

ORIGINAL RESEARCH

Endoscopic versus external repair of orbital blowout fractures

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OBJECTIVES: This study evaluates the usefulness of endoscopic repair compared to external repair in the treatment of blowout fracture (BOF) of the orbit.

STUDY DESIGN AND SETTING: This retrospective study comprised 100 patients who had had surgical repair of orbital BOF since 1992. Forty-eight of the 100 had undergone endoscopic repair, 48 patients had had external repair, and four patients underwent surgery that combined the two approaches. The two basic approaches were evaluated and compared with respect to technique, results and complications.

RESULTS: Endoscopically, transnasal and transantral approaches had been used for reduction and support of fractured medial and inferior walls, respectively. In the external approach, various transorbital incisions were made and the fractured wall was repaired with alloplastic or autologous materials. Complete or partial resolution of preoperative diplopia was achieved in 94% of the endoscopic group and 83% of the external group (NS). Enophthalmos was improved in 89% of the endoscopic group and 76% of the external group (NS). Though the endoscopic group had no significant complications, the external group had ectropions, significant facial scars, extrusion of inserted Medpor, and intra-orbital hematoma.

CONCLUSIONS: Endoscopic repair appears to be a safe and effective technique for the treatment of BOF of the orbit.

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Traditionally, external transorbital approaches have been used in the repair of blowout fracture (BOF) of the orbit. External approaches generally require either a medial canthal incision, a subciliary incision, or a transconjunctival incision, depending on the location, extent, and complexity

of the fracture. External repairs with transorbital incisions have known complications that include external scars, ectropion, and a frequent need for alloplastic materials to support the fractured wall.^{1–3}

Because the application of endoscopic surgery has been extended to the diverse fields of head and neck surgery including facial trauma, many reports about the endoscopic repair of medial and inferior orbital BOF have been published.^{4–13} These reports either discuss endonasal repair of medial BOF^{4–8} or transantral repair of inferior BOF.^{9–13} However, studies that include both endoscopic approaches are rare. Moreover, these studies generally have been case series or preliminary reports on cadavers combined with small numbers of surgical patients. To date, there are no published studies that examine the advantages and disadvantages of endoscopic versus external repair of orbital BOF in an adequate number of surgical cases.

This study evaluates the usefulness of endoscopic repair compared with external repair of BOF of the orbit; the primary outcomes are resolution of diplopia and enophthalmos. In addition, the advantages and limitations of endoscopic repair will be discussed, and the surgical techniques described in comparison with the external approach.

PATIENTS AND METHODS

From 1992 to 2004, 316 patients with BOF of the orbit were managed at the Department of Otolaryngology of Chungbuk National University Hospital. All of the fractures were di-

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Table 1
Demographics of the 100 surgical patients

Method of repair	Average age (years)	Sex	
		Male	Female
Endoscopic (n = 48)	31	36	12
External (n = 48)	28	37	11
Combined (n = 4)	36	3	1
Total	30	76	24

agnosed by computed tomography (CT) scan. Of these, 203 patients were managed conservatively and 113 patients underwent surgery by the senior author or chief residents under the supervision of the senior author. A retrospective chart review was performed for the 113 surgical patients with a predetermined check list. All information was collected from the medical records and CT scans with prior approval from the Chungbuk Research Internal Review Board. The patient's age, sex, site of the fracture, presenting symptoms and signs, surgical method and results, complications, and follow-up period were included in the check list. Two residents of our department performed the chart review while blinded to the objectives of the study. Thirteen patients were excluded from the study mainly because of a short follow-up period or inadequate data including a CT scan that did not meet study criteria; the remaining 100 patients were available for further review and analysis.

Among the 100 patients reviewed, there were 76 males and 24 females; their mean age was 30 years (Table 1). Injuries were on the left side in 65 patients and on the right side in 35 patients. Fracture sites involved the inferior wall in 45 (45%) patients, medial wall in 32 (32%) patients, and both walls in 23 (23%) patients (Table 2). The follow-up period varied from three months to four years with an average of seven months.

