

Orbital Trapdoor Fracture in Children

This study was performed to evaluate the clinical symptom, fracture finding, and surgical outcome in children with orbital trapdoor fracture. Forty-four patients with pure orbital trapdoor fracture, under 18 yr of age, were included. Time interval between injury and surgery, length of time for improvement, resolution of ocular motility restriction, and other factors were analyzed in 36 patients who underwent surgery. The median improvement time was 3.5 days for patients (n=8) receiving surgery within 5 days, 18.0 for those (n=19) receiving surgery between 6 and 14 days, and 50.0 for those (n=9) receiving surgery after 15 days ($p=0.03$). One month after operation, the mean change in supraduction limitation was 3.50 ± 0.53 for patients receiving surgery within 5 days, 2.11 ± 1.24 for those receiving surgery between 6 and 14 days, and 1.67 ± 0.82 for those receiving surgery after 15 days ($p=0.04$). Three months after operation, the mean change in supraduction limitation was 3.88 ± 0.35 , 2.94 ± 1.55 , and 2.50 ± 1.38 , respectively ($p=0.14$). In conclusion, trapdoor fracture of the orbit in children must be diagnosed by careful CT evaluation and clinical evidence of entrapment. For patients with severe limitation of ocular motility, early surgery within 5 days of injury leads to more rapid and better postoperative improvement.

Key Words : Child; Orbital Fractures; Surgery; Wounds and Injuries

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INTRODUCTION

The natural history, clinical symptom, type of fracture, and treatment indication of isolated orbital wall fracture are different in the children from those in the adults (1, 2). Children are particularly susceptible to pure orbital fractures of the trapdoor variety (3). Trapdoor fracture, which first described by Soll and Poley (4), occurs when a circular segment of the bony orbit fractures and becomes displaced, but remains attached on one side (5). It makes orbital contents herniated through the fracture sites, which results in entrapment of these herniated contents (3, 4, 6).

Because orbital fracture in children is relatively uncommon, data on pediatric orbital wall fracture has been reported in a few case series by reviewing individual fracture patterns or as part of series describing facial fractures, and studies on isolated trapdoor fracture in children are rare (3, 7). The purpose of this study is to evaluate the clinical symptom, fracture finding, and surgical outcome in children with trapdoor fracture.

MATERIALS AND METHODS

We retrospectively reviewed the medical records and computed tomography (CT) scans of 102 patients, under 18 yr of age, with orbital wall fracture presenting to the Chonnam National University Hospital from January 1998 to January

2003. In this study, 44 patients who had pure orbital trapdoor fracture were studied and the cause of injury, clinical symptom, radiologic finding, and associated ocular injury were investigated. Among the patients with trapdoor fracture who have soft tissue entrapment only, 8 patients did not undergo surgery because of mild restriction of ocular motility. Time interval between injury and surgery, length of time required for improvement, resolution of ocular motility restriction and diplopia, complication, and presence of persistent diplopia were analyzed in 36 patients who underwent surgery.

Limitation of ocular motility was graded on a numerical scale of 0 to -4, with 0 representing no limitation and -4 representing no movement in the field of gaze (7). Severe limitation of ocular motility was defined as -3 or -4. Forced duction test was performed when patient cooperated. CT was evaluated to determine fracture type, fracture site, involvement of orbital rim, entrapment of muscle or soft tissue (fat or peri-orbital tissue), and presence of other facial bone fracture on the basis of coronal scans.

When patient were admitted to the hospital, surgery was scheduled as soon as possible. Surgery was determined mainly on the basis of clinical evidence of muscle entrapment and CT confirmation of trapdoor fracture. Surgical repair was performed through transconjunctival incision under general anesthesia. Forced duction test was performed before making incision. After dissecting in the preseptal plane to the inferior orbital rim and elevating the periosteum off the floor, the entrapped

tissue was gently freed from the fracture site. Forced duction test was repeated at this point to confirm whether tissue entrapment was released completely. Silastic sheet with or without Medpor® implant was positioned to the fracture site and the wound was closed. Postoperatively the patient was treated with systemic antibiotics for 1 week. Statistical analysis was done by ANOVA and Student's *t* test using SPSS.

