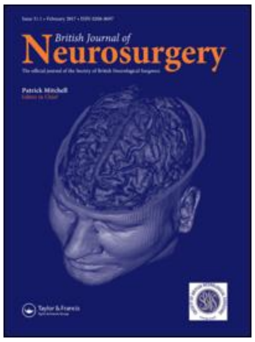

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CASE REPORT

Minimally invasive keyhole supraorbital craniotomy as treatment option for penetrating foreign body through orbital roof

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ABSTRACT
Intraorbital foreign body is a rare condition, especially when extending into the intracranial compartment. When facing this scenario in the ER, the neurosurgeon must carefully choose the optimal point of surgical access in order to reduce morbidity. The authors hereby report the case of a 66 year-old male with a penetrating trauma to the orbit reaching the anterior cranial base through the orbital roof and associated with an intracerebral hematoma. The removal of the foreign body was performed by a dual approach: an 'eyebrow' supraorbital keyhole craniotomy and an intra-orbital extra-ocular exploration, with later microsurgical drainage of the hematoma and evisceration of the eye 48 hours later. The patient developed a pseudomeningocele, which was treated with lumbar puncture and compressive dressing. After proper intravenous antibiotic prophylaxis, the patient was discharged 21 days after hospital admission.

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Foreign body; craniofacial trauma; minimally invasive surgery; eyebrow craniotomy

Introduction

Intraorbital foreign body is a rare form of trauma defined as a penetrating object within the orbit but outside the ocular globe. It usually occurs in younger males secondary to high-velocity trauma such as gunshot wounds, traffic and industrial accidents [1], usually involving important destruction of the eye, orbit and adjacent structures (e.g. frontobasal brain and paranasal sinuses) [2]. In the rarer occurrences when there is low-velocity trauma, the lesion is usually restricted to the structures in direct contact with the foreign body or in its trajectory [2]. In most cases, foreign bodies require removal, although some small inorganic bodies may be left in place without further complications if the patient remains asymptomatic [2].

Numerous studies have shown that brain retraction and prolonged exposure may harm cerebral tissue and cause neurological deficit, which led to an increasing use of minimally invasive, custom keyhole craniotomies [3]. These techniques, when performed correctly, may provide not only a wide enough surgical exposition of the anterior fossa, but also lower complication rate and better cosmetic and clinical outcomes in less hospitalization time [2,3].

Case report

We report the case of a 66-year-old male, who presented to the emergency department with headache and orbital pain after a work-related accident involving broken glass. On arrival, the patient was hemodynamically stable, with lowered consciousness level (GCS 13) and multiple lacerations across the upper half of the face, especially around the right eye. The left eye was intact. Emergency CT scan showed a foreign body of 6.04 cm in the right orbit, going through the frontal bone and into the right frontal lobe of the brain (Figure 1), as well as intracerebral haemorrhage (Figure 2(B)) around the lesion and ventricular haemorrhage in the lateral, third, and fourth ventricles. Contrasted, vascular imaging studies showed proximity to the A2 segment of the anterior cerebral artery (Figure 2(A)).

The patient was taken to the OR for surgical extraction of the foreign body, a glass fragment. A minimally invasive dual approach was made, combining a supraorbital craniotomy through an 'eyebrow' incision (Figure 3(A,B)) – with satisfactory visualization of the glass fragment and of the hematoma – and an intra-orbital extra-ocular exploration. The extraction of the fragment was performed by simultaneously pushing downwards the intracranial portion with an angled dissector and pulling outwards the intra-orbital portion with an Allis clamp (Figure 4(A,B)).

This simultaneous motion was important so that the fragment would not be displaced and cause further tissue disruption.

After the extraction of the foreign body, the surgical team proceeded to microsurgically drain the intracerebral haematoma, thus revealing a hollow in the orbital roof (Figure 5) and occlude it with a patch of pericranium and artificial dura mater. After duraplasty, the bone was fixated with a double-sided titanium clamp and a miniplate (Figure 3(C)).

The subcutaneous tissue was sutured with polyglactin 910 and both the eyebrow incision and the periorbital lesions were sutured with nylon. A tarsorrhaphy was performed for protection of the intra-orbital content until later evisceration by the ophthalmology staff, which took place after 48 hours, without complications.

