Clinical Analysis of Surgical Approaches for Orbital Floor Fractures

Jae Hwan Kwon, MD, PhD; Jeong Geun Kim, MD; Jung Hwan Moon, MD; Joong Hwan Cho, MD

Objective: To identify the optimal surgical method for managing blowout fractures of the inferior orbital wall by analyzing the location and type of fracture based on computed tomographic findings and medical records.

Methods: Medical records of 102 patients with pure inferior blowout fractures who were treated between June 1996 and December 2005 were reviewed regarding fracture type and location and surgical approach.

Results: Ocular symptoms persisted in 14 of the 102 cases after surgery, and revision procedures were performed in 11 of those cases. Cases with persistent symptoms were analyzed in terms of fracture location and type of surgery. For anterior orbital floor fractures, symptoms persisted in 2 of the 4 cases treated using a transantral approach, while no symptoms persisted in any of the 15 cases treated using a transorbital approach or in either of the 2 cases treated using a combined approach. For posterior orbital floor fractures, symptoms persisted in 2 of the 31 cases treated using a transantral approach, in 4 of the 6 cases treated using a transorbital approach, and in 1 of the 19 cases treated using a combined approach. For anteroposterior orbital floor fractures, symptoms persisted in 2 of the 5 cases treated using a transorbital approach and in 3 of the 20 cases treated using transantral and combined approaches.

Conclusion: Patients with large orbital floor fractures or posterior half fractures of the orbit should undergo surgery via a transantral or a combined approach, while patients with trapdoor fractures or anterior half fractures of the orbit should undergo surgery via a transorbital or a combined approach.


External impact such as blunt injury can often lead to orbital blowout fractures in the inferior or medial orbital wall as a result of the abrupt increase in intraorbital pressure. Orbital blowout fractures were first described by Smith and Regan in 1957. Since then, many studies have investigated the indications and optimal time for surgery as well as the optimal surgical methods for orbital blowout fractures. While the traditional mainstream surgical method for blowout fractures of the medial orbital wall has involved a transorbital approach with a medial canthus incision, an endoscopic endonasal approach has also been used. This latter approach has been of particular interest to otolaryngologists who commonly perform nasal endoscopies. For orbital floor fractures, surgical procedures are routinely performed via transorbital, transantral, or endoscopic endonasal approaches, and all of these approaches can be used in combination for orbital blowout fractures.

Many studies have sought to identify the optimal surgical modality for blowout fractures of the inferior orbital wall. It is imperative that otolaryngologists consider the location and shape of the fracture when determining the optimal surgical method. Currently, some studies report that each specific surgical method (transorbital, transantral, or combined approach) offers some advantage in treating patients with blowout fracture of the inferior orbital wall. In the present retrospective study, we investigated the optimal surgical method for blowout fractures of the inferior orbital wall in terms of the location and shape of the fracture based on computed tomographic findings and medical records and evaluated the type of fracture, the postoperative ophthalmic symptoms, and the surgical approach.

METHODS

We examined 102 patients who underwent surgical procedures for pure blowout fractures of the inferior orbital wall at our hospital between June 1996 and December 2005. The mean patient age was 28 years, and the male-female ratio was 77:25. The mean follow-up period was 6.9 months (range, 14 days to 42
Ophthalmic symptoms persisted in 14 of the 102 patients who underwent surgery, and 11 of the 14 patients underwent revision surgery. The cases were analyzed in terms of persistent symptoms, fracture location, and type of procedure. Symptoms persisted in 2 of the 4 patients with anterior orbital fractures who were treated with a transantral approach, while no symptoms persisted in any of the 15 patients who were treated with a transorbital approach or in either of the 2 patients who were treated with a combined approach. Symptoms persisted in 4 of the 6 patients with posterior fractures who were treated with a transantral approach and in 3 of the 50 patients who were treated with other surgical approaches. They also persisted in 2 of the 5 patients with anteroposterior fractures who were treated with a transantral approach and in 3 of the 20 patients who were treated with other surgical approaches (Table 1).

All 15 anterior fracture cases in which a transantral approach was used showed improvement in postoperative ocular symptoms. Therefore, the transantral approach was found to be superior to the transorbital approach (P = .04). Statistical analysis was not appropriate for the combined approach because of the small number of such cases.