RESULTS

The incidence of trapdoor fracture in pediatric orbital fracture was 43.1% (44 of 102). Of the 44 children with trapdoor fracture, 43 (97.7%) were male and 1 (2.3%) was female. The mean age was 13.7 yr (range, 7-18 yr), and the mean duration of follow-up was 5.3 months (range, 3-21 months). Twenty-seven (61.4%) patients were occurred in left side and 17 (38.6%) in right side. The mean time interval between injury and first visit was 8.1 days (range, 1-56 days).

The most common cause of injury was assault (68.2%), followed by falling down (11.3%), sport injury (9.1%), motor vehicle accident (9.1%) (Table 1). No patient had orbital rim involvement. The most common location was inferior wall (86.4%) (Table 2).

Associated facial bone fracture was present in 3 patients (6.8%) and the most common associated ocular injury was subconjunctival hemorrhage (10 patients, 22.7%) (Table 3).

Ocular motility restriction at the initial examination is

Table 1. Cause of injury leading to orbital trapdoor fracture in children

Cause of injury	No. of patients (%)
Assault	30 (68.2)
Fall	5 (11.3)
Sport injury	4 (9.1)
Motor vehicle accident	4 (9.1)
Other	1 (2.3)
Total	44 (100)

Table 2. Location of orbital trapdoor fracture

Location	No. of patients (%)
Inferior wall	38 (86.4)
Inferior and medial wall	5 (11.4)
Inferior and lateral wall	1 (2.3)
Total	44 (100)

Table 4. Limitation of ocular motility in trapdoor fracture at initial examination

	-4	-3	-2	-1	0	Total
Supraduction	29 (65.9%)	3 (6.8%)	7 (15.9%)	3 (6.8%)	2 (4.6%)	44 (100%)
Infraduction	29 (65.9%)	6 (13.6%)	14 (31.8%)	1 (2.3%)	17 (38.7%)	44 (100%)
Abduction	0 (0%)	1 (2.3%)	0 (0%)	1 (2.3%)	42 (95.4%)	44 (100%)
Adduction	0 (0%)	0 (0%)	1 (2.3%)	0 (0%)	43 (97.7%)	44 (100%)

presented in Table 4. Thirty-two (72.7%) had severe limitation of supraduction and 12 (27.2%) had severe limitation of infraduction. Forty-three of 44 patients showed entrapment of inferior rectus muscle or soft tissue (fat or periorbital tissue) by CT scan. Patients with entrapment of inferior rectus muscle with or without soft tissue were more likely to have severe limitation of ocular motility than patients with entrapment of soft tissue only ($p < 0.01$) (Table 5).

The average time of surgical intervention after the injury was 12.8 days (range, 1-57 days). Eight patients who had soft tissue entrapment only and no severe gaze limitation did not undergo surgery. On the first month of injury, 7 of them had full ocular motility and 1 had mild limitation of supraduction.

In 36 patients (81.8%) who underwent surgical repair, 8 underwent within 5 days of injury, 19 between 6 and 14 days of injury, and 9 after 15 days of injury. Thirty-three patients (91.7%) showed improvement in ocular motility, but 3 patients (8.3%) had supraduction limitation of -3 scale and persistent diplopia at the last visit. On postoperative CT, 1 patient receiving surgery on 8 days of injury showed remnant soft tissue herniated posteriorly to the fracture site, but 2 patients receiving surgery on 46 days and 57 days of injury, respectively, had no abnormality. Excluding these 3 patients, the median time for the improvement of preoperative motility deficit and diplopia was 11.0 days (range, 1-60 days). The median improvement time was 3.5 days (range, 1-10 days) for patients receiving surgery within 5 days, 18.0 days (range, 3-60 days) for those receiving surgery between 6 and 14 days, and 50.0 days (range, 3-56 days) for those receiving surgery after 15 days ($p = 0.03$).

