Orbital Roof Fracture and Orbital Cellulitis Secondary to Halo Pin Penetration: Case Report

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Abstract

Study Design Case report.

Objective To report and discuss a rare complication after a patient was treated conservatively with a halo vest.

Methods A 51-year-old man sustained a hangman's injury of the C2 vertebra following a motor vehicle collision. He was treated conservatively in a halo vest appliance and following mobilization was discharged from the hospital. Two weeks after discharge, the patient presented to the emergency department complaining of proptosis, ptosis, diplopia, and pin loosening. He was readmitted to the hospital, the halo vest was removed, and urgent imaging studies including computed tomography scan and magnetic resonance imaging were performed. They revealed that one of the halo pins had penetrated the orbital roof with active infection of the extraocular soft tissues. In consultation with the ophthalmologist, he was treated conservatively with antibiotics for 10 days.

Results His ophthalmologic complaints resolved gradually and his eye returned to normal appearance and function. In the meantime, he was immobilized in a sterno-occipital mandibular immobilizer brace.

Conclusion Though rare, penetrating injuries after cranial pin insertion can occur. Halo devices must be applied by, or under close supervision of, experienced personnel to avoid such complications, and halo vests should be reviewed frequently to detect such incidents early.

Keywords
- halo vest
- cranial halo
- penetrating orbital injury
- proptosis
- ptosis
- orbital cellulitis

Introduction

The halo vest orthosis is a well-accepted treatment modality for upper cervical spine injuries. It provides excellent immobilization to the cervical spine while allowing the patient to ambulate normally and also reduces in-hospital care for these patients. It has also been described as relatively well tolerated.[1] In many instances of cervical spine injuries, it has been considered as a safer alternative to surgical treatment. However, conservative treatment using this device is not without complications.[2–4] The literature reports many complications with its use including pin loosening, loss of fracture reduction, loss of cervical alignment, neurologic deterioration, pin site infection, skin breakdown, respiratory restrictions, and dysphagia.[2] We report a case with a rare complication of halo vest application due to pin penetration into the orbit resulting in cellulitis of the extraocular muscles and other orbital soft tissues leading to severe proptosis, ptosis, and diplopia. The authors believe that this is the first case report of this type of penetrating pin injury in literature.

Case Report

A 51-year-old man presented to the orthopedic department at a tertiary care center following a motor vehicle accident. He

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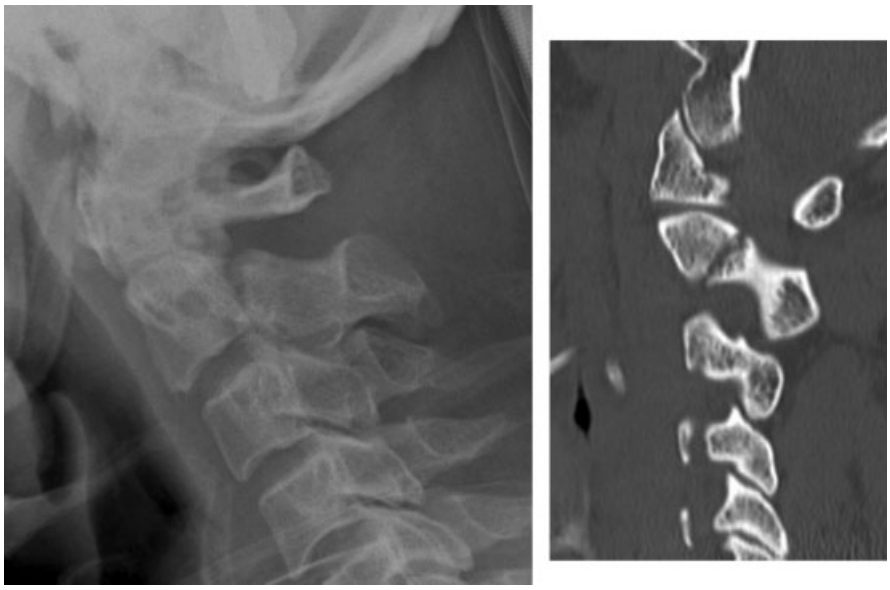

Fig. 1 X-ray and computed tomography scan of the patient's cervical spine depicting minimally displaced hangman's injury.

complained of pain at the back of the upper neck. His clinical examination was unremarkable with no numbness or weakness in the upper or lower limbs. Imaging studies including plain radiographs and computed tomography (CT) scans were obtained. They revealed a traumatic spondylolisthesis of the axis with a pars fracture on one side and a similar fracture on the other but extending into the body of C2 vertebra (►**Fig. 1**). It was diagnosed as a type 1 according to the Levine classification system of hangman's fracture.

