PENETRATING TRANSORBITAL - CRANIO-CEREBRAL WINDSHIELD GLASS INJURY: REPORT OF TWO CASES

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ABSTRACT

Two unusual cases of penetrating transorbital cranio-cerebral windshield glass injury following road traffic accident seen over a period of 10 years are reported. In the first case, the clinical course was complicated by a delayed frontal pneumocephalus and in the second case by a cerebrospinal fluid leak through the upper eye lid and a frontal intracerebral haematoma. In both cases, delayed complications prompted the use of computed tomography of the head (CT head) which revealed foreign bodies in the orbit and frontal regions with aforementioned features. Removal of foreign bodies via a transcranial subfrontal approach and the dural repair was successful in both cases. The use of high penetration-resistant laminated windshield in vehicles is recommended to reduce penetrating facio-orbito-cranio-cerebral windshield glass injuries.

INTRODUCTION

Penetrating cranio-cerebral injuries secondary to foreign bodies with a high kinetic energy entering through the orbit, face or paranasal sinuses have greater potential for serious complications as opposed to cranio-cerebral injuries caused by foreign bodies directly entering through the cranial vault[1,2,3,4]. This is mainly attributed to direct proximity of inferior cranial wounds to paranasal air sinuses, basal parts of the brain and brain stem and intracranial vessels and nerves[3,5]. Serious complications in such orbito-cranio-cerebral injuries include loss of focal or widespread neurological functions, meningitis, cerebral abscess, intracranial haematomas, brain lacerations, pneumocephalus, cerebrospinal fluid (CSF) leaks, traumatic aneurysms and arterio-venous fistulas and consequently these complications result in a high morbidity and mortality[2,6,7,8]. A variety of unusual metallic and wooden foreign bodies resulting in orbito-cranio-cerebral injuries have been reported in the literature; however, crushed glass fragments due to windshield impact in a road traffic accident causing orbito-cranio-cerebral injuries have not been sufficiently highlighted. Extended Medline search revealed only two reports from Japan[9,10] and one from Iran[11] suggesting scant attention to these unusual but potentially dangerous injuries in Europe and America. We report two cases to illustrate the dangers of orbito-cranio-cerebral crushed windshield glass injuries in road traffic accidents and discuss their management.

CASE 1

In November 1980, a 19 year old right-handed female was involved in a road traffic accident when her car had a head-on collision with another car. She was a front seat passenger without a seat belt and was thrown against the windshield. She sustained multiple lacerations over the forehead and the right eyebrow due to crushed windshield glass fragments. On admission to another hospital she was noted to have no neurological deficits or impairment of ocular functions. Plain x-rays showed many pieces of windscreen glass in the facial soft tissues. Removal of the foreign bodies from the facial wounds and repair of the lacerations were performed. She was given systemic antibiotics and recovered very well from this accident, and was then discharged home.

One month later she developed progressive bifrontal headaches and on 16th January 1981 she had a series of generalised tonic clonic seizures, which were controlled with anticonvulsants. She was then referred to the Neurosurgery Department, Royal Preston Hospital. On examination, she had no neurological deficits except loss of sense of smell in the right nostril. Plain skull films showed (Fig 1a+b) presence of air in the right frontal region and foreign bodies in the orbito-frontal region involving the frontal sinus. The CT scan (Fig 2) confirmed the presence of air in the right frontal lobe with associated oedema. She underwent frontal craniotomy for removal of glass pieces from the air sinuses, orbit and frontal lobe with intradural repair of the dural defect. In all six pieces of glass were removed. She had an uneventful postoperative recovery and remained well thereafter.

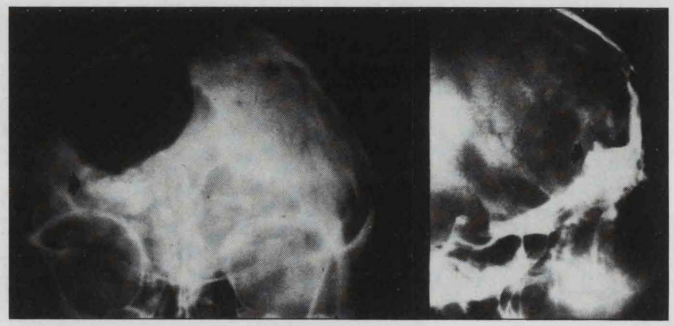

Figure 1 (a+b) – Plain skull films, antero-posterior and lateral views, showing glass fragments (arrows) and pneumocephalus in the right fronto-orbital region and right frontal sinus.

