The Differences of Blowout Fracture of the Inferior Orbital Wall Between Children and Adults

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Objectives: To review the clinical features and recovery period of patients with blowout fractures of the inferior orbital wall treated surgically and to examine the differences between children and adults.

Design: A retrospective study.

Setting: Department of Otorhinolaryngology, Maryknoll General Hospital, Busan, Korea.

Patients: Medical records of 70 patients were reviewed: 16 patients were children (aged <16 years) and 54 were adults (aged ≥17 years).

Main Outcome Measures: Symptoms and fracture patterns were compared between both groups in all subjects, and the recovery period relative to the timing of surgery after the trauma was compared in subjects who complained of diplopia or extracocular limitation.

Results: Serious periorbital edema was noted in 43 adults (80%) and 4 children (25%), diplopia in 27 adults (50%) and 16 children (100%), and extracocular muscle limitation in 23 adults (43%) and 13 children (81%). Trapdoor fractures were frequent in the children group (n=13; 81%), whereas 30 patients (56%) had open-door fractures in the adult group. In the children group, no differences in the recovery period relative to the timing of surgery was noted when all types of orbital fractures were considered. However, among the 13 children with trapdoor fractures, the recovery period was significantly shorter in those who underwent surgery 1 to 5 days after the trauma compared with those who underwent surgery after 6 to 14 days and 15 days or longer. In adults, the recovery period of those who underwent surgery 1 to 5 days and 6 to 14 days after the trauma were significantly shorter compared with those who underwent surgery after 15 days or longer.

Conclusions: Diplopia, extraocular muscle limitation, and trapdoor fractures were more frequent in children than in adult patients. After trauma, surgical intervention might be required within 5 days in children with trapdoor fracture vs within 2 weeks in adults.


LOWOUT FRACTURES OF THE inferior orbital wall have been occurring more frequently. This may be owing to the rising number of traffic accidents, social activities, violence, the higher sensitivity of computed tomography (CT) in diagnosing these types of fractures, and the decrease in the average age of patients. Several reports have noted characteristics of the blowout fracture of the inferior orbital wall in children. Some have suggested that earlier surgical intervention will result in a better outcome in children compared with adults. However, no general standard of care has been defined, and to our knowledge, there have been no reports on the differences between children and adults. Thus, we investigated the clinical characteristics, ocular symptoms, fracture type, and optimal time for surgical intervention between children and adults with blowout fracture of the inferior orbital wall.

METHODS

Our study population comprised 70 patients with blowout fracture of the inferior orbital wall, who were treated surgically from January 1998 to September 2003. The patients were divided into 2 groups: a children group (16 patients aged <16 [mean age, 14 years]) and an adult group (54 patients aged ≥17 [mean age, 34 years]).

For all patients, progress was monitored for at least 3 months, and the average length of observation was 12 months (range, 3-69 months). All patients received an eye examination at the Department of Ophthalmology before and after the operation. They were
checked for visual acuity and examined with the extraocular muscle movement test, diplopia test, forced duction test, and Hertel exophthalmometry before and after the operation. These measurements were compared between the children and adult groups. Based on CT, the subjects were divided into groups with trapdoor fractures or open-door fractures (Figure 1), which was confirmed during the operation. The state of periorbital swelling after the trauma was recorded. The operation was performed when the periorbital swelling disappeared and/or within 2 weeks after the trauma. However, patients who presented after 2 weeks from the time of the trauma were operated on as soon as possible.

The operation was carried out with the patient under general anesthesia through either the transorbital or transantral approach or both. Among the children group, 13 patients underwent the transorbital approach and 3 underwent both the transorbital and the transantral approach. For the adult group, 13 patients underwent the transorbital approach for reduction, 17 underwent the transantral approach, and 22 underwent both. To analyze the period of recovery from diplopia or extraocular muscle limitation, the children and adult groups were again divided. However, we excluded 25 adults who did not complain of diplopia or extraocular muscle limitation but had significant enophthalmos before the operation or were expected to have enophthalmos afterward. The patients were divided into 3 subgroups based on the time from the trauma to the operation (1-5 days, 6-14 days, and ≥15 days).

Extraocular muscle limitation or diplopia before surgery was recorded quantitatively for the patients in each subgroup. Extraocular muscle limitation was recorded as follows:

- 0 if eye movement was the same as that of a normal eye without fracture of the inferior orbit;
- −1 if the distance measured from the bottom boundary of the cornea of the healthy side to the bottom boundary of the cornea of the affected side, with the eye looking up as high as possible, was no longer than 1 mm;
- −2 if the distance was between 1 and 2 mm;
- −3 if the distance was between 2 and 3 mm; and
- −4 if the distance was longer than 3 mm (Figure 2).

