is made between the two sutures, and then a scissors is used to bluntly dissect toward the medial orbital wall immediately posterior to the lacrimal apparatus [Fig. 1]. With progressive blunt dissection, the periorbita is incised behind the posterior lacrimal crest to avoid severance of the medial canthal ligament and injury to the lacrimal sac. The periorbita is elevated further superiorly and inferiorly with a Freer elevator; then the dissection proceeds posteriorly, thereby creating a periosteal opening wider than the conjunctival incision. Initially, the anterior part of the medial wall is dissected under direct vision with the aid of a headlight. Because the orbital roof is intact in most cases, the authors prefer starting the dissection from the superior medial wall near the orbital roof and then proceeding downward to the inferior portion of the orbital medial wall.

The optical cavity is created and maintained with insertion of a baby retractor medially and a narrow malleable retractor laterally to retract the orbital contents gently. A 2.7 mm diameter, 0° endoscope is introduced through the transcaruncular approach. With the aid of endoscope, the posterior dissection of the medial wall is performed using an orbital periosteal elevator. The first important structure that is encountered is the anterior ethmoid vessels coming out from the anterior ethmoid foramen, which is on average 24 mm behind the anterior lacrimal crest. The vessels should be cauterized meticulously to avoid any undue bleeding and facilitate further posterior dissection. Subsequently, the posterior ethmoid vessels appear in the surgical field and indicate the limit of safe dissection along the medial wall. This landmark is on average 36 mm away from the anterior lacrimal crest. One should keep in mind that the optic nerve is located on average 7 mm posterior to the posterior ethmoid vessels. A horizontal line connecting the anterior and posterior ethmoid vessels indicates the superior limit of the ethmoid sinus. Generally, the medial wall fractures rarely extend above this horizontal line. The entrapped orbital contents gradually are reduced from the ethmoid sinus into the orbital cavity, and the fracture fragments of the medial wall are removed. After that, the whole boundary of the medial wall defect is defined clearly [see Fig. 1].

To reconstruct the bony defect, the authors use the synthetic implants titanium micromesh or Medpor (Porex Surgical, Incorporated, Newnan, Georgia) in most cases. The orbital implant is trimmed to proper size and shape, with the dimension no greater than 1.5 cm in width and 3 cm in length, because the small incision prevents placement of a larger graft. The implant is inserted through the transcaruncular incision to cover the bony defect in the subperiosteal space and fixated with a microscrew [see Fig. 1]. In the scenario of a larger bony defect extending onto the inferior medial wall, additional implant is required, with one overlapping the other, to completely cover the bony defect. Finally, the proper position of these implant areas is rechecked and adjusted under endoscopic visualization. A forced duction test is performed after placement of these implants to confirm the mobility of the globe in any direction. The conjunctival wound is closed with a 6-0 plain