Surgical methods and timing, surgical techniques, surgical results that included improvement of diplopia and enophthalmos, and complications associated with the surgery were evaluated and analyzed. Improvement of preoperative diplopia was categorized into three groups: complete resolution, partial resolution, and residual deformity. Complete resolution was defined as no diplopia at all; partial resolution as slightly remaining diplopia within 30° of the primary gaze, especially in upward gaze with no discomfort in daily life; and residual deformity as persistent diplopia that causes discomfort in daily life. Complete and partial resolutions were considered to be a surgical success. The degree of enophthalmos was measured with a Hertel exophthalmometer.

Intergroup differences in improvement of diplopia and enophthalmos were assessed with chi-square test and Fisher's exact test. A *P* value < 0.05 was considered statistically significant.

RESULTS

Management Principle

Initial management started with ophthalmologic consultation and supportive care that included cold pack application and intake of analgesics although steroids were not used routinely. Visual acuity, ocular motility, exophthalmometry, and forced duction testing were checked regularly until the day before surgery. Persistent diplopia that lasts two weeks after injury, restriction of eye movement with CT evidence of extraocular muscle entrapment, and an enophthalmos of greater than 2 mm were treated as indications for surgery. Final evaluation for the presence of diplopia and the degree of enophthalmos was performed three months after surgery.

Selection of Surgical Method

The selection of surgical approach in management of BOF mainly depended on the time of injury. From 1992 to 1996, only external repair was used to treat all orbital BOF. Starting in 1997, endoscopic repair replaced external repair to treat medial BOF. From 1997 to 1999, inferior BOF was still managed with an external approach whereas medial BOF was managed endoscopically. Endoscopic repair of inferior BOF started in 2000, and since then inferior BOF largely has been managed endoscopically although a few cases with severe periorbital laceration and associated tripod fracture were managed with an external approach.

Overall, an endoscopic repair was used in 48 patients (endoscopic group), an external repair in 48 patients (external group), and both approaches in four patients (combined group). In the endoscopic group, an endonasal reduction was used in 25 patients, a transantral reduction in 20 patients, and both endonasal and transantral reductions were used in three patients with simultaneous medial and inferior BOFs (Table 2). In the external group, 28 patients had inferior BOF, 12 had medial BOF, and eight had both medial and inferior BOFs. There were four patients with simultaneous medial and inferior BOFs who were treated with both endoscopic and external repairs.

Table 2
Methods of repair and sites of blowout fracture in 100 surgical patients

Method of repair	Site of fracture			Total
	Medial	Inferior	Medial and inferior	
Endoscopic	20	17	11	48
Endonasal	20	1	4	25
Transantral	0	16	4	20
Endonasal + transantral	0	0	3	3
External	12	28	8	48
Combined	0	0	4	4
Total	32	45	23	100

Table 3
Timing of surgical repair

Method of repair and site of fracture*	Days from the injury				
	0-7	8-14	15-21	22-28	>28
Endoscopic (n = 48)	7 (15%)	27 (56%)	8 (17%)	4 (8%)	2 (4%)
Medial (n = 20)	5	11	2	1	1
Inferior (n = 17)	2	9	4	2	0
Both (n = 11)	0	7	2	1	1
External (n = 48)	4 (8%)	29 (60%)	7 (15%)	6 (13%)	2 (4%)
Medial (n = 12)	1	7	1	3	0
Inferior (n = 28)	2	17	4	3	2
Both (n = 8)	1	5	2	0	0
Combined (n = 4)					
Both (n = 4)	0	1 (25%)	2 (50%)	1 (25%)	0

*No statistical difference in the timing of surgical repair between the endoscopic group and external group ($P > 0.05$).

Timing of Surgery

The time to surgical repair was stratified by weekly intervals (Table 3). In the endoscopic group, 34 patients had surgery within two weeks from the injury; 14 patients had surgery two weeks after their injury. In the external group, 33 patients had surgery within two weeks of the injury whereas 15 patients had surgery two weeks after the injury. There was no statistical difference in the timing of surgery between the two groups ($P > 0.05$). In the combined group, one patient had surgery within two weeks after the injury, and three patients had surgery two weeks after the injury.