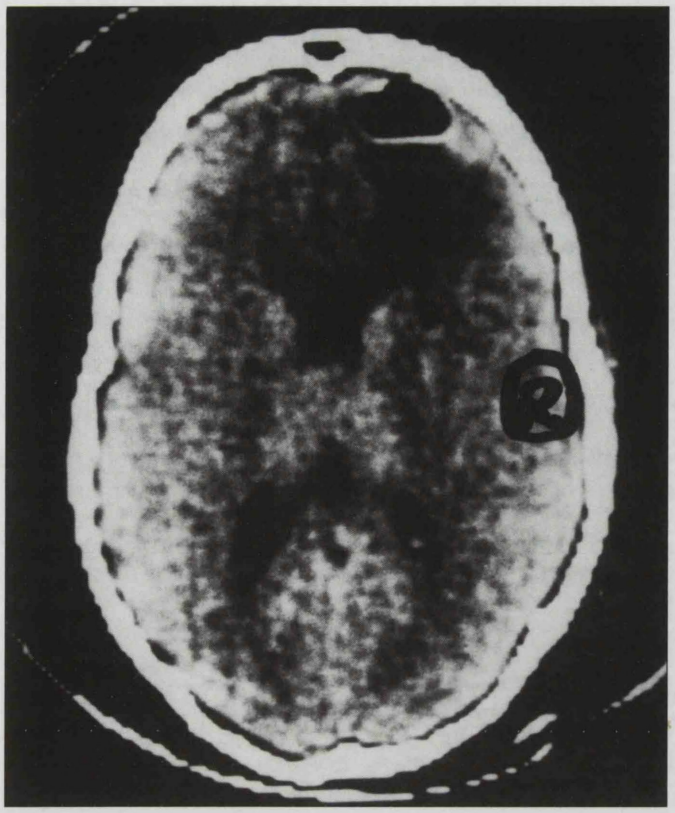

Figure 2 – The CT scan showing presence of air in the right frontal region with surrounding cerebral oedema.

CASE 2

On 5th June 1991 a 19 year old right-handed male was involved in a road traffic accident. He was a front seat passenger without a seat belt on. He sustained severe facial lacerations which were contaminated with windscreen glass pieces. On arrival at the Accident and Emergency (A&E) Department at another hospital, his vital signs were stable and neurological examination normal. Among the many facial lacerations sustained, there was a deep wound over the left eyebrow and upper eyelid which was extending into the orbit. Plain x-rays of the skull showed multiple fractures of the roof of the left orbit and some foreign bodies.

Initially the facial lacerations were explored by maxillo-facial surgeons and multiple glass pieces were removed, and lacerations repaired. Post-operatively he complained of frontal headaches. Intermittent transient cerebrospinal fluid (CSF) leak was noted from the sutured wound over the left eyebrow and upperlid area, during the second week following surgery. The patient was treated with prophylactic antibiotics. Postoperative plain skull films (Fig 3a+b) and CT scan (Fig 4a+b) showed glass pieces in the superior part of the orbital

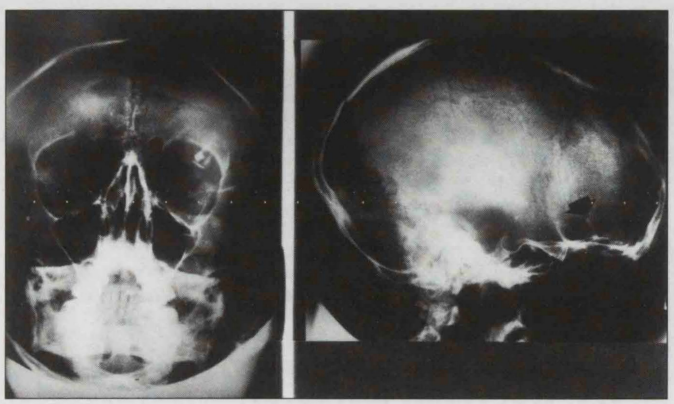

Figure 3 (a+b) – Plain skull films, antero-posterior and lateral views, showing glass fragments in the left orbit and left frontal region (arrow).

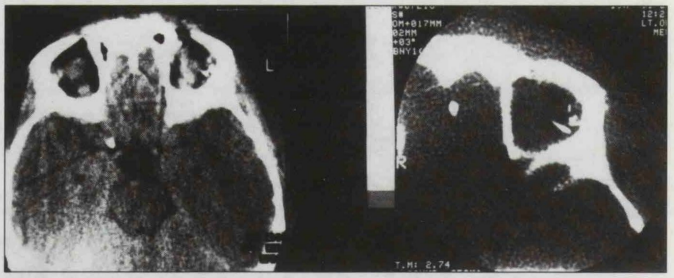

Figure 4 (a+b) – The CT scans, formal and bone window setting, showing glass fragments in the upper part of the left orbital cavity