He was admitted to the ward, and halo vest immobilization was planned to be the definitive treatment. After appropriate informed consent, the halo vest was applied by two orthopedic residents working in the spinal service, under the supervision of a specialist senior registrar. A Bremer Halo Crown system (DePuy Synthes, Raynham, Massachusetts, United States) was used. The two anterior and two posterior fixation pins (titanium) were inserted through the safe zones with respect to the anatomical landmarks as described in the device's technical manual. The Bremer system has a disposable torque-limiting wrench for tightening the pins with break-off caps to prevent overtightening. The torque of the pin driver is set at 8 in./lb. Retightening of the pins after 24 hours (as recommended) was not performed in this case, and the locknuts were tightened after initial seating of the cranial pins. The stability of the whole construct was checked and immediate mobilization of the patient started, supervised by the physiotherapist. Postprocedural radiographs showed the fracture in good alignment. The patient was discharged home with instructions for pin care and outpatient follow-up visit 4 weeks after discharge.

Two weeks later, the patient presented to the emergency department complaining of left eye swelling, ptosis, proptosis, diplopia, and watery discharge from the eye (►**Fig. 2**). These symptoms started a few days after the patient's discharge from the hospital. The left anterior pin was found to be loose and had dislodged. There was minimal serous discharge and mild superficial infection at the pin site. The patient was readmitted to the ward for investigations and management. The halo vest was removed and a sterno-occipital mandibular immobilizer brace was applied instead. Pus swabs were obtained for culture and sensitivity. Scanty growth of *Staphylococcus aureus* was detected on culture.

Urgent CT scan was done, which demonstrated fracture of the roof of the left orbit, associated with an adjacent soft tissue density. A provisional diagnosis of fracture and orbital cellulitis was made. Magnetic resonance imaging (MRI) study with contrast was also performed, which further confirmed the diagnosis. It was clear by that time that the left pin was positioned deep into the left orbit, penetrating the orbital roof. The abnormal pin track and the orbital roof fracture were evident on CT and MRI (►**Figs. 3**, **4**). An infection appeared to involve the soft tissues in the extraconal region with no evidence of fluid collection demonstrated on imaging.

Differential Diagnosis

This condition had to be differentiated from other disorders resulting in eye swelling or proptosis. Conjunctivitis,

Fig. 2 Clinical photograph of the patient showing proptosis and ptosis of the left eye.

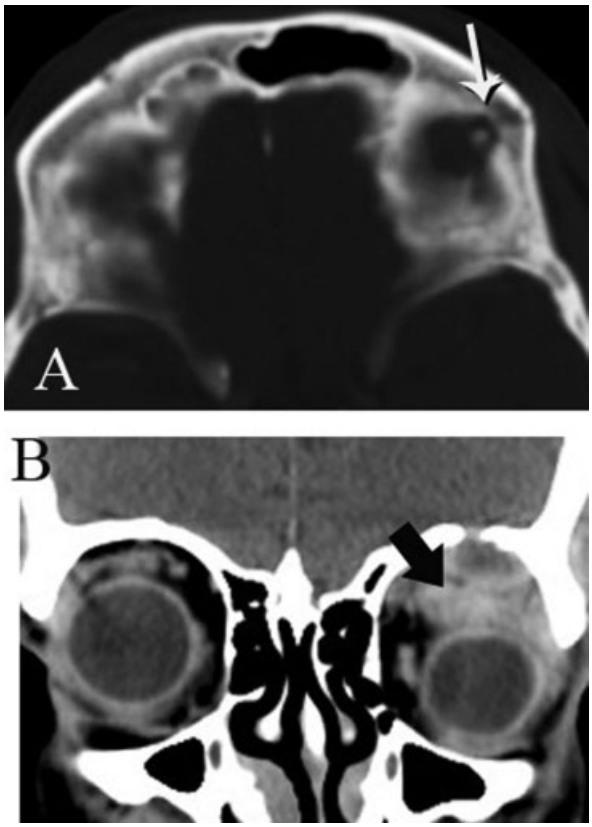

Fig. 3 Contrast-enhanced orbital computed tomography scan. (A) Axial section. (B) Coronal reformat. Images show fracture of the roof of the left orbit (white arrow) associated with an inflammatory mass (black arrow).

uveitis, osteomyelitis, and cavernous sinus thrombosis were important differential diagnoses considered at the time.