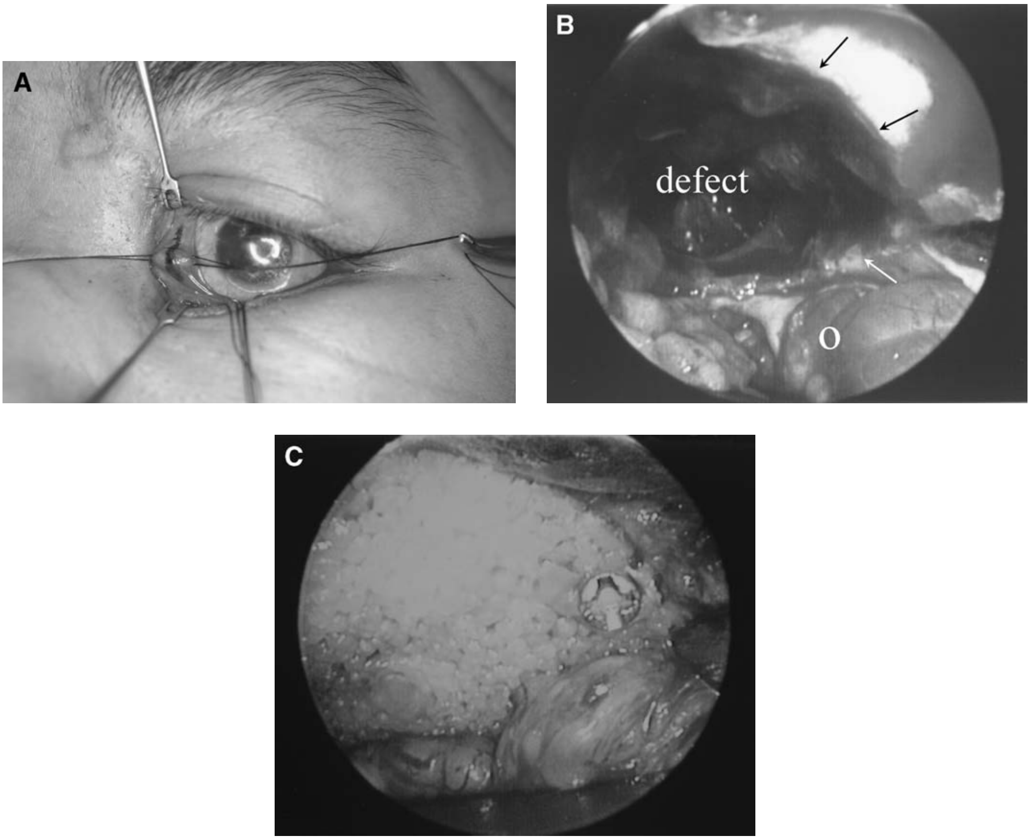

Fig. 1. (*A*) Transcaruncular incision made posterior to the caruncle with two parallel traction sutures. (*B*) Endoscopic view of the bone defect of the orbital medial wall. Arrow points to the boundary of the bone defect; "O" indicates periorbital tissue. (*C*) Endoscopic view of Medpor implant placed across the defect with microscrew fixation.

catgut suture. A clinical case using this technique is illustrated in Fig. 2.

Intranasal endoscopic-assisted technique

The operation is performed under general anesthesia with the patient in a supine position. The orbital floor is approached through a transconjunctival incision with a canthotomy and cantholysis. A preseptal dissection is carried down to the orbital rim. The arcus marginalis then is incised sharply at the orbital rim. Dissection continues along the orbital floor, deep to the periorbita. A concomitant orbital floor fracture can be addressed with reduction of the orbital contents. Before the manipulation of the medial orbital contents, the medial orbital wall is approached intranasally.

After proper nasal decongestion is accomplished, a 4.0 mm 0° endoscope is introduced into the nostril. The uncinate is identified and resected. Approximately 3 to 4 mm of uncinate is left intact superiorly to prevent frontal recess stenosis. This exposes the natural ostium of the maxillary sinus. The bulla ethmoidalis then is entered medially and resected to expose the lamina papyracea defect. The herniated orbital contents are usually apparent at this stage, and great care is taken to prevent further injury. The dissection is carried posteriorly through the ground lamella to fully expose the defect in the lamina papyracea.

Next, from the periorbital incision, the orbital contents are reduced and held in place with a malleable retractor. Adequate reduction is confirmed from the intranasal endoscopic and external approaches. The orbital implant then is cut to the appropriate shape and size to cover the floor and lamina papyracea defect. The implant is introduced through the periorbital incision and guided into position using the endoscopes for visualization. While an assistant holds the endoscope in proper position, the implant is manipulated bimanually from the sinonasal and periorbital approaches into proper position. A clinical case illustrating this technique is described in Figs. 3 and 4.

No nasal packing is necessary, in contrast to the temporary intranasal stent placement procedures.