Operative Techniques of Endoscopic Repair

Surgery was performed under general or local anesthesia, determined by the extent of the fracture and the status of the patient. Either a 0-degree or 30-degree, 4-mm diameter endoscope (Karl Storz GmbH & Co, Tuttlingen, Germany) was used. In medial BOF, the herniated orbital tissue was approached through the ethmoid cavity. After topical and infiltration anesthesia, an uncinectomy was performed. Care was taken during this procedure not to incise or remove orbital tissue that herniated into the ethmoid cavity when fractures were severe. If necessary, an ethmoidectomy was performed to clearly delineate the fracture site from herniated orbital tissue. Bony fragments that did not interfere with normal muscle action were preserved to obtain a more rigid medial orbital wall postoperatively. On occasion, herniated orbital tissue had adhered to the ethmoid sinus mucosa; it was separated by careful dissection with the use of an elevator. Compressing the orbit gently during surgery helped to identify herniated orbital tissue. After herniated orbital tissue was reduced to its original position, a silastic sheet was sculpted to fit the ethmoid cavity and inserted as an inverted U-shape. Merocel (Xomed, Jacksonville, Fla) soaked with an antibiotic and steroid solution was inserted to fill the cavity evenly to the ethmoid roof (Fig 1). Care was taken to fully reduce the fracture and evenly pack the Merocel to prevent the protrusion of orbital tissue into the

unreduced or unpacked site. Care also was taken not to obstruct the middle meatal antrostomy site and the frontal sinus ostium, because this may predispose the patient to postoperative sinusitis. Excessively tight packing was avoided because it generally causes orbital pain after surgery.

In inferior BOF, the orbital floor was approached through a small bony window (1.0 × 1.5 cm) made at the anterior wall of the maxillary sinus after gingivobuccal incision. The orbital floor, herniated orbital tissue, maxillary sinus ostium, and infraorbital nerve indentation were carefully observed with the endoscope. While gentle pressure was applied to the affected eyeball, fracture size and patterns were observed with the endoscope. In a trapdoor-type fracture, herniated orbital tissue was repositioned into its preorbital position together with the bone flap, with an appropriately sized elevator or a cotton ball held in place by a small Kelly clamp. Care was taken not to strangulate herniated orbital tissue during the reduction. In a large fracture with orbital floor disruption, a decision was made whether to use the implant for floor support after careful inspection with the elevator. If a large bony fragment had been preserved, it was left in place for floor support after reduction of the orbital contents. In large fractures without any useful bony frag-

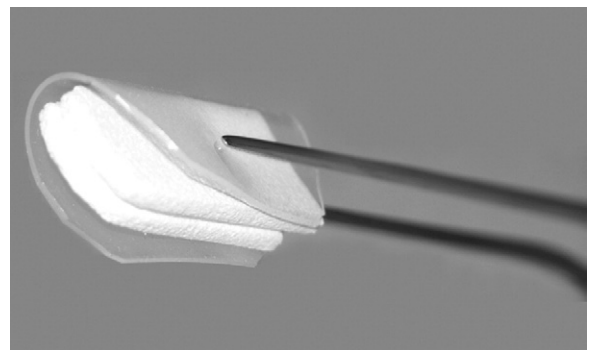


Figure 1 Design of a silastic sheet and Merocel that are packed at the ethmoid cavity.

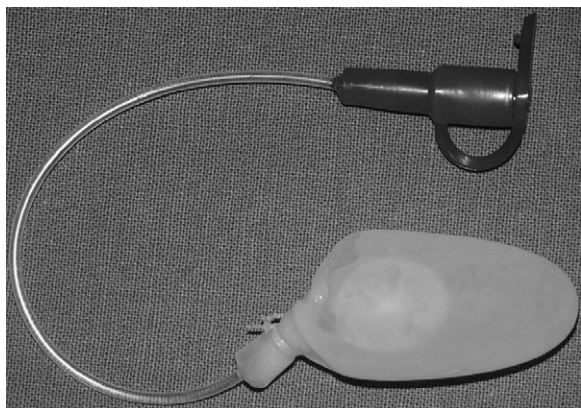


Figure 2 Balloon made with a surgical glove and a pediatric feeding tube.

ments for floor support, harvested anterior maxillary wall or a Medpor implant (Porex Surgical Inc, College Park, Ga) was inserted below the reduced orbital tissue and supported by the remaining stable bony shelves. After reduction, the mucosal flap was repositioned and the wall was supported with a balloon catheter inserted through the enlarged maxillary ostium. The balloon catheter was constructed of a surgical glove and a pediatric feeding tube (Fig 2).