Postoperative symptoms persisted in 2 of the 31 posterior fracture cases in which a transantral approach was used. Therefore, the transantral approach was superior to the transorbital approach (P = .003). Symptoms persisted in 1 of 19 posterior fracture cases in which a combined approach was used (P = .006). There was no significant difference between the transantral and combined approaches in terms of persistent symptoms (P = .68). Postoperative symptoms persisted in 3 of the 33 trapdoor fracture cases and in 11 of the 69 nontrapdoor fracture cases. Statistical analysis showed that the outcomes were similar for these 2 patient groups (P = .54) (Table 2). Post-

### Table 1. The Proportion of Patients With Persisting Ocular Symptoms as a Function of Surgical Method and Location of Fracture

<table>
<thead>
<tr>
<th>Location of Fracture</th>
<th>Transantral</th>
<th>Transorbital</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>2/4</td>
<td>0/15</td>
<td>0/2</td>
</tr>
<tr>
<td>Posterior</td>
<td>2/31</td>
<td>4/6</td>
<td>1/19</td>
</tr>
<tr>
<td>Anteroposterior</td>
<td>1/8</td>
<td>2/5</td>
<td>2/12</td>
</tr>
<tr>
<td>Total</td>
<td>5/43</td>
<td>6/26</td>
<td>3/33</td>
</tr>
</tbody>
</table>

*a Data are expressed as number of patients with persistent ocular symptoms after surgery and total number of patients who underwent surgery. All patients presented with blowout fractures of the inferior orbit wall.

Surgical procedures were performed via transorbital, transantral, or combined approaches. Preoperative and postoperative symptoms were assessed. Symptomatic patients were defined as those in whom the ophthalmic symptoms did not improve or deteriorated and those in whom the ophthalmic symptoms persisted to such an extent as to interfere with daily life at a minimum follow-up of 8 weeks. The type of procedure and the location and shape of the fracture were analyzed in terms of symptom persistence. The type or presence of restorative materials used to fill the inferior orbital wall fracture area was not taken into consideration during analysis. The Fisher exact test was used for statistical analysis, and P < .05 was considered significant.

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operative symptom persistence was analyzed in terms of fracture location, ie, anterior, posterior, and anteroposterior. No association was found between fracture location and surgical outcome regardless of the surgical approach (P = .63). No statistical significance was found in relationship between each surgical approach regardless of the location and type of fracture (P = .33).

The transorbital approach is currently regarded as the mainstream method for reduction of blowout fractures of the inferior orbital wall. However, many attempts have been made to restore the maxillary sinus via a transantral approach or to combine other approaches using the anterior maxilla wall, and each of these approaches has advantages and disadvantages. Because the majority of investigations to date have examined only 1 approach per study, little is known about the relationship between the surgical approach and the type of fracture. A transorbital approach is useful in releasing the incarceration of the inferior orbital wall. However, in grafting for the reconstruction of the inferior orbital wall, otolaryngologists must dissect all the soft tissue around the fracture area. The pyramidal shape of the orbit essentially makes the posterior region of the orbit narrower. Therefore, otolaryngologists have difficulty in identifying and then dissecting the fracture area in the posterior region of the orbit. Also, in situations in which good surgical vision cannot be obtained, an excessive dissection might cause optic nerve damage. Furthermore, the posterior orbital tissue or muscle might be jammed by the graft material when it is implanted into the orbital floor without complete dissection.

In the present series, revision surgery was performed on 3 patients with posterior fractures who initially underwent surgery via a transorbital approach and who persistently presented with postoperative symptoms. In 2 of the patients, incarceration of the inferior rectus muscle due to graft material had developed, and in the third patient, the posterior region of the orbit was not completely dissected.

The transantral approach has the advantage of providing a direct view of the fracture area. This approach is clinically useful in cases involving severe fractures in the posterior orbit region. The present study found that a transantral approach was more effective than a transorbital approach for posterior fractures. Some authors maintain that the incarceration of orbital tissue cannot be completely reduced by the single use of a transantral approach. Using a combined approach, we successfully treated the cases of posterior fracture in which orbital tissue incarceration was suspected. In cases in which the single use of a transantral approach cannot release orbital tissue incarceration, surgeons must use their fingers or other instruments with an endoscope. They must lift the incarcerated orbital tissue upward through the maxillary sinus window to complete the reduction with ease.

Very few studies have analyzed data in terms of fracture types. The present series identified 33 trapdoor and 69 nontrapdoor fracture cases. In a study involving pediatric patients, Cohen and Garrett reported that nontrapdoor fractures were more prevalent than trapdoor fractures, and our study found that 21% of total cases were anterior fractures, 55% were posterior fractures, and 24% were anteroposterior fractures.