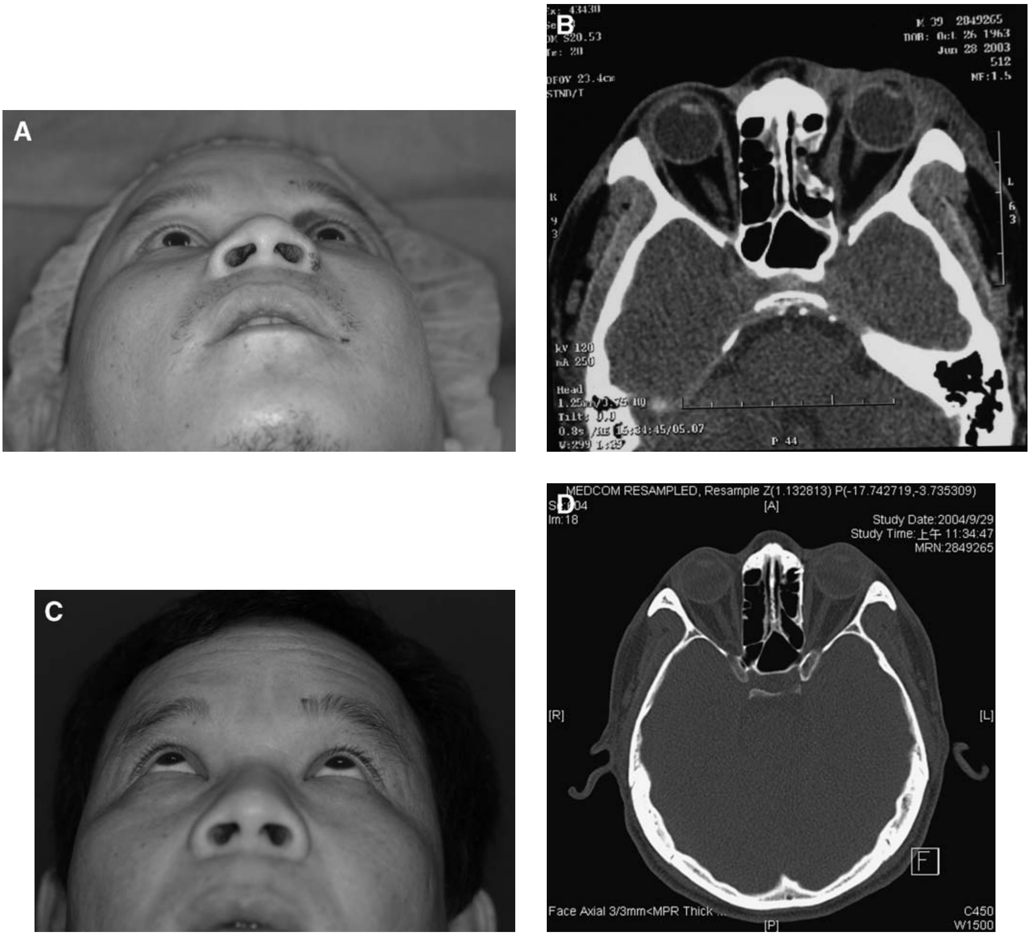

Fig. 2. (*A*) 40-year-old patient with left orbital medial wall blow-out fracture. Preoperative submental view showing left upper eyelid ecchymosis and enophthalmos (1.5 mm). (*B*) Preoperative CT scan revealing a blowout fracture of the left orbital medial wall with soft tissue prolapse. (*C*) Postoperative submental view 5 months following correction of the orbital medial wall defect with symmetric projection of the globe. (*D*) Properly reconstructed medial wall with titanium mesh implant shown in postoperative CT scan.

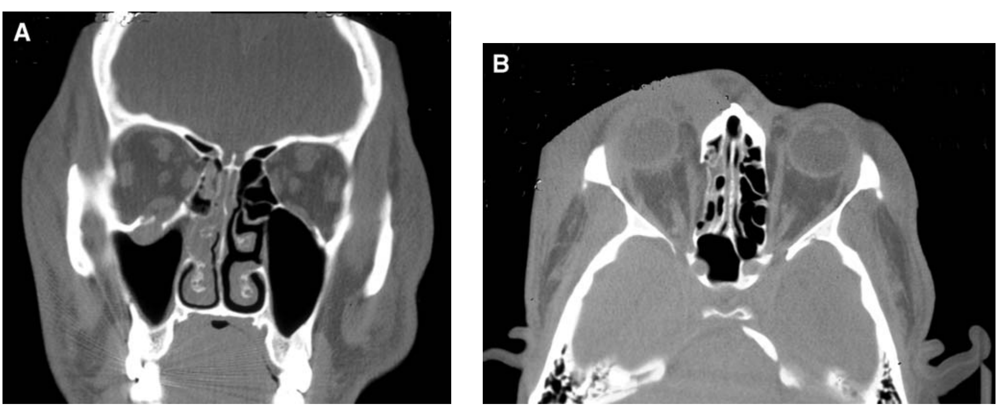

Fig. 3. Patient with a combined fracture of the orbital floor and medial wall without evidence of entrapment, as seen on (*A*) coronal and (*B*) axial CT. Intranasal endoscopy-assisted repair of medial orbital wall fractures. (*From* Rhee JS, Lynch J, Loehrl TA. Intranasal endoscopy-assisted repair of medial orbital wall fracture. Arch Facial Plast Surg 2000;2(4):269–73; with permission.)