The mean changes in supraduction limitation according to the duration between injury and surgery at postoperative 1 month and 3 months are shown in Table 6. At postoperative 1 month, the mean change in supraduction limitation using quantitative scale was 3.50 ± 0.53 for patients receiving surgery

Table 3. Associated facial fracture and ocular injury

	No. of patients
Associated facial fracture	
Nasal bone fracture	2
Maxilla fracture	1
Associated ocular injury	
Subconjunctival hemorrhage	15
Traumatic mydriasis	1
Corneal erosion	1
Subretinal hemorrhage	1

Table 5. Tissue entrapment image by CT and mean limitation of ocular supraduction

	No. of patients	Mean limitation of supraduction
IRM	19	-3.61
Soft tissue	9	-1.50
IRM and soft tissue	15	-3.87

IRM: inferior rectus muscle.

Table 7. Postoperative complication in children with orbital trapdoor fracture

Complication	No. of patients
Hypertropia	10
Infraorbital nerve dysfunction	4
Optic neuropathy	2
Hypotropia	1
Persistent cheek edema	1

Table 6. Mean change in limitation of ocular supraduction according to the duration between injury and surgery at postoperative 1 month and 3 months

Duration between injury and surgery	No. of patients	Mean preop. supraduction limitation	Mean supraduction limitation at postop. 1 month	Mean supraduction limitation at postop. 3 months	Mean change in supraduction limitation at postop. 1 month*	Mean change in supraduction limitation at postop. 3 months**
0-5 days	8	-4.00	-0.50	-0.13	3.50	3.88
6-14 days	19	-3.42	-1.32	-0.56	2.11	2.94
15- days	9	-3.67	-2.00	-1.17	1.67	2.50
Total	36	-3.61	-1.24	-0.58	2.36	3.09

* $p=0.04$, ** $p=0.14$.

within 5 days, 2.11 ± 1.24 for those receiving surgery between 6 and 14 days, and 1.67 ± 0.82 for those receiving surgery after 15 days ($p=0.04$). At postoperative 3 month, the mean change in supraduction limitation was 3.88 ± 0.35 for patients receiving surgery within 5 days, 2.94 ± 1.55 for those receiving surgery between 6 and 14 days, and 2.50 ± 1.38 for those receiving surgery after 15 days ($p=0.14$).

Eighteen (50%) of 36 patients had postoperative complications (Table 7). Ten patients (27.8%) had hypertropia of 12-16 prism diopter. Nine of them improved within 1 month, but one patient underwent strabismus surgery at postoperative 6 months. Four patients (11.1%) complained of infraorbital nerve dysfunction, which was improved within 2 months. Two cases of optic neuropathy were observed. In one patient, postoperative visual acuity decreased to light perception. Orbital decompression was performed immediately and steroid pulse therapy was done, and a final visual acuity of 20/20 was obtained. In the other patient, visual acuity decreased to 40/200 postoperatively, but recovered to 20/20 spontaneously in postoperative 1 month.

One case of hypotropia was occurred due to inferior oblique muscle palsy and one case of persistent cheek edema was occurred due to impairment of lymphatic drainage.

DISCUSSION

Two mechanisms explaining orbital wall fracture have been accepted. Smith and Regan (8) proposed that direct trauma to the ocular globe resulted in increased hydraulic pressure from soft-tissue compression, thereby caused blowout of the orbital floor and medial wall. On the other hand, Fujino (9)

proposed that transmission of a buckling force to the bone of the orbital floor resulted in the blowout fracture. Although these two mechanisms are presented as individual concepts, it is likely that the wide variety of clinically observed orbital fracture is resulted from a combination of these two mechanisms (10).

In children, type of fracture are different from that in adult in that small trapdoor fracture is predominant and risk of muscle or soft tissue entrapment is higher (3, 5, 7). It is postulated that before puberty, a large portion of the orbital floor consists of immature bone and overlies a small maxillary sinus. Because of this greater elasticity of the orbital bone, when it is subjected to force, it is more likely bend and break in a linear pattern along the obliquely situated infraorbital canal resulting in trapdoor type fracture (1, 3). The anteromedial floor then goes inferiorly to the posterolateral floor. As the orbital rim moves back into its natural position, the prolapsed orbital tissue is caught and trapped in the fracture site.