cavity and the left frontal lobe respectively. The CT scans also showed associated left frontal lobe contusion, haematoma and cerebral oedema, surrounding the glass piece in the area of fractured orbital roof (Fig 5a+b). He was then referred to the Neurosurgical Department, RPH. On arrival at the Neurosurgical Ward on 18th June 1991 he was clinically stable. Repeat CT scan (20th June 1991) confirmed the aforementioned findings. CSF leak subsided on conservative therapy, but frontal headaches worsened progressively. An elective left lateral frontal craniotomy was performed on the 28th June 1991. Glass pieces were found to be coming from the left orbit in the frontal lobe through the orbital roof fractures. The orbital roof plate had to be partially removed and the left orbit was entered. A total of seven glass pieces from the orbit and frontal region were removed, along with the intracerebral clot and a small necrotic part of the frontal lobe. He made a good recovery with no cerebrospinal fluid leak and no ocular or neurological impairment. He was discharged home the following week and has remained well.

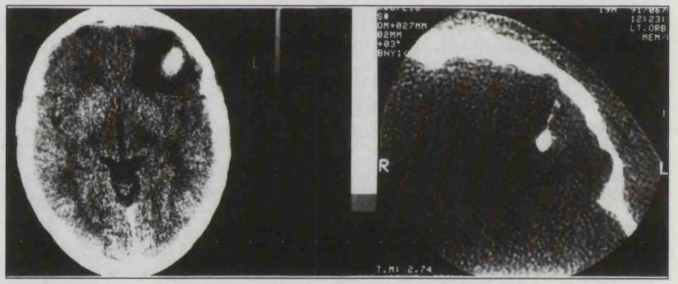

Figure 5 (a+b) – The CT scans, formal and bone window setting, showing contusion-haematoma and cerebral oedema surrounding the glass fragment in the left frontal lobe.

DISCUSSION

A foreign body that penetrates through the orbit into the brain may have only a small entrance wound and the patients can have normal vision, neurological examination and plain x-rays despite significant trauma[12]. A small entrance wound in such cases often appears trivial, minor or superficial to patients or physicians rather than a marker of serious orbito-cranio-cerebral injuries. At times, it may go undetected. Misdiagnosis is therefore not uncommon until early or delayed complications develop[13].

This is more likely in cases of multiple facial lacerations in the road traffic accidents when a small puncture wound caused by a foreign body entering through the orbit into the brain gets incorporated in one of the facial lacerations. In some of these patients, especially those who have normal ocular and neurological functions, the medical attention in the Accident and Emergency Departments may be directed towards the removal of the foreign bodies from the facial wounds and repair of the lacerations as happened in our patients. The diagnosis of orbito-cranio-cerebral injury is then delayed until serious complications such as meningitis,

cerebral abscess, intracranial haematoma, pneumocephalus or CSF leak develop days, months or even years after the initial injury. In 1977, Miller et al[7] reviewed 42 case reports of early and delayed complications of periorbital puncture wounds with intracranial penetration by sharp wooden objects and found permanent neurological sequelae in 74% of the cases and mortality rate of 25% out of 28 cases occurring in the post antibiotic era. Intracranial suppuration was the major complication with brain abscess having occurred in nearly one half of the cases. However, in our patients, the offending foreign bodies were glass fragments. The orbito-cranio-cerebral complications came to light in our first patient because of bifrontal headaches, recurrent generalized seizures and the finding of pneumocephalus on plain x-rays two months following initial trauma and in the second case because of progressive frontal headaches and intermittent CSF leak from the upper eyelid during the second week after the injury.

Most penetrating civilian inferior cranio-cerebral injuries occur following domestic or road traffic accidents. Patients in the paediatric or young age group are particularly vulnerable as the thin orbital roof, cribriform plate and temporal squama allow access to the intracranial cavity for objects not usually strong enough to penetrate the hard thick bone of the cranial vault and other thick areas of the cranial base[2,3,11]. Various metalic and wooden objects i.e., pencils, nails, wooden arrows, knitting needles, auto antennae, chopsticks, umbrella tips, tent pole spikes, bamboo sticks, have been described causing inferior cranio-cerebral injuries[14,15]. Lawson et al (1990)[16] reported a very unusual penetrating orbital trauma in the driver of a motor vehicle which collided with a kangaroo. A tooth fragment from the kangaroo traversed the orbit lodging intracranially. Perforating oculocerebral trauma by foreign bodies may be caused by industrial accidents as well. Scarfo et al[4] described two unusual injuries explaining the mechanism in most similar cases. In their first patient a nail shot from a nail gun ricocheted off the target and crossed the right eyeball and the posterior wall of the orbit lodging in the homolateral temporal lobe. In their second a metal fragment expelled by an agricultural machine penetrated the left maxillary sinus, crossed the floor of the orbit, the eyeball and the roof of the orbit and lodged in the frontal lobe. After accurate neurological examination the patients were operated upon using a simultaneous transcranial and transorbital access, with a successful outcome in both cases. Though ocular injuries as the result of glass fragments from exploding bottles of carbonated drinks are not unusual[17], the occurrence of transorbital craniocerebral injury due to glass fragments is rare. Review of the literature revealed only three previous reports, two from Japan (Isu et al, 1979[9]; Sugawa et al, 1988[10]) and one from Iran (Rahimizadeh, 1987[11]). In the road traffic accidents, sudden breaking or crushing of the windshield glass due to considerable force at the time of impact may release glass fragments which act like missiles with high kinetic energy. These glass pieces penetrate periorbital tissue transversing the orbit and cranial base and lodge into the cranial cavity and the brain leaving only small entrance wounds on the surface. Multiple facial lacerations result from larger glass fragments. Intracranial penetration of the crushed windscreen glass can have early and delayed effects on the eye and/or the brain as happened in our patients. Such patients are at high risk of infection and there is a common association with intracranial haemorrhage.

