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REVIEW ARTICLE

Review article: Maxillofacial emergencies: Maxillofacial trauma

Adrian F DEANGELIS,[1] Roland A BARROWMAN,[1] Richard HARROD[2] and Alf L NASTRI[1]

[1]Maxillofacial Surgery Unit, Royal Melbourne Hospital, Melbourne, Victoria, Australia, and [2]Emergency Medicine Department, Royal Melbourne Hospital, Melbourne, Victoria, Australia

Abstract

Fractures of the facial skeleton are a common reason for patients to present to EDs and general medical practice in Australia. Trauma to the maxillofacial region can lead to airway obstruction, intracranial injuries, loss of vision or long term cosmetic and functional deficits. This article focuses on the emergency assessment, triage and non-specialist management of traumatic injuries of the orbit and facial skeleton.

Key words: *assessment, facial fracture, orbital blowout, zygoma.*

Introduction

Fractures of the facial skeleton are common reasons for presentation to EDs.[1,2] Recreational activities and contact sports are frequently implicated as are pedestrian, motorcycle and motor-vehicle accidents. Interpersonal violence is also common, often related to alcohol and illicit drug use.[3–6]

The head and neck contains a number of structures essential for life that perform complex functions such as speech, sight, swallowing and smell.[7] The face is important aesthetically and failure to diagnose and manage facial fractures can lead to disfigurement, masticatory difficulty, sensory paraesthesia, visual disturbance, visual loss and death.[7–10]

Early assessment and intervention can significantly reduce morbidity and mortality and avoid complex reconstruction later.[6] The aim of this paper is to discuss the presentation of maxillofacial trauma to the ED and outline the principles of its management.

Initial assessment and management

History

In all cases, rapid patient assessment and stabilisation takes first priority over taking a history.[11,12] A thorough history detailing the mechanism of injury helps identify occult injuries and screens for cervical spine and closed head injuries.[13–16] Differentiation between high and low energy mechanisms is important as high energy injuries predispose to unusual trauma patterns.[17,18]

It is important to establish if the injury was witnessed, any periods of unconsciousness or symptoms of concussion (nausea, vomiting or visual disturbance). In road trauma and interpersonal violence, accurate documentation of the manner in which an injury is alleged to have occurred and substance use may affect the outcome of court proceedings or insurance claims.[13,14,17]

Airway assessment

Upper airway obstruction may result from fracture of the laryngeal cartilages, tissue oedema, haemorrhage or comminuted mandible fractures where the tongue is unsupported anteriorly.[18,19] Dentoalveolar injuries are common in maxillofacial trauma and tooth fragments may be aspirated, especially in an unconscious patient, and must be excluded by chest X-ray if unaccounted for.[20,21] Trismus with drooling, stridor, dysphonia, dyspnoea or haemoptysis are ominous signs of impending loss of airway patency.[22,23]

Trismus usually results from pain and swelling; however, it may be due to muscle impingement by bony fragments, collections or haematoma. When trismus becomes severe (<25 mm) fibre-optic intubation may be required to secure the airway.[22,24,25] Fibre-optic intubation is also indicated in patients with suspected cervical spine injury to avoid unnecessary neck movement.[24,25] Ongoing upper airway haemorrhage and secretions may limit visibility and effectiveness of fibre-optic intubation.[25]

When securing the airway, a cuffed endotracheal tube, with or without

Key findings

- Mandible fractures are bilateral until proven otherwise, always look at the contralateral angle, condyle or parasymphysis.
- Midfacial injuries can be associated with a base of skull fracture. Clear fluid leakage from the nose may be cerebrospinal fluid.
- Zygomatic and orbital fractures may be associated with significant eye injury. A painful proptosed eye with fixed pupils and opthalmoplegia is a surgical emergency requiring urgent decompression to save vision.

Correspondence: Dr Adrian F DeAngelis, Maxillofacial Surgery Unit, Royal Melbourne Hospital, Parkville, VIC 3050, Australia. Email: ADeAngelis1@gmail.com

Adrian F DeAngelis, BDSc (Hons), MBBS, PGDipOMS, Maxillofacial Surgery Resident; Roland A Barrowman, BDS, MBBS, PGDipOMS, Maxillofacial Surgery Registrar; Richard Harrod, MBBS, FACEM, Consultant Emergency Physician; Alf L Nastri, MDSc, MBBS, FRACDS (OMS), Head of Oral & Maxillofacial Surgery.