Immediate post-operative care took place in the neurosurgery wards, where the patient developed a pseudomeningocele and was treated with a lumbar puncture and compressive dressings,

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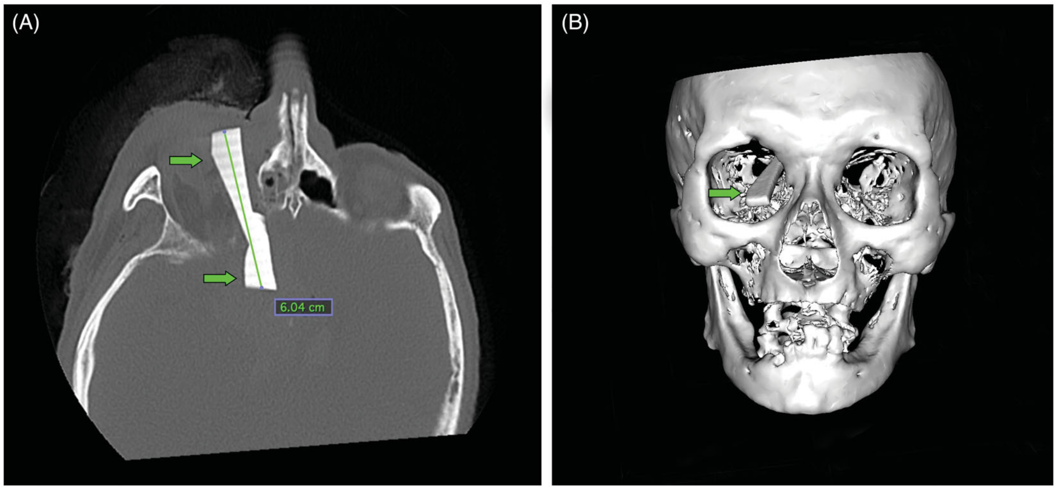

Figure 1. Preoperative CT scan. (A) 2D axial reconstruction of the 6.04 cm foreign body (green arrows) through the orbital roof. (B) 3D craniofacial reconstruction, anterior view; foreign body entering through the orbital roof (green arrow).

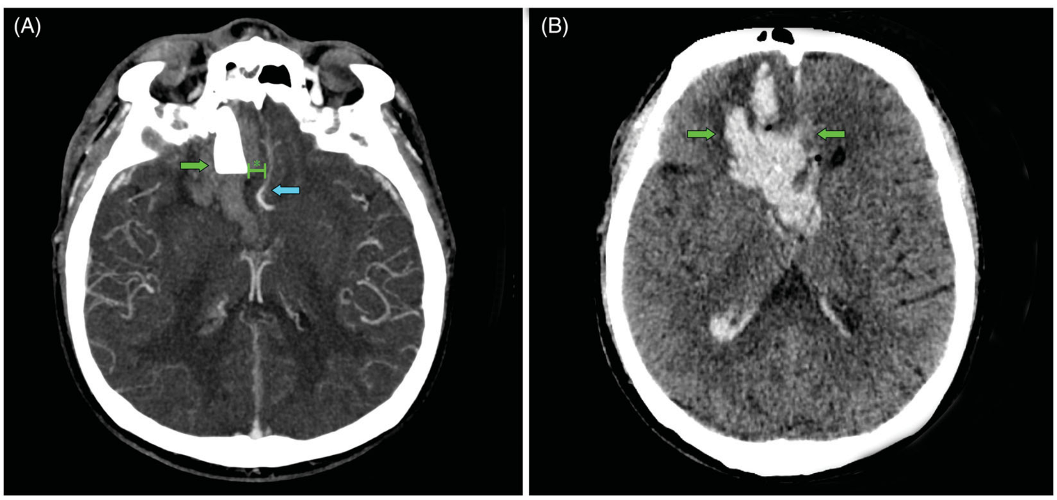

Figure 2. (A) Angio CT scan showing the 9.0 mm distance (*) between the foreign body (green arrow) and the A2 segment of the anterior cerebral artery (blue arrow). (B) Preoperative CT scan showing the frontal intracerebral haematoma (green arrows).

without further complications, as the patient still scored 15 points on the GCS and had no deficits.

The patient underwent antibiotic prophylaxis for meningitis and was discharged 21 days after hospital admission with no motor or cognitive deficits for outpatient follow-up. Post-op. CT scan showed frontal encephalomalacia, without other findings (Figure 4(C)).

Discussion

Neurosurgical pathologies involving the orbit are a rough terrain for most neurosurgeons due to the unfamiliar anatomy and decreased caseload, especially in the trauma scenario where said anatomy is frequently distorted and the bleeding may make procedures more challenging.