According to Dillon and Meirowsky (1975)[5] craniocerebral injuries resulting from foreign bodies with high kinetic energy that penetrate the orbit, maxillary region, sphenoid wing, temporal bone, or floor of the anterior or middle cranial fossae, deserve special attention. Their proximity to accessory air sinuses, basal intracranial vessels, and cranial nerves leads to a high incidence of such serious complications as pneumocephalus, CSF leak, traumatic aneurysm and arteriovenous fistula in addition to infection and haematoma, while direct disruption of brain stem structures is usually incompatible with life (Harsh and Harsh 1985[2]). As seemingly trivial adnexal injuries may be associated with extensive injuries to the globe, orbit and brain, meticulous ophthalmologic and neurologic examinations and orbital and brain computed tomography scans (axial and coronal views) are essential for complete evaluation of these patients[18]. Even in minor orbito-facial injuries when there is some suspicion of intracranial penetration the importance of CT scan cannot be over emphasized, to prevent diagnostic delay. The CT images are much clearer than conventional x-rays and help in both early and late management of penetrating orbital-cranial trauma[19]. The detection of subtle pneumocephalus may be the only clue that intracranial penetration has occurred[19]. Currently, the CT scans are considered to be essential in planning the surgical approach and evaluation of the secondary complications as in our patients[20]. In cases of delayed intracranial haemorrhage or vascular episode, cerebral angiography is mandatory to exclude traumatic aneurysm or arteriovenous fistula[2,21]. Factors significantly related to brain damage and its derivates include the nature and velocity of the foreign bodies, the site of intracranial injury and the interval between injury and surgical intervention[5,2]. The intensity of destructive force and the time interval from trauma to treatment decide the outcome in inferior cranial wounds[2]. Overall management of the orbital cranial trauma requires a team approach by the neuro-surgeon, ophthalmologist, plastic surgeon and maxilliofacial surgeon, in view of the complexity of these injuries, to ensure complete removal of the foreign materials and to minimise the morbidity of the surgical extraction[22,23]. Orbital-cranial injuries have great potential for disability and death. The goals of surgical management therefore are removal of the indriven foreign body and bone fragments, debridement of the track and duraplasty. Immediate antibiotic therapy, anticonvulsants and drugs to control raised intracranial pressure remain important therapeutic adjuncts. In our patients with orbito-craniocerebral injuries due to windshield glass fragments, transcranial – subfrontal – orbital roof approach gave excellent access. Following debridement, the contused necrotic brain and haematoma were removed and dural repair performed, with successful outcomes. In road traffic accidents, toughened windshields cause more severe injuries than high penetration-resistant laminated windshields and therefore the use of high penetration resistant laminated windshields in all vehicles is recommended.

CONCLUSIONS

Penetrating transorbital cranio-cerebral injuries in road traffic accidents due to crushed windshield glass fragments are indeed potentially dangerous lesions but fortunately rare and preventable. Initial failure to recognise the true nature of intracranial penetration may lead to early and delayed complications, i.e. pneumocephalus, intracranial haematoma, CSF leak, meningitis and cerebral abscess. Routine use of the CT scan in cases of penetration facio-orbito-cranial injuries cannot be over emphasized.

The aims of surgical management are removal of the indriven foreign body, debridement of the path, duraplasty with the use of antibiotics and anticonvulsants. High penetration resistant laminated windshields in vehicles are recommended.

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Answer to Quiz on page 325

1. Kala-azar (visceral Leishmaniasis). These are Leishmann-Donovan bodies or amastigotes in a macrophage.

2. Pentavalent Antimonials such as Pentostam (sodium stibogluconate) remain the treatment of choice.