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rapid sequence induction, is preferred as supraglottic devices may become dislodged.[19,26,27] This may be later converted to a submental airway at operation by passing the tube through the floor of the mouth and connecting to the anaesthetic circuit below the chin.[28,29] Nasotracheal tubes should be avoided in suspected or proven comminuted skull base fractures due to the risk of displacement into the middle cranial fossa.[30]

Acute upper airway obstruction usually requires emergency cricothyroidotomy followed by tracheostomy.[19] Tracheostomy should be considered when other airway options are infeasible or have failed, where airway compromise from swelling is expected or long term intubation required.[19,28] Risks of tracheostomy include recurrent laryngeal nerve palsy, subglottic stenosis, tracheoesophgeal fistula, respiratory infection and death from displacement, obstruction or haemorrhage.[28,29]

Haemorrhage and circulation

Blood loss from the scalp, oral cavity and pharynx may be extensive and easily overlooked, especially in unconscious patients.[19,31] Even minor lacerations may bleed profusely and large volumes of blood can be swallowed leading to gastric mucosal irritation, vomiting and aspiration, especially in the unconscious patient.[18,19,31,32] As part of haemorrhage and circulation stabilisation, scalp lacerations should be controlled with packing, Raney clips, suturing or stapling.[11,31]

Bleeding from midface fractures can be insidious and difficult to control. Epistaxis is common in maxillary injuries and may require anterior or posterior nasal packing with Foley catheters, double lumen balloon catheters (epistat) or nasal packing materials (kaltostat, ribbon gauze). In mobile fractures of the maxilla, the nasal septum may not be attached to the nasal floor and bilateral nasal packing is required to prevent septal deviation and ongoing haemorrhage.[17,18,22,33]

Life-threatening haemorrhage occurs in up to 10% and may require emergency arterial ligation or embolisation. Nasal packing may cause distraction of maxillary fractures leading to increased haemorrhage. Manual reduction, impaction and stabilisation of fractured segments in these situations may be life saving.[31]

Cervical spine and neurological assessment

Patients with traumatic injuries to the head are at high risk of cervical spine injury.[15,17–19,22] The Nexus criteria and Canadian C-spine rules may help decide if imaging is required to clear the cervical spine although the Nexus criteria are unlikely to be helpful in significant facial injury and fracture.[34–36]

Baseline objective assessment of neurological status is important and the patient must be closely monitored if there is any deviation from normal.[11,13,17,22] The Canadian CT head injury rules and New Orleans head CT criteria may be helpful to guide the need for the need for radiological investigation although the latter is only applicable to patients who remain GCS 15.[37,38]

Age greater than 65 years, new onset focal neurology, seizures, persistent reduced GCS, ongoing vomiting or signs of base of skull fracture (haemotympanum, raccoon eyes, Battle's Sign, CSF oto/rhinorrhea) are indications for CT imaging. Imaging should also be considered in patients who are intoxicated or anticoagulated.[37–39]

Ophthalmic injuries

Any midfacial injury can cause occular trauma and associated neurovascular injury. It is important to exclude vision-threatening injuries that require urgent intervention such as penetrating eye injuries, retinal injuries and retrobulbar haemorrhage.[40–42]

Traumatic mydriasis presents as a dilated or asymmetrical pupil secondary to a tear in the pupillary constrictor ring. This may be difficult to distinguish from other causes of unilateral dilated pupil including occulomotor nerve compression due to raised intracranial pressure and haemorrhage.[17]

Laceration of the ethmoidal arteries may result in intra-orbital (retrobulbar) haemorrhage and compartment syndrome with progressive increase in intra-orbital pressure, compression of the optic nerve, ophthalmic artery and blindness.[10,40,41] Signs of retrobulbar haemorrhage include pain, reduced light perception, a fixed dilated pupil, loss of the direct pupillary reflex, preservation of the consensual reflex, proptosis and ophthalmoplegia. Retrobulbar haemorrhage may be decompressed by lateral canthotomy under telephone guidance and is vision saving.[10,17,18,22,41]

Peripheral nerve injuries

Paraesthesia after facial trauma is highly suggestive of fracture due to injury or impingement of trigeminal nerve branches. Mandible fractures can present with loss of lip sensation due to injury to the inferior alveolar nerve (V_3) running within. Midface injuries may present with cheek numbness due to injury to the infraorbital nerve (V_2) as it traverses beneath the orbital floor. Injury to the supraorbital and supratrochlear branches (V_1) in the forehead region may also occur.[17,18,22]

Facial nerve branch palsy may result from penetrating injuries or superficial lacerations as the nerve exits the beneath the external auditory meatus and divides within the substance of the parotid gland anterior to the ear. As these nerves are at risk with operative intervention, it is important to record any deficits identified on examination.[17,18,22]

Examination

Examination begins with inspection for asymmetry and haematoma, palpation of the cervical spine for pain and tenderness and inspection for scalp and facial lacerations. The contours of the skull and orbital rims should be palpated for step deformities suggesting loss of continuity and the nasal bones gently mobilised. Significant haematoma may make the detection of step-deformity difficult.[12,17,18]