The degree of diplopia was recorded as follows:

- 0 if the patient did not complain of diplopia;
- −1 if the patient complained of diplopia when looking up or down at an angle greater than 45° from the horizon;
- −2 if the angle was between 15° and 45°;
- −3 if the angle was within 15°; and
- −4 when looking straight ahead. If a patient complained of both diplopia and extraocular muscle limitation, a more severe score was indicated (Table 1 and Table 2).

We also investigated and compared the period of recovery from ocular symptoms after surgery in each group. If symptoms did not disappear, the investigation was performed up to 90 days, the minimal observation period. Analysis of covariance was used for statistical analysis, and \( P < .05 \) was considered statistically significant.
RESULTS

DIFFERENCE IN THE EXPRESSION OF SYMPTOMS BEFORE OPERATION

Periorbital swelling, which was so serious that ophthalmological examination was impossible at the first visit, was found in 43 adults (80%) and 4 (25%) children. Thus periorbital swelling was more serious in the adult group than in the children group. Average time for resolution of the periorbital swelling was 3 days after the trauma in children and 7 days after the trauma in adults. Diplopia appeared in 27 adults (50%) and 16 children (100%). Extraocular muscle limitation appeared in 23 adults (43%) and 13 children (81%). Thus, the children group had less serious periorbital swelling compared with the adults, but they had more serious eye sequela.

DIFFERENCE IN FRACTURE PATTERN

In the children group, 13 patients (81%) had trapdoor fractures and 3 had open-door fractures. In the adult group, 24 patients (44%) had trapdoor fractures and 30 (56%) had open-door fractures. Therefore, the percentage of trapdoor-type fracture was higher in the children group than in the adult group.

PERIOD OF RECOVERY FROM OCULAR SYMPTOMS AFTER SURGICAL INTERVENTION

In the children group, 9 patients underwent surgery 1 to 5 days after the trauma, 3 after 6 to 14 days, and 4 after 15 days or longer. When stratified by fracture type, 1 patient with open-door fractures was present in the group that underwent surgery 6 to 14 days after the trauma and

Table 1. Quantification of the Diplopia or Extraocular Muscle Limitation in the Adult Group

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*For an explanation of the measurement scores, see the “Methods” section.
†Mean, 23.1 days; median, 15 days.
‡Mean, 17.8 days; median, 15 days.
§Mean, 60.0 days; median, 70 days.

Table 2. Quantification of the Diplopia or Extraocular Muscle Limitation in the Pediatric Group

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*For an explanation of the measurement scores, see the “Methods” section.
†Mean, 8.3 days; median, 3 days.
‡Mean, 62.3 days; median, 90 days.
§Mean, 48.5 days; median, 49 days.
||Open-door fracture.
2 in the group that underwent surgery after 15 days or longer. These 3 patients did not complain of extraocular muscle limitation but complained of diplopia when looking up. No difference was found among the children subgroups regardless of fracture type. However, when the 13 patients with trapdoor fractures were investigated (with the exclusion of the 3 patients with opendoor fractures), those who underwent surgery 1 to 5 days after the trauma had a shorter recovery period compared with those who underwent surgery after 6 to 14 days or after 15 days and longer ($P<.05$). When those who underwent surgery 6 to 14 days after the trauma were compared with those who underwent surgery after 15 days or longer, no difference on recovery period was found ($P>.05$) (Figure 3). In the adult group, the recovery period was significantly shorter for those who underwent surgery 1 to 5 days and 6 to 14 days after the trauma compared with those who underwent surgery after 15 days or longer (Figure 3).

In our study, diplopia, extraocular muscle limitation, and trapdoor fractures were more frequent in the children group than in the adult group. This suggests that trapdoor fractures may contribute to the sequela of diplopia or/and extraocular muscle limitation in children. The springlike restoring force of the inferior orbital wall when depressed after trauma has been proposed as a possible mechanism for a trapdoor fracture. The inferior orbital wall bone is more flexible in children than in adults and loses its flexibility as one ages. This loss of flexibility results in the bone being crushed by external impact. We believe that the flexibility of inferior orbital wall bone worsens the incarceration of tissue around the eye or extraocular muscle, which may explain why diplopia or extraocular muscle limitation was more frequent in children compared with adults. In the present study, all of the pediatric patients with trapdoor fractures complained of diplopia and extraocular muscle limitation, whereas only 15 adult patients (63%) with trapdoor fracture complained. Thus, trapdoor fracture caused more serious eye symptoms in children than in adults.