Treatment

A treatment strategy was formulated in consultation with the neurosurgeon and the ophthalmologist. The management plan was nonsurgical. The patient was kept in the hospital for 10 days under parenteral antibiotics (amoxicillin + clavulanic acid 1.2 g intravenously every 8 hours) as well as local antibiotic instillation into the eyes (ofloxacin eye drops) with close observation for eye swelling and movement. He progressively improved, and the pain and swelling of the eyes slowly regressed. He was discharged after 10 days and reviewed in the orthopedic and ophthalmology outpatient clinics at 1-month and 3-month intervals. At last review, 6 months from the date of injury, his C2 vertebra fracture had united completely with no further displacement or angulation and his left eye returned to almost normal appearance and full function (►**Fig. 5**).

Discussion

The halo vest is an essential tool in the day-to-day management of upper cervical injuries. Since it was introduced by Perry and Nickel in 1959,[5] this orthosis has enjoyed uniform popularity as the definitive treatment and temporary immobilization and corrective device in many cervical and cervicodorsal pathologies. The apparatus consists of two

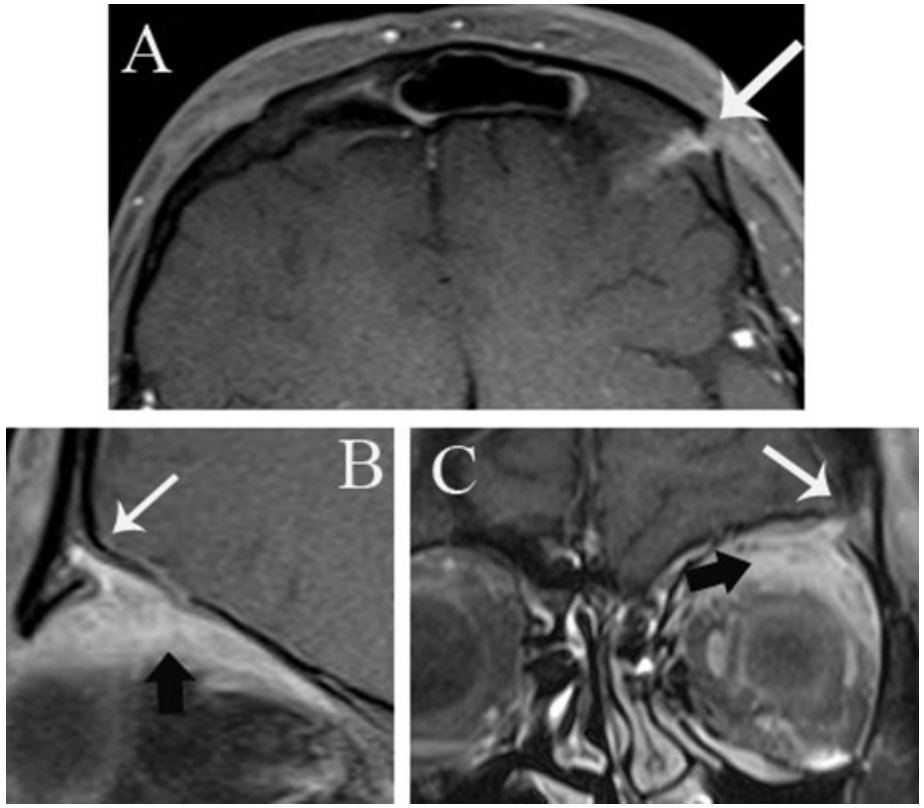

Fig. 4 Contrast-enhanced magnetic resonance imaging. (A) Axial section. (B) Sagittal section. (C) Coronal section. Images reveal a fracture and a track extending from the site of pin entry to the roof of the left orbit (white arrows). An inflammatory process is also seen (black arrows).