Penetrating trauma to the orbit is a potentially serious and somewhat rare occurrence when associated with traumatic brain injury. It is likely to damage structures as important as the frontal lobe, anterior cerebral arteries, orbit-related cranial nerves (II, III, IV, V and VI) and bears a higher risk of infection (e.g. orbital/periorbital cellulitis, meningitis) when associated with fracture and communication with paranasal sinuses.

Also, it may have serious aesthetic implications for the patient because of the possibility of deformity of the eye or the upper segment of the face. Still on the cosmetic impact of this kind of lesion, wide incisions with large craniotomies may imply further disfigurement of the patient's face and consequent self-esteem related issues. Usually, larger surgical approaches are related to longer surgical procedures (thus increasing infection rates) and higher risk of excessive intraoperative bleeding.

From the anatomical point of view, a supraorbital craniotomy may be performed safely with the incision made laterally to the supra-orbital notch with less risk of lesioning the frontalis branch of the facial nerve. The craniotomy provides the surgeon with an excellent exposure of the frontobasal region and allows LCR drainage to be performed intraoperatively from the basal cisterns, if necessary.

Another feasible approaches would be the transpalpebral [4], that would offer similar exposure. A possible downside of the eyebrow approach would be patients with blonde/thin eyebrows, which could make the scar to visible. For such cases, the Lateral supraorbital approach, reported by Hernesniemi et al. [5], could be a another less invasive option. This approach consists of a short incision behind the hairline. Galea, fascia and a small antero-superior portion of the temporalis muscle can be retracted