**Table 2. The Proportion of Patients With Persisting Ocular Symptoms as a Function of Surgical Method and Fracture Type**

<table>
<thead>
<tr>
<th>Type of Fracture</th>
<th>Transantral</th>
<th>Transorbital</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapdoor</td>
<td>2/10</td>
<td>1/12</td>
<td>0/11</td>
</tr>
<tr>
<td>Nontrapdoor</td>
<td>3/33</td>
<td>5/14</td>
<td>3/22</td>
</tr>
<tr>
<td>Total</td>
<td>5/43</td>
<td>6/26</td>
<td>3/33</td>
</tr>
</tbody>
</table>

a Data are expressed as number of patients with persistent ocular symptoms after surgery and total number of patients who underwent surgery. All patients presented with blowout fractures of the inferior orbit wall.

![Figure 3](http://archfaci.jamanetwork.com/pdfaccess.ashx?url=/data/journals/faci/5635/ on 04/04/2017)
Consistent with the current findings, Jones and Evans found that 79% of total fracture cases occurred in the posterior region of the inferior orbital wall and that posterior fractures accounted for 55% of total fractures. The relatively common occurrence of posterior fractures is presumably because the S-shape of the inferior orbital wall makes the posterior region most vulnerable to external impact and because the anterior region of the inferior orbital wall is thicker than its posterior counterpart.

In the present study, a transantral approach was used in 42% of cases, a combined approach was used in 32% of cases, and a transorbital approach was used in 29% of cases. A transmaxillary sinus approach was most frequently used. To date, most authors report preferentially using a transorbital approach because a transmaxillary sinus approach is not effective in relaxing orbital tissue incarceration. Those authors also noted that a transantral approach was associated with (1) instability of the restorative material in the maxillary sinus, (2) infection, and (3) damage to optic nerve fibers as a result of excessive reduction. Furthermore, it can be inferred that a transorbital approach has been preferentially used because ophthalmologists and plastic surgeons have generally managed cases of blowout fractures even though they are not necessarily highly familiar with maxillary sinus anatomy. We were successful in reducing blowout fractures using various methods because we are accustomed to using a transmaxillary sinus approach. In the present series, we actively used a combined approach. We resolved instability problems by implanting a folded silicone tube into the maxillary sinus.

Revision surgery was undertaken in 11 of 14 cases in which the postoperative symptoms persisted. The reasons for revision surgery included orbital muscle incarceration owing to the graft material implanted in the orbital floor in 5 cases, to underreduction in 4 cases, and to hyperreduction in 2 cases. The 5 cases of orbital muscle incarceration all involved posterior fractures, suggesting that orbital muscle incarceration is specifically linked to this type of fracture. In 3 of the 4 underreduced cases, the posterior part of the orbital floor was not fully dissected via a transorbital approach. Accordingly, in those cases, the escaped periorbital tissue was not fully reduced. In the remaining 1 case, which involved both an anterior fracture and a trapdoor fracture, the incarceration of the orbital muscle was not fully resolved after surgery via a transantral approach. Hyperreduction was caused by silicone packing in one case and by a porous high-density polyethylene implant (Medpor; Porex Technologies, Fairburn, Georgia) in the other. The possibilities of such complications must be given particular attention.

**CONCLUSIONS**

We found that for anterior fractures a transorbital approach was effective in terms of postoperative complications and symptom improvement. For posterior fractures, both transanral and combined approaches were effective in regard to postoperative complications and symptom improvement. Neither the location, the type of fracture, nor the surgical approach was found to affect surgical outcomes. In terms of posterior fractures, trapdoor fractures were the most common, while for anterior fractures, trapdoor fractures were the most common. These findings imply that anterior fractures are more subject to incarceration of orbital muscles or periorbital tissue than posterior fractures. Our results indicate that the posterior orbital region must be fully dissected when reducing posterior fractures via a transorbital approach and that great care must be taken in the implantation of graft material for the reconstruction of the orbital floor lest the graft material cause reincarceration of orbital tissue. In conclusion, patients with large orbital floor fractures or posterior half fractures of the orbit should undergo surgery via a transantral or a combined approach, while patients with trapdoor fractures or anterior half fractures of the orbit should undergo surgery via a transorbital or a combined approach.

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**Author Contributions:** Study concept and design: Kwon, Moon, and Cho. Acquisition of data: Kwon, Kim, and Moon. Analysis and interpretation of data: Kwon and Kim. Drafting of the manuscript: Kwon, Kim, and Moon. Critical revision of the manuscript for important intellectual content: Kwon and Cho. Statistical analysis: Kwon, Kim, and Moon. Obtained funding: Kwon. Administrative, technical, and material support: Kwon. Study supervision: Kwon and Cho.

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**REFERENCES**