After surgery, visual acuity and ocular motility were checked. Mild orbital pain subsided spontaneously. The packed Merocel in the endonasal group was kept dry with frequent suctioning during the hospital admission. After discharge, weekly follow-up and oral antibiotics were recommended until removal of the Merocel or balloon catheter. The balloon catheter was easily removed through the nose after removing the saline filling the balloon at the outpatient clinic. Under usual circumstances, the Merocel or the balloon was removed three to four weeks after surgery. After this removal, a routine ophthalmologic examination, including exophthalmometry, was carried out.

Surgical Outcomes

Diplopia and enophthalmos measurements of the day before surgery and three months after surgery were compared to evaluate the outcome. Before surgery, diplopia was present in 76 (76%) patients (endoscopic group, 37; external group, 35; combined group, 4) (Table 4). In the endoscopic group, complete resolution of diplopia was achieved in 26 (70%) patients and partial resolution in nine (24%) patients for an overall rate of improvement in preoperative diplopia of 94%. In the external group, complete resolution was achieved in 15 (43%) patients and partial resolution in 14 (40%) patients for an overall rate of improvement in preoperative diplopia of 83% (Table 4). The rate of complete resolution was significantly higher in the endoscopic group ($P < 0.05$) versus the external group; however, the overall rate of surgical success, including both complete and partial resolution, was not significantly different. In the combined group, complete resolution was achieved in 1 (25%) patient and partial resolution in two (50%) patients, for an overall rate of improvement in preoperative diplopia of 75 percent. In both endoscopic and external groups, there was no statistical difference in the rate of residual deformity according to the site of fracture ($P > 0.05$) (Table 4).

Preoperatively, an enophthalmos of greater than 2 mm was present in 38 (38%) patients (endoscopic group, 19; external group, 17; combined group, 2) (Table 5). The severity of preoperative enophthalmos was not significantly different between the endoscopic group and external group (2.7 mm vs 2.9 mm) ($P > 0.05$). Preoperative enophthalmos was corrected in 31 (82%) of 38 patients. Enophthalmos was corrected in 17 (89%) of 19 patients in the endoscopic group and 13 (76%) of 17 patients in the external group with no statistical difference between the 2 groups ($P > 0.05$) (Table 5). In the combined group, enophthalmos was corrected in one (50%) of two patients. In both endoscopic and external groups, there was no statistical difference in the rate of enophthalmos correction according to the site of

Table 4
Improvement of diplopia after surgical repair

Method of repair and site of fracture*	Before surgery	After surgery		
		Complete resolution†	Partial resolution	Residual deformity
Endoscopic (n = 48)	37 (100%)	26 (70%)	9 (24%)	2 (6%)
Medial (n = 20)	14	11	1	2
Inferior (n = 17)	15	8	7	0
Both (n = 11)	8	7	1	0
External (n = 48)	35 (100%)	15 (43%)	14 (40%)	6 (17%)
Medial (n = 12)	8	4	2	2
Inferior (n = 28)	22	9	10	3
Both (n = 8)	5	2	2	1
Combined (n = 4)				
Both (n = 4)	4 (100%)	1 (25%)	2 (50%)	1 (25%)

*No statistical difference in the ratio of residual deformity according to the method of repair or site of fracture ($P > 0.05$).

†Statistical difference between the endoscopic and external groups ($P < 0.05$).

Table 5
Incidence of enophthalmos before and after surgical repair

Method of repair and site of fracture*	Before surgery	After surgery
Endoscopic (n = 48)	19 (100%)	2 (11%)
Medial (n = 20)	8	1
Inferior (n = 17)	4	0
Both (n = 11)	7	1
External (n = 48)	17 (100%)	4 (24%)
Medial (n = 12)	3	1
Inferior (n = 28)	10	3
Both (n = 8)	4	0
Combined (n = 4)		
Both (n = 4)	2 (100%)	1 (50%)

*No statistical difference in the rate of enophthalmos correction according to the method of repair or site of fracture ($P > 0.05$).

fracture ($P > 0.05$) (Table 5). Satisfactorily reduced orbital walls could be observed by nasal endoscopy or by CT scan (Figs 3 A and B and Fig 4).