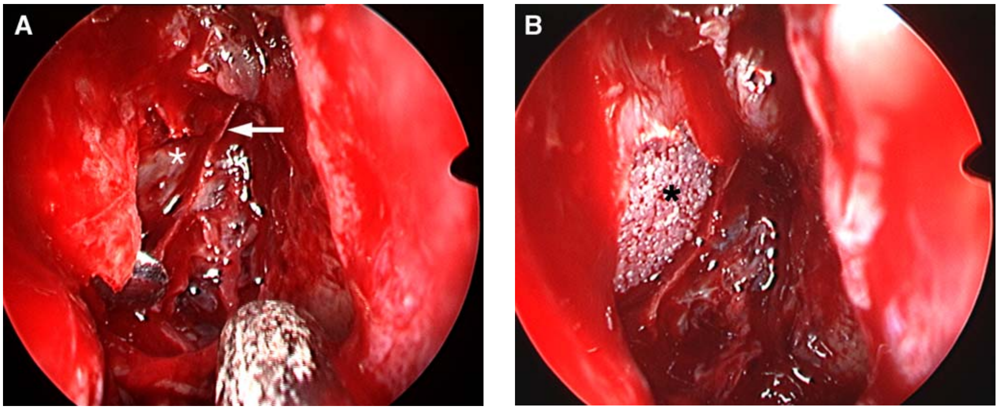

Fig. 4. (*A*) Intranasal endoscopic view of right medial orbital wall fracture. Asterisk indicates bony defect of the lamina papyracea. Arrow delineates the intact posterior medial wall. (*B*) Intranasal endoscopic view of the Medpor implant in proper position. (*From* Rhee JS, Lynch J, Loehrl TA. Intranasal endoscopy-assisted repair of medial orbital wall fractures. Arch Facial Plast Surg 2000;2(4):269–73; with permission.)

The periorbital incision is closed in standard fashion. Postoperatively, the patient is placed on nasal saline irrigations and is seen every 7 to 14 days with endoscopic debridement performed until the ethmoid cavity is mucosalized.

Complications

In the authors' experience, postoperative complications with either transcaruncular or intranasal approaches have been minimal. There have been no cases of infection or sinusitis using an implant to repair the medial wall defect. One minor complication related to the transcaruncular incision was reported by Graham and colleagues [23], in which excessive medial canthal scarring caused diplopia that resolved after revision conjunctivoplasty surgery.

Other potential intraoperative complications include optic nerve injury, cerebrospinal fluid rhinorrhea, intraorbital or nasal hemorrhage, damage to extraocular muscle, lacrimal sac and cornea, inadequate reduction of herniated orbital tissue, or incomplete coverage of the medial wall defect. When a transcaruncular approach is adopted, one should avoid too much anterior or posterior dissection causing injury to the lacrimal sac and to the medial rectus muscle, respectively. The use of a corneal shield during the procedure is essential to prevent incidental injury to the cornea.

Displacement of the bone grafts [10,21] or implants [22] has been reported, especially when repairing a large bony defect through the transcaruncular incision. To prevent displacement of grafts, one of the authors usually fixates the material used for repairing the medial wall defect with microscrews [10]. Mun and colleagues [21] reported an alternative bone graft-shaping method, a combination of an inlay–onlay graft, which is thinned at the edge and set on the edge of the intact medial wall in the onlay position, to minimize the risk of graft migration. Transient diplopia and exophthalmos can be expected as in other orbital reconstructive surgeries, with usual resolution by 3 months. Residual enophthalmos caused by reherniation of the orbital contents has been reported when using a temporary intranasal stenting procedure [24]. The authors advocate using a permanent implant placed either by means of the transcaruncular or intranasal endoscopic-assisted approach to decrease the likelihood of reherniation of orbital contents into the ethmoid cavity.

Summary

Fractures of the medial orbital wall are more common than previously thought and pose unique challenges to the reconstructive surgeon. The use of endoscopes can facilitate visualization, reduction, and placement of grafts to reconstruct this area. The authors advocate using either the endoscopic-assisted transcaruncular approach or an intranasal endoscopic-assisted approach combined with a periorbital incision to place a permanent graft or implant to repair the medial orbital wall. Both techniques have been successful in treating this difficult fracture without the need for long-term intranasal stenting or external skin incisions.