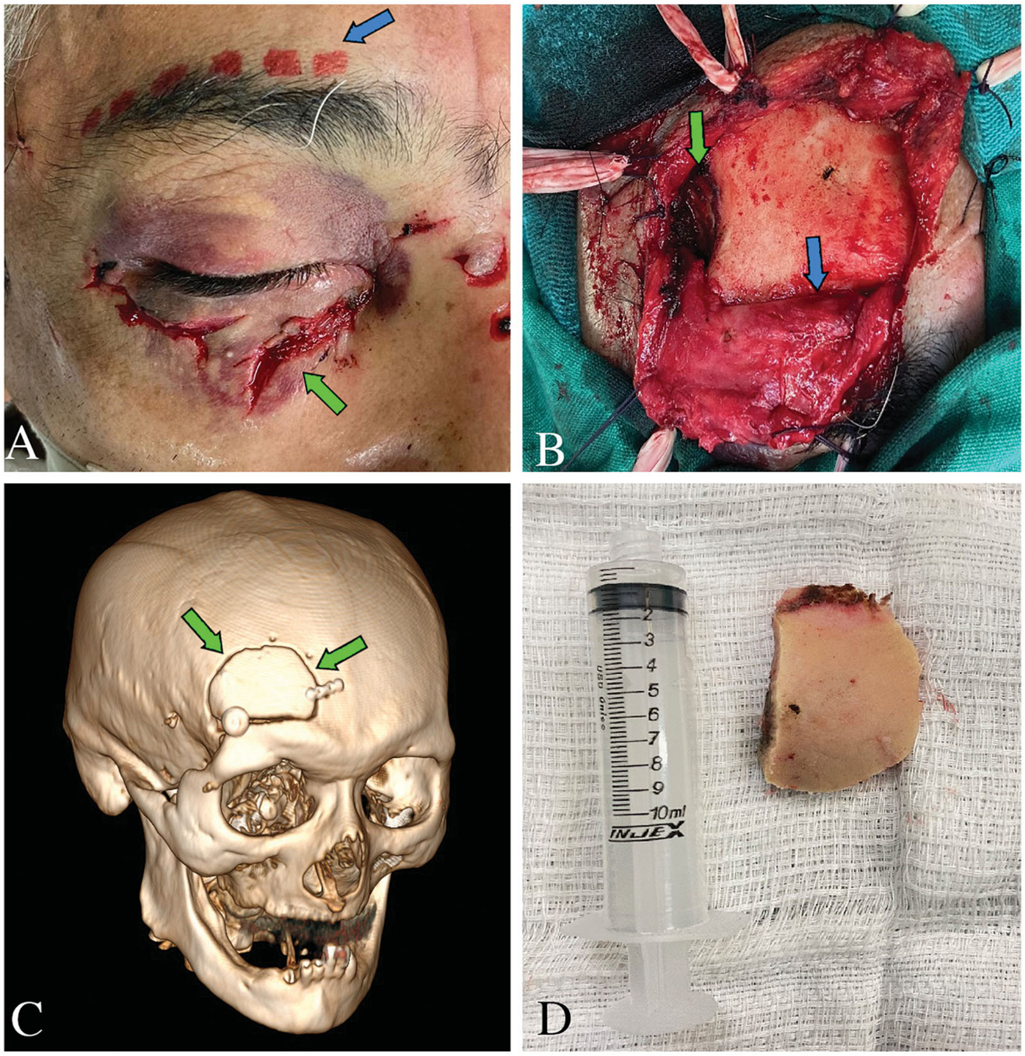

Figure 3. Supraorbital approach. (A) Preoperative incision planning (blue arrow) and aspect of the eye, presenting multiple lacerations, including the one containing the foreign body (green arrow). (B) After skin retraction, the lateral border of the frontal bone exposed (blue arrow), as well as the anterior part of the temporalis muscle (green arrow). (C) 3D volumetric reconstruction of the post-operative CT scan, showing the supraorbital craniotomy (green arrows) after cranioplasty. (D) Frontal bone flap, when compared in size to a 10 mL syringe.

Figure 4. (A) Here, the foreign body (glass shard) is being removed through the same laceration it penetrated the orbit, via a combined intraorbital-extraocular approach, while simultaneously being pushed outward via the supraorbital approach. (B) The glass shard, when compared in size to a 10mL syringe. (C) Postoperative CT scan showing frontal encephalomalacia and complete removal of the glass shard, as well as satisfactory drainage of the haematoma.

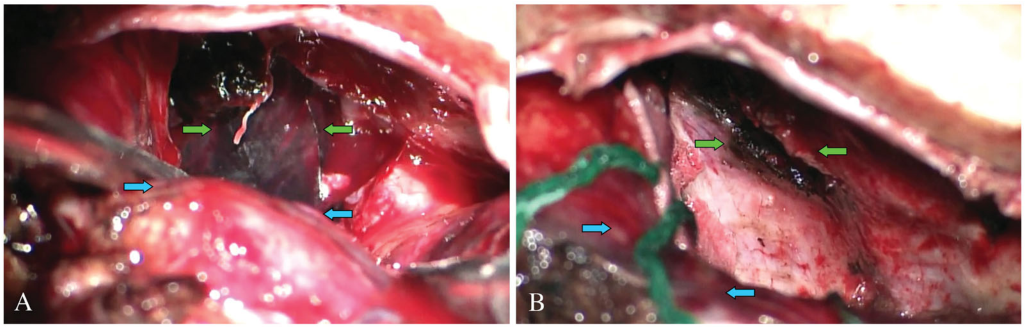

Figure 5. Microsurgical approach. Frontal lobe (blue arrows) retraction, exposing the subfrontal space. (A) The intracranial portion of the glass shard (green arrows) is seen after partial haematoma drainage. (B) After removal of the glass shard, the hollow left on the orbital roof can be seen.

in a single-layered flap. It allows for a subfrontal approach and is located more anterior and frontal when compared to a classic pterional approach [5].

Regarding the anterior skull base (ASB) reconstruction, it can be performed via a locoregional pericranial (like the one in this report) or a galeopericranial flap – both of which have the advantage to keep the tissues' original vascularization, via the supraorbital and supratrochlear arteries for the first and superficial temporal artery for the latter – or a free graft selection. When considering a small incision with minimal bone (and consequently pericranium) exposure, the more posterior the ASB lesion is, the harder will it be for the flap to reach and seal the defect, and a free graft selection may be needed [6].

In the reported case, we performed a minimally invasive technique (eyebrow incision and supraorbital craniotomy). While a more traditional, standard, pterional [7,8] or bicoronal approaches could have provided a wider surgical exposure, the resulting skin flap would have obstructed the exposure of the exterior portion of the orbit, inhibiting the simultaneous traction of the glass fragment from inside the craniotomy and from outside the cranial vault that was performed via the intra-orbital extra-ocular exploration. The tailored minimally invasive eyebrow approach allowed for this maneuver, as well as provided superior cosmetic results for the patient [9], with the disadvantage of a narrower surgical exposure. Another similar minimally invasive approach that could potentially provide the same benefits, as mentioned before would be a transpalpebral approach [10]. We believe that the choice between minimally invasive approaches should be tailored to the patient's individual characteristics and to the surgical team's experience.

This highlights the importance of a carefully planned approach to penetrating foreign bodies, as there may be underlying vascular injury with the foreign body tamponing a potential haemorrhage. Vascular studies and direct visualization allow for safe removal of such foreign bodies, with tailored, minimally invasive approaches allowing for optimal patient care in such scenarios.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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