Surgical Complications

In the endoscopic group, no significant intraoperative or postoperative complications were discovered except for one patient who developed orbital cellulitis that resolved with antibiotic treatment; transient mild orbital pain and decreased sensation of the cheek improved over time. In the external group, two patients developed transient ectropion that improved with massage; one patient developed an unsightly medial canthal scar; one patient had extrusion of inserted Medpor; and one patient developed an intra-orbital hematoma.

DISCUSSION

Endoscopic repair of BOF of the orbit has been reported to provide surgeons with several advantages over conventional

external repair.⁴⁻¹³ First, it provides excellent visualization of the medial and inferior walls of the orbit, which enables safe removal of bony fragments and clear anatomic reduction of fractures. Second, the use of intraocular alloplastic implants, commonly used with external repairs, can be avoided or minimized. Third, endoscopy virtually eliminates the risk of significantly visible facial scarring and eyelid complications, complications reported with transorbital incisions. Fourth, endoscopic surgery can be performed under local anesthesia, which makes intra-operative evaluation of ocular movements and diplopia possible.

Some of the advantages of endoscopic repair were evident in our study. In our endoscopic group, there were no postoperative complications associated with transorbital incisions, such as ectropion or unsightly facial scars that were observed in the external group. A case of Medpor extrusion into the ethmoid cavity after external repair of a medial BOF was managed successfully with endoscopic endonasal reduction after Medpor removal. When the anterior maxillary wall or Medpor is used to support the orbital floor, an endoscope enables clear identification of the bony shelves so that the implant can be placed safely and with adequate support.

No specific major disadvantages have been reported for endoscopic repair of BOF.⁴⁻¹³ In endonasal repair of the medial wall, maxillary and/or frontal sinusitis can be caused by obstruction of the sinus ostium. This can be avoided by careful insertion of a silastic sheet and Meroceel and administration of antibiotics until the packing is removed. In our study, transantral repair of an orbital floor fracture resulted in transient numbness of the cheek, but symptoms slowly resolved over time. One potential difficulty with transantral repair of inferior BOF is in the fabrication and maintenance of a balloon that conforms to the shape of the orbital floor to support the reduced orbital tissue. In our experience, this can be overcome by using a self-made balloon fashioned from the fingers of a surgical glove and a pediatric feeding tube. With a small diameter catheter to facilitate the posi-

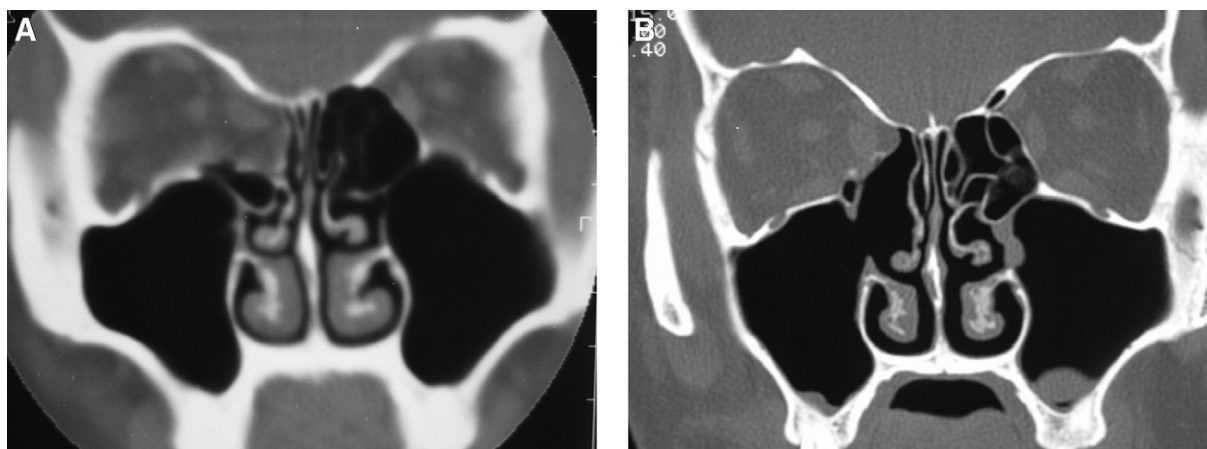


Figure 3 (A) Preoperative CT scan shows a large blowout fracture of the right medial orbital wall with herniation of orbital tissue. (B) CT scan taken at 8 weeks after surgery shows a well-reduced medial orbital wall.