References

[1] Burm JS, Chung CH, Oh SJ. Pure orbital blowout fracture: new concepts and importance of medial orbital blowout fracture. Plast Reconstr Surg 1999;103:1839–49.

[2] Whitehouse RW, Batterbury M, Jackson A, et al. Prediction of enophthalmos by computed tomog-

raphy after blow out orbital fracture. Br J Ophthalmol 1994;78:618–20.
[3] Rhee JS, Kilde J, Yoganadan N, et al. Orbital blowout fractures: experimental evidence for the pure hydraulic theory. Arch Facial Plast Surg 2002;4:98–101.
[4] Rumelt MB, Ernest JT. Isolated blowout fracture of the medial orbital wall with medial rectus muscle entrapment. Am J Ophthalmol 1972; 73:451–3.
[5] Leone Jr CR, Lloyd III WC, Rylander G. Surgical repair of medial wall fractures. Am J Ophthalmol 1984;97:349–56.
[6] Chen CT, Chen YR, Tung TC, et al. Endoscopically assisted reconstruction of orbital medial wall fractures. Plast Reconstr Surg 1999;103:714–20.
[7] Baumann A, Ewers R. Transcaruncular approach for reconstruction of medial orbital wall fracture. Int J Oral Maxillofac Surg 2000;29:264–7.
[8] Oh JY, Rah SH, Kim YH. Transcaruncular approach to blowout fractures of the medial orbital wall. Korean J Ophthalmol 2003;17:50–4.
[9] Chen CT, Chen YR. Endoscopically assisted repair of orbital floor fractures. Plast Reconstr Surg 2001;108:2011–8.
[10] Chen CT, Chen YR. Endoscopic orbital surgery. Atlas Oral Maxillofac Surg Clin North Am 2003; 11:179–208.
[11] Lee HM, Han SK, Chae SW, et al. Endoscopic endonasal reconstruction of blowout fractures of the medial orbital walls. Plast Reconstr Surg 2002;109:872–6.
[12] Otori N, Haruna S, Moriyama H. Endoscopic endonasal or transmaxillary repair of orbital floor fracture: a study of 88 patients treated in our department. Acta Otolaryngol 2003;123:718–23.
[13] Sanno T, Tahara S, Nomura T, et al. Endoscopic endonasal reduction for blowout fracture of the medial orbital wall. Plast Reconstr Surg 2003; 112:1228–37 [discussion 1238].
[14] Rhee JS, Lynch J, Loehrl TA. Intranasal endoscopy-assisted repair of medial orbital wall fractures. Arch Facial Plast Surg 2000;2:269–73.
[15] Edwards WC, Ridley RW. Blowout fracture of medial orbital wall. Am J Ophthalmol 1968;65: 248–9.
[16] Thering HR, Bogart JN. Blowout fracture of the medial orbital wall, with entrapment of the medial rectus muscle. Plast Reconstr Surg 1979; 63:848–52.
[17] Merle H, Gerard M, Raynaud M. Isolated medial orbital blow-out fracture with medial rectus entrapment. Acta Ophthalmol Scand 1998;76: 378–9.
[18] Naraghi M, Kashfi A. Endonasal endoscopic treatment of medial orbital wall fracture via rotational repositioning. Am J Otolaryngol 2002; 23:312–5.
[19] al-Qurainy IA, Stassen LF, Dutton GN. The characteristics of midfacial fractures and the association with ocular injury: a prospective study. Br J Oral Maxillofac Surg 1991;29:291–301.
[20] Lakits A, Prokesch R, Scholda C, et al. Helical and conventional ct in the imaging of metallic foreign bodies in the orbit. Acta Ophthalmol Scand 2000;78:79–83.
[21] Mun GH, Song YH, Bang SI. Endoscopically assisted transconjunctival approach in orbital medial wall fractures. Ann Plast Surg 2002;49: 337–43 [discussion 344].
[22] Kim S, Helen Lew M, Chung SH, et al. Repair of medial orbital wall fracture: transcaruncular approach. Orbit 2005;24:1–9.
[23] Graham SM, Thomas RD, Carter KD, et al. The transcaruncular approach to the medial orbital wall. Laryngoscope 2002;112:986–9.
[24] Jin HR, Shin SO, Choo MJ, et al. Endonasal endoscopic reduction of blowout fractures of the medial orbital wall. J Oral Maxillofac Surg 2000;58:847–51.