A case of isolated blowout fracture of the orbital roof, trapdoor type, repaired using the transpalpebral approach

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Abstract
An extremely rare case of an isolated fracture of the orbital roof caused only by an eye contusion and a simultaneous blowout fracture, trapdoor type, which was operated on using the transpalpebral supraorbital rim approach was reported herein. The patient was a 35-year-old male who fell off the surfboard into the sea with the fin hitting hard the patient’s right eye. The patient had right ptosis, pain on looking upwards, and forehead paralysis. No bruises on the head or face other than the lower eyelid were noted. The orbital computed tomography scan showed that only the orbital roof was fractured, the bone fragments cranially deviated, and the orbital fat was incarcerated in the fracture site. The patient underwent surgery using the transpalpebral supraorbital rim approach on day 14 postinjury. The fracture was of the trapdoor type, and the orbital fat, levator palpebrae superioris muscle, and supraorbital nerve were strangulated at the fracture site. Ptosis and eye movement disorder quickly improved postoperatively. Isolated orbital roof blowout fracture, trapdoor type, is a rare condition, and the fracture can be repaired using the transpalpebral approach in the absence of intracranial lesions and extensive bony deviation.

Key words: brunt eye trauma, isolated orbital roof fracture, blowout fracture, trapdoor type, transpalpebral approach

Introduction
Two possible mechanisms were noted of orbital blowout fracture: the first is the hydraulic theory in which the intraorbital pressure is increased by the impact force on the eye, causing the orbital wall to rupture and fracture, and the second is the buckling theory in which the impact force is transmitted to the orbital rim, causing the maeorbit wall to snap. The orbital floor and medial orbital wall are more prone to fracture than the other two walls, the lateral orbital wall and the orbital roof, due to their thinner and more fragile bones. The majority of the orbital roof is the orbital area of the frontal bone. The back of the orbital roof is the anterior cranial fossa, which houses the frontal lobe covered by the dura mater. It is thought to be resistant to fracture by ocular contusion because the orbital roof is relatively thick and the frontal bone is strongly adherent to the epidural layer. However, in very rare cases, blowout fracture of the orbital roof may occur as a result of the impact force of an eye blow going upward through the orbital roof. Symptoms of orbital roof fracture are ptosis and hypoesthesia of the anterior forehead, which are not seen in orbital floor fractures. These symptoms are the result of the incarceration of the levator muscle and supraorbital nerve in the fractured area of the orbital roof. Surgical treatment of isolated orbital roof blowout fractures can be performed by craniotomy or by eyelid incision. The current study reports on a patient with an isolated orbital roof blowout fracture, trapdoor type, who developed ptosis, anterior forehead hypoesthesia, and significant ocular motor deficits after an eye contusion, and whose symptoms improved after eyelid incision and performing the transpalpebral approach in the early postinjury period.
Case report

The patient was a 35-year-old male pilot. When the patient fell from the surfboard into the sea, the fin hit the patient’s right eye hard in the water. Immediately after the injury, the patient had difficulty opening the right eyelid, felt pain in the back of the eye when looking upward, and was aware of nausea simultaneously. The lower eyelid laceration was sutured by a doctor on the same day. The patient came to the department of the current study for a thorough examination on day 13 postinjury.

Right side ptosis and purpura on the upper eyelid skin were observed (Fig. 1). The margin reflex distance-2 (MRD-2) of the right eye and the levator function were 3 and 0 mm, respectively. Hypoesthesia was observed from the right eyebrow to the right frontal region. Visual acuity and intraocular pressure were normal. A right subconjunctival hematoma was found on the bulbar conjunctiva. Fundus examination was normal. The patient had a significant disturbance looking upward (Fig. 2) and oculomotor pain on oculomotor examination. The Hess chart also showed a significant elevation limitation of the right eye (Fig. 3). Orbital imaging studies are shown in Figs. 4 and 5. No intracranial or orbital hematoma was noted, but an isolated orbital roof fracture was noted with the fragment slightly intracranially deviated. The orbital fat was protruding into the skull from the nasal side of the fracture, and a marked oculomotor disturbance and oculomotor pain were noted, leading to the diagnosis of trapdoor type.

Early surgery was required based on the clinical recommendations for repair of isolated orbital floor fractures, and surgery was performed on day 14 postinjury. The orbicularis oculi muscle was bluntly dissected after incising the eyelid skin below the eyebrows. The supraorbital margin was exposed and the supraorbital foramen through which the supraorbital nerve passes was identified. The periosteum of the supraorbital margin was incised and dissected to reach the fracture site, where the orbital fat was incarcerated in the L-shaped fracture (Fig. 6). The door was pushed intracranially and the incarcerated fat was pulled out after confirming that the fracture was of the trapdoor type. The supraorbital nerve and part of the levator muscle were simultaneously found to have prolapsed into the skull (Fig. 7). No evidence of cerebrospinal leakage was noted. The operation was completed with the closure of the door without the use of replacement materials after removing all incarcerated tissues from the fracture site. The pain previously felt when looking upward disappeared shortly postsurgery. Eye movement gradually improved (Fig. 8), and the Hess chart normalized after 3 months. Ptosis also gradually improved, and MRD-2 was 7 mm at 10 months postsurgery (Fig. 9). However, the levator function was inadequately improved to only 4 mm. The
hypoesthesia in the forehead area disappeared after 10 months.