The literature cites that trapdoor fractures may cause severe vomiting just after trauma with the entrapment of extraocular muscle. In our hospital, 3 patients who had nausea and vomiting also had severe diplopia and extraocular muscle limitation when looking straight ahead. The same symptoms recurred with bending the neck to the affected side to compensate for the diplopia (torticollis). In all 3 patients, serious incarceration of the extraocular muscle was observed during the operation.

Damage of soft tissue such as edema around the eye and hypodermal bleeding appeared to be less frequent in pediatric patients than in adult patients. In our study, 43 adults patients (80%) could not receive an accurate ophthalmological examination at their first visit because of the severe edema around the orbit, whereas most children, except for 4 infants, completed a full ophthalmological examination. The periocular swelling resolved more quickly in children than in adults (3 vs 7 days), indicating that periocular swelling is less severe and disappears more quickly in children than in adults. Jordan et al coined
the term white-eyed blowout fracture in patients 16 years or younger with minimal soft tissue injury, severe diplo-
opia, extraocular muscle limitation, and extremely small ex-
trusion of tissue around the orbit on CT.

The optimal time for surgical intervention after a blow-
fout fracture of the inferior orbital wall has been contro-
versial. Some have expressed that observation after di-
agnosis may be better than early surgical intervention. However, recently, it has become commonly accepted that surgery should be performed within 2 weeks after the edema around the eye has decreased. In children, cal-
lus is formed on the bone fracture in 7 days, which makes it difficult to reduce fractures accurately. The early cal-
lus formation is due to the high bone regeneration po-
tential and good blood supply in children. Hence, facial bone fractures should be operated on earlier in children than in adults. Blowout fractures of the orbit in chil-
dren are also prone to be accompanied by serious incar-
ceration of eye tissue and extraocular muscle from trap-
door fractures. For this reason, several authors have pro-
posed earlier surgical intervention to prevent eye se-
quela in children with blowout inferior wall frac-
tures. In our study, pediatric patients who were op-
erated on within 5 days after the trauma recovered from diplopia or extraocular muscle limitation earlier than those who had the operation after 5 days. However, peri-
orbital swelling increases the difficulty of the operation and lengths the time required for recovery. Thus, we sug-
gest that if the fracture is an open-door fracture on CT ex-
amination and the incarceration of tissue around the eye
 is not confirmed by diplopia and eye movement tests, it may aid in the timing of the surgery. Three patients with open-door fractures who complained of diplopia without incarceration of tissue around the eye and were operated on after 5 days, recovered within 10 days from the operation. In the present study, pediatric patients were seen earlier after the trauma compared with adult pa-
tients (4 vs 7 days). However, some of the pediatric pa-
tients who were seen late after the trauma had unsatis-
factory results after the operation. The fact that edema or ecchymosis around the eye can be minimal in chil-
dren after a trauma can mislead the children's parents and even clinicians. Moreover, because children cannot ef-
cfectively express their situation, this can result in a de-
lay in treatment. Thus, pediatric patients should be ob-
served carefully at the early stages after a trauma.

For the adult group, time required for recovery was sig-
ficantly shortened when they had the operation within 2 weeks after the trauma compared with those who were operated on after 2 weeks. This is consistent with the exis-
ting standard that surgical intervention should be performed within 2 weeks after the trauma. In the adults as well, serious entrapment of tissue around the eyeball was observed on CT and ophthalmological ex-
amination. Little research has been conducted in adults in this area. We strongly suggest that both pediatric and adult patients with a trapdoor fracture and serious extra-
ocular muscle limitation should be operated on within
5 days after the trauma for a favorable resolution of the diplopia and extraocular muscle limitation. Based on our pediatric patient population, this is likely to be appli-
cable to all the patients; however, further research may be needed.

CONCLUSIONS

This study compared 70 patients who had an operation at our hospital for blowout fracture of the inferior or-
bital wall. Patients were divided into adult and children groups. The occurrence of trapdoor fracture and the fre-
quency of diplopia or extraocular muscle limitation were higher in the children than in the adult group. How-
ever, the damage of soft tissue, such as periocular swell-
ing, appeared to be less in the children than in the adults. Moreover, the children’s recovery period was shortened when surgical intervention occurred within 5 days after the trauma. Therefore, compared with the existing rec-
ommendations, earlier surgical intervention on pedi-
atriic patients is necessary. For adult patients, operation within 2 weeks after the trauma is believed to shorten the period of recovery.

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