The maxilla is assessed bimanually for mobility by mobilising the maxillary alveolus while applying counter-pressure at the forehead. The malar eminences and zygomatic arches should also be palpated along with the lower border of the mandible and

ramus.[17,18] This is followed by asking the patient to open and close the mandible while palpating anterior to the ear for localisation of the condyle and temporomandibular joints.[12,17,18]

Sensory nerve injury is assessed with the patient's eyes closed and gently brushing a fingertip above the orbit (V_1), below the orbit (V_2), lower lip and cheek (V_3). Signs of facial nerve injury include a drooping lower face and lip, inability to raise the eyebrow, wrinkle the forehead or close the eye.[7,17,18,22] The facial nerve can be tested by directing the patient to close their eyes tight (zygomatic branch), raise their brow (temporal branch), show their teeth and puff out their cheeks (buccal branches) and to frown (marginal mandibular branch).[17,18,22] The examination is completed by performing an eye, ear, nose and intraoral examination.[12,17,18]

It is essential to test visual and pupillary function despite significant periorbital haematoma along with direct and indirect pupillary reflexes for relative defects via the swinging light (RAPD) test.[17,18,22] The clinician should screen for new onset of visual disturbance, diplopia, visual field deficits or reduced visual acuity and examine the eyeglobe, eyelids and pupillary reflexes.[17,18,40–43]

Visual acuity in some cases may be limited to finger counts or light perception only. Signs of penetrating eye injury include hyphaema, teardrop shaped pupils, and prolapsed intraocular contents. If there are any concerns about visual acuity or function then ophthalmology opinion should sought immediately.[17,18,40–43]

Once adequate light perception and visual acuity have been established, the entire range of ocular motion should be tested for diplopia followed by fundoscopic examination.[17,18,22,40,43,44]

Investigations

Due to overlap of midfacial anatomical structures on plain films, CT is the investigation of choice but should not be used as a screening tool in place of clinical examination, especially in paediatrics where there may be significant long term radiation related complications.[12,17,45,46] When both the cervical spine and brain are to be imaged on their own merits it is reasonable to include the face if clinical examination suggests injury.[12,17,46]

Most mandibular injuries (except in severe comminution) may be adequately visualised with a combination of an orthopantomogram (OPG) and reverse Towne's views. Lateral oblique films may be used when OPG is not available.[17,18,22] In suspected isolated zygomatic arch fractures, the submentovertex view is useful to avoid CT imaging.[17,18] There is currently little role for MRI except in neurotrauma.[12]

Antibiotics

Antibiotics are necessary for open fractures, which includes all fractures involving tooth sockets and dirty facial wounds. Antibiotics active against oral and pharyngeal organisms such as amoxycillin or clindamycin in combination with metronidazole are preferred.[17,47,48]

Currently there is limited evidence for benefit with antibiotics in most midfacial fractures.[48] Patients with CSF leakage and fractures involving sinus and orbit communication may be at risk; however, the current literature does not support antibiotic prophylaxis based on incomplete and potentially biased evidence.[48,49] Ultimately opinion should be sought from the treating surgical team.

Timing of referrals

Urgent surgical review is required in any situation with airway compromise, large volume or ongoing haemorrhage, occular injury with altered visual signs, panfacial or suspected base of skull fractures.[17,18,44,50] Isolated zygomatic arch and malar fractures, nasal fractures, condylar fractures, anterior maxillary wall and nasal rim fractures are generally appropriate for outpatient review.[17,44,50]

All other injuries will require timely surgical review either in the ED or after admission to the ward in consultation with the on-call maxillofacial surgeon. In paediatrics, facial fractures are rare except in high velocity trauma.[5,51] Most paediatric injuries are stable and best managed conservatively with early outpatient review.[52]

Mandibular fractures

Fracture patterns

Mandible fractures are common at the condylar neck, angle and parasymphysis and may be bilateral due to the shape of the mandible. When one fracture is identified, a second must be excluded.[22,53] Fractures of the parasymphysis are associated with fracture of the contralateral (rarely ipsilateral) angle or condylar neck (Fig. 1). Bilateral condylar neck fractures with midline (symphysis) fracture (Guardsman's fracture) can occur following a blow to the chin.[22,53,54]

Assessment

Signs of mandible fracture include occlusal step, inability to bite, trismus, floor of mouth haematoma and lip paraesthesia. Inability to bite is common in posterior fractures and occlusal steps may be mistaken for avulsed teeth.[17,18,22] Lip paraesthesia is due to stretching or injury to inferior alveolar nerve (V_3) within the mandible.[17,18,22]

Imaging

Mandibular fractures are best imaged using a combination of an OPG and reverse Towne's views. Both are required as fractured condylar segments may not be visible on single views due to angulation and overlap.[17,18,22] An OPG-like image can also be obtained from CT data using a wide curved reformat.