**Discussion**

This case has the following characteristics:
* The fracture was caused only by blunt eye contusions.
* The fracture was characterized as an isolated orbital roof, blowout fracture, and trapdoor type, which is a rare combination among orbital fractures.
* The fracture was suspected to be of the trapdoor type and required early surgery.
* Surgery was performed using the transpalpebral supraorbital rim approach.

The orbital roof fracture is one of the orbital disorders associated with craniofacial trauma and is considered to be a subtype of anterior skull base fractures. The orbital floor and medial orbital wall are the most common orbital walls to be fractured by blunt eye trauma, but the orbital roof alone is rarely fractured. In this case, a laceration of the lower eyelid was noted, and the eye may have been pushed upward from below during the contusion.

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**Fig. 4.** Orbital CT coronal section image. Orbital roof is intracranially displaced. The orbital fat and part of the levator muscle are intracranially incarcerated at the yellow arrow.

**Fig. 5.** Orbital MRI (T1) sagittal section image. Orbital fat (yellow arrow) and part of the levator muscle (red arrow) are intracranially incarcerated.

**Fig. 6.** Intraoperative findings: Orbital roof was fractured at the dotted line. The orbital fat and supraorbital nerve (star) were strangulated.

**Fig. 7.** Intraoperative findings. All of the incarcerated orbital tissue (star) was removed from the fracture.

**Fig. 8.** Ten months after surgery. Limitation when looking upwards disappeared.

**Fig. 9.** Ptosis has improved.
Two types of orbital roof fracture exist: the blow-in fracture (BIF), in which the fragment is incarcerated in the orbit, and the blowout fracture (BOF), in which the fragment is incarcerated in the cranium. Moreover, two types of BIF exist: the pure type without supraorbital rim fracture and the impure type with supraorbital rim fracture. The isolated orbital roof fracture is a pure type. Moreover, BOF has been reported less frequently than BIF and is not expected to be classified like BIF. No facial bone or orbital rim fracture was noted in this case, and only the orbital roof was intracranially deviated and was considered as an isolated orbital roof blowout fracture.

Ptosis and diplopia occur whether the fracture type is BIF or BOF when the orbital roof alone is fractured. The bone may return to its original position and heal spontaneously if the deviation of the fragment is mild in the BIF. Lofrese et al. reported that two showed good outcomes in four of 13 cases followed up. A case report exists of healing using manual repair, but a manual repair may cause damage to the external ocular muscle fibers. No case reports exist of spontaneous healing in the BOF of the orbital roof. The ptosis and oculomotor disturbance were severe in this case, and the computed tomography imaging showed BOF in the orbital roof. Thus, surgical treatment was chosen. In addition, the orbital tissue was trapped at the fracture site. Thus, early surgical treatment, within 2 weeks postinjury, was decided to be necessary following the surgical timing of isolated orbital floor fracture. The fracture morphology was of the trapdoor type, and the orbital fat, levator muscle, and supraorbital nerve were strangulated at the fracture site. Eye movement was completely restored, but the function of the levator muscle was not fully recovered. Thus, surgery should be performed earlier than 14 days postinjury to further improve the function of the levator muscle.

Two approaches to the orbital roof were noted: a bicoronal skin incision, followed by a superolateral orbital rim approach, and a transpalpebral approach, in which the supraorbital rim is approached through the upper eyelid skin. A meta-analysis by Lucas et al. showed that the rates were 94.8% and 5.2%, respectively. Patients who opted for craniotomy included one with BIF requiring pulling up of the incarcerated orbital tissue to the cranial side, one with bone fragments impinging on the dura mater, and one with CSF leakage or intracranial hematoma. A craniotomy is useful when intracranial complications are predictable or when a large surgical field is required but is highly invasive. A transpalpebral and supraorbital approach was chosen because none of these conditions were present in this case. The supraorbital bone resection technique was not performed because the supraorbital rim did not interfere with the surgery. Furthermore, little adhesion of the incarcerated tissue was noted because of the early surgery, and it could be easily removed. Thus, the surgery was very minimally invasive.

Complications of the orbital roof fracture include encephalocele, skull base hematoma, frontal lobe hernia, and spinal fluid leakage. A craniotomy should be planned if these complications are likely to occur because the transpalpebral approach is incapable of dealing with sudden changes in head lesions even if the fracture appears minor. The surgery should be stopped, and the patient should be immediately referred to neurosurgery even if the surgery is started using the transpalpebral approach and spinal fluid leakage from the fracture is noted. Other orbital complications include acquired Brown’s syndrome due to entrapment of the superior oblique muscle, which did not occur in this case.

The trapdoor type of isolated orbital roof blowout fracture is a rare condition. It can be repaired using the transorbital approach in the absence of complications of intracranial involvement and severe bone deviation if the fracture occurs within 2 weeks of injury.

Conflict of interest disclosure
None

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