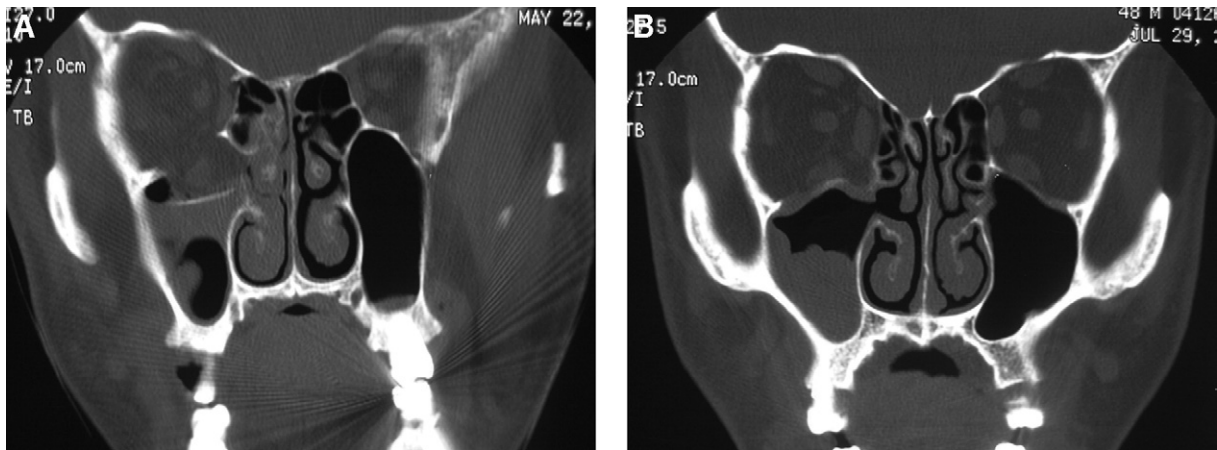


Figure 4 (A) Preoperative CT scan shows an inferior blowout fracture of the right orbit. (B) CT scan taken at two months after surgery shows a well-reduced orbital floor.

tioning of the balloon, you can avoid the inconvenience to the patient of a large diameter foley catheter.

Under usual circumstances, the Merocele or the balloon is removed three to four weeks after surgery, though the timing of removal depends on the type and extent of the fracture and whether supporting materials were used. In medial BOF, the Merocele can be removed early if the fracture is small or if only those bony fragments that might interfere with ocular muscle function are removed. In inferior BOF, the balloon can be removed early when a trapdoor type fracture is reduced with the bony fragment intact or when the fracture site is supported by a large bony fragment or implant. Usually, the Merocele packing that supports the medial wall can be removed earlier than a balloon catheter that supports the inferior wall because the inferior wall must be rigid enough to support the orbit against gravity.

Failure of diplopia to improve after adequate repositioning of orbital tissue is not an infrequent outcome after surgery for BOF, as we found in our study.¹⁴⁻¹⁷ There are a few explanations for residual diplopia even after adequate surgery. The first possible explanation is that entrapment, contusion, or hematoma of ocular muscle by fractured bony fragments may influence muscle function even after adequate repositioning.¹⁵ Second, there may be an undetected, persistent palsy of the oculomotor nerve.^{16,17} Third, altered orbit position may occur.

In this study, the endoscopic group was statistically more likely to experience complete resolution of diplopia than the external group, though the percentage in the two groups who experienced either complete or partial resolution was not different. The apparent improvement in complete resolution rate might be explained by improved visualization and anatomic reconstruction of the fracture in the endoscopic group.

Enophthalmos of greater than 2 mm is another indication for surgery, mostly for cosmetic reasons. Though there was no intergroup difference in the success rate for enophthalmos correction, only two Medpor implants were required to support the fractured inferior wall. This suggests that our

endoscopic repair technique provides sufficient strength to support the repositioned orbital tissue with minimal use of any artificial implants even with large inferior fractures. When observed through the endoscope postoperatively, usually the reduced medial wall was strong enough to hold the orbital tissue in place. Although the inferior wall could not be observed through the endoscope, a well-aligned inferior wall was observed by CT scan.

CONCLUSIONS

Endoscopic repair of orbital blowout fractures represents an innovative and highly successful and safe alternative to external repairs. Prospective, randomized studies are warranted to study this new technique further.

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