Emergency management

Almost all mandible fractures involve dentoalveolar segments and are open fractures requiring antibiotics.[17,22,44,47,48] Urgent surgical review may be required in bilateral fractures with an unsupported airway.[18,19] Ideally these patients should be reviewed in the department although, depending on access to services, admission to the ward and next day transfer may be appropriate. Exceptions include paediatric greenstick injuries and isolated condylar fractures without malocclusion, which may be suitable for outpatient review.[17,22,52,55]

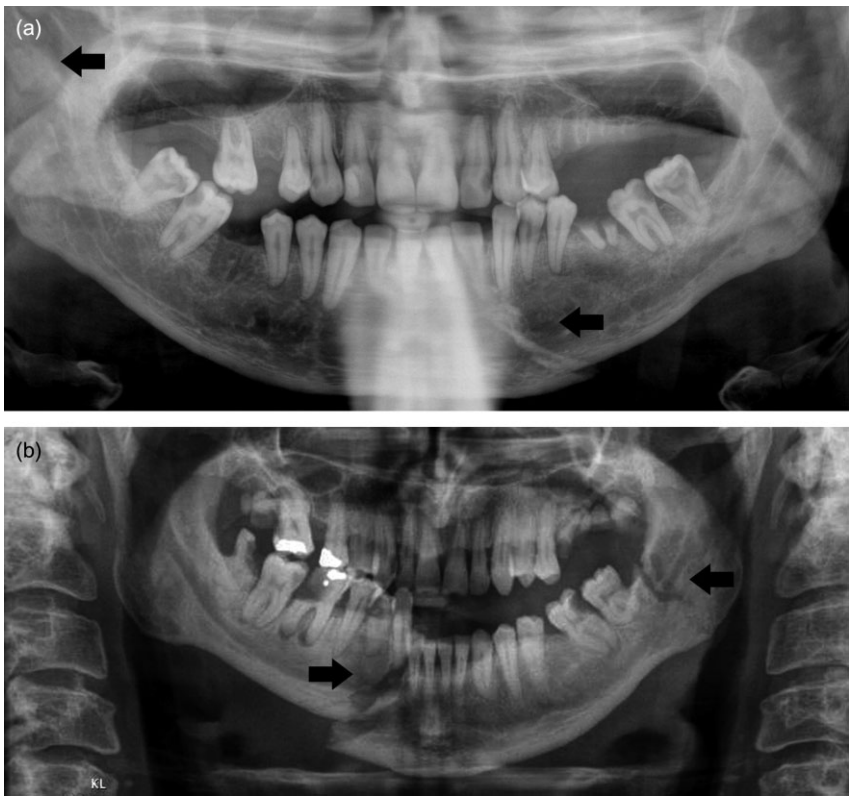

Figure 1. *Common patterns of mandible fracture. (a) Parasymphysis fracture with contralateral condyle. (b) Angle fracture with contralateral parasymphysis (or condyle).*

Maxillary fractures

Fracture patterns

Isolated fractures of the anterior and lateral maxillary sinus walls are common and rarely require treatment.[17,18,46] Direct trauma can lead to separation of the maxillary alveolus and palate (Le Fort I) or separation of the entire maxilla (Le Fort II Injury) from the rest of the face.[17,18]

Assessment

Clinical examination and bimanual examination will reveal most significant mobile maxillary injuries (Le Fort I or II). Infraorbital nerve (V_2) paraethesia is common but rarely represents significant injury.[18] In LeFort II injuries the patient may present with malocclusion, anterior open bite or bilateral periorbital haematoma (raccoon eyes) (Fig. 2).[17,22,39] The nose must be examined for septal haematoma, which can cause ischaemic necrosis of the septal cartilages, perforation and saddle nose deformity.[56]

Figure 2. *Bilateral periorbital haematoma (raccoon eyes) with lengthened midface suggestive of Pyramidal (Le Fort II level) maxillary fracture.*

Imaging

While CT is the modality of choice, it should only be performed to further characterise a clinically significant injury or when there are other indications for imaging.[17,18,22,46]

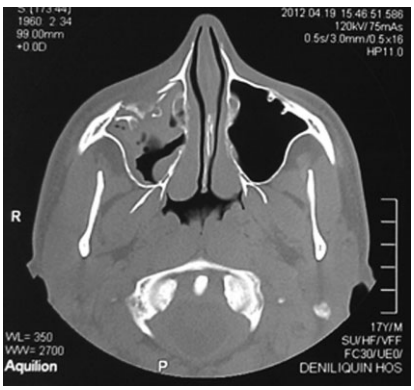

Figure 3. *Anterior maxillary sinus wall fracture, despite comminution these fractures are managed