Fig. 5 Clinical photograph of the patient at last review. The appearance and function of the left eye has become almost normal.

components: the crown, which is secured to the head using two anterior and two posterior pins, and the vest, which is tightened to the trunk, with rods linking these two major components. The safe zones for secure insertion of the pins into the skull have been well described in the literature.[2,6] The safe area for the two anterior pins is 1 cm above the superior orbital rim over the outer half of the eyebrow, avoiding the superior orbital nerves, and the safe zone for the posterior pins is just superior and posterior to the pinna.[6–8] The current pin design is intended to avoid penetration beyond the outer table of the skull.

Despite technical sophistication and personal care, complications associated with the use of halo vest are not uncommon, and the rate of these complications cannot be described as low. The true incidence of such complications varies in the literature but ranges from 11 to 91% (the latter being the cumulative total of multiple complications occurring in the same patient).[9] These often happen at the time of application of the halo vest and pin tightening or during the subsequent period of immobilization and treatment. Halo vest–related complications may be grouped broadly under the following headings:

1. Pin-related complications
2. Vest-related complications
3. Issues related to the original spinal pathology or surgery
4. Miscellaneous complications

The first category includes, among others, pin track infections, cerebrospinal fluid leaks, pin loosening, pneumocranium, subdural hematoma, and orbital nerve injuries. Van Middendorp et al described a 1.5% incidence of permanent supraorbital or greater occipital nerve injury following application of the appliance.[9] Pin penetration into the skull has also been described leading to intracranial abscesses or pneumocraneum.[9–11] Medhkour et al reported subdural hematoma following pin tightening.[12] The vest itself is perhaps responsible for the reduced pulmonary compliance and related respiratory infections and respiratory failure, particularly in the elderly.[13] The appliance is reported by some authors to provide up to 96% immobilization to the cervical spine,[7] though this has been debated. Nevertheless, graft failures, implant migration, loss of reduction, and snaking of the subaxial cervical spine, among other problems, have been recorded possibly due to inadequate immobilization provided by the system. Overdistraction of the cervical spine has also been documented. There are also several other rare complications reported in the literature such as dysphagia,[8] transient hearing loss, visual disturbances, among others.[3] The overall complication rate reported in some studies is a staggering 91%, but this includes all the minor and major problems (often multiple in the same patient) associated with the use of this device.[9] Glaser et al reported a 29% complication rate in their study of 245 patients including one death,[13] and Taitsman and colleagues had an overall complication rate of 55% with an alarming 8% death rate. [14] Van Middendorp et al's study of 239 patients recorded a 6% death rate and 50% minor, 30% intermediate, and 11% major complication rates.[9] Bransford's review of 342 patients is another recent large study emphasizing an overall success of 85%, but with an anticipated 35% complication rate.[15] Longo and associates have recently reviewed the literature (47 publications on the subject) for nonsurgical management of upper cervical injury and concluded that evidence regarding the benefits against risks of such treatment is still not available.[16]

In this report, we recognize yet another complication, which despite being rare is potentially dangerous. Pin penetration into the orbit by the halo device has not been described before in the literature to the best of our knowledge. It was recognized that the left anterior pin was placed lower than the right (►**Fig. 2**), though apparently still within the safe zone. Review of the clinical photographs and CT scans show that the offending pin may have been placed too lateral and inferior, thereby entering the relatively thin bone lateral to the temporal ridge of the frontal bone. The insertion torque and the application of the break-off caps appeared to be adequate on retrospective analysis. Our patient was treated successfully with minimal residual sequelae. Yet orbital cellulitis is recognized as potentially threatening to the eyeball and rarely to life itself. It was also recognized that despite close supervision by qualified personnel, injury to the patient can occur when residents in training perform procedures, and this needs appropriate administrative and advocacy measures to be adopted in teaching institutions to protect the patients and the staff.

Conclusion

Halo vest immobilization is a widely used treatment modality for upper cervical injuries. Despite establishing safe zones for cranial pin insertion, occasional penetration injuries of the skull do occur. Therefore only qualified personnel with appropriate knowledge of the regional anatomy should perform device application to minimize risks of penetration injuries. It is also recommended that patients be followed at frequent intervals during the immediate postapplication period to detect these complications early.

Disclosures
K. Venugopal Menon, none
Asif Esam Al Rawi, none
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