The incidence of trapdoor fracture in pediatric orbital wall fracture is reported as 36-93% (2, 5, 7, 11). Orbital roof fracture occurs primarily in children, 7 yr of age and younger, because of the proportionally larger cranium and the lack of frontal sinus pneumatization (1, 11, 12). Lower orbital fracture occurs primarily in older children as a consequence of the increased vulnerability of the face due to growth and the pneumatization of the paranasal sinuses (1, 13). In our series, the incidence of trapdoor fracture was 43.1% and the most common location was inferior wall, in agreement with recently reported series (5, 7, 11).

The most common symptom associated with trapdoor fracture is restriction of ocular motility. Supraduction limitation is more severe in patients with trapdoor fractures than in those

without trapdoor fractures (5). In our study, 72.7% of the patients had severe limitation in supraduction and 27.2% had severe limitation in infraduction. Limitation of ocular motility is more severe in patients with muscle entrapment than in those with soft tissue entrapment only. Despite severe limitation of ocular motility, orbital edema or sign of soft tissue injury is relatively minimal. Jordan et al. (14) termed this "the white-eyed blowout".

Nausea and vomiting are other important symptoms. Nausea and vomiting coupled with severe restriction of ocular motility suggest the increased possibility of the trapdoor fracture in pediatric patients, and are promptly relieved after surgery (5, 7, 15). Oculocardiac reflex can occur (16).

Coronal CT is used routinely to identify trapdoor fracture and entrapment of muscle or soft tissue. But, if the fracture size is small and the tissue is incarcerated minimally, radiological diagnosis can be missed (14, 17). Therefore CT findings should be carefully evaluated and combined with additional clinical information before ruling out possibilities of fracture and entrapment in children (5). Forced duction test may be more reliable especially when CT findings do not correspond with clinical symptoms, but would be difficult to be performed in acutely injured young patients because of poor cooperation.

Indications for surgery are clinical evidence of muscle entrapment and CT confirmation. However, if there is no clinical evidence of muscle entrapment, mere existence of the trapdoor fracture is not an indication for surgery (3). In this study, eight patients, who had trapdoor fracture with soft tissue entrapment only and no severe gaze limitation, did not undergo surgical intervention.

In trapdoor fracture, entrapment of muscle or soft tissue induces not only limitation of ocular motility but also ischemia of the extraocular muscle by impaired blood supply and results in subsequent loss of muscle function and permanent gaze restriction, therefore, earlier surgical intervention should be considered (18-21). Early surgical repair within 7 days or 14 days of injury resulted in more rapid improvement of ocular motility and diplopia (5, 7). Recently, Grant et al. (3), in a study of 19 pediatric patients, reported negative association between return of ocular motility and delay (greater than 2 days) until surgery. In our study, the duration between injury and surgery was classified into 0-5 days, 6-14 days, and >15 days. Early surgery, especially within 5 days of injury, resulted in not only more rapid improvement of preoperative motility deficit and diplopia but also larger decrease in supraduction limitation at postoperative 1 month. On the contrary, among 9 patients who underwent late surgery after 15 days of injury, 2 patients had permanent and severe limitation of ocular motility and diplopia.

As postoperative complications in our study, hypertropia, infraorbital nerve dysfunction, and optic neuropathy were occurred in 27.8%, 11.1%, and 5.6% of patients, respectively. We think that meticulous freeing of the entrapped tissue

from the fracture site, taking care of infraorbital neurovascular bundle, positioning appropriate implant material, and shortening operation time could prevent these complications.

In conclusion, trapdoor fracture of the orbit in children must be diagnosed by careful CT evaluation and clinical evidence of entrapment. For patients with severe limitation of ocular motility, early surgery within 5 days of injury leads to more rapid and better postoperative improvement. Practitioners need to keep in mind the possibility of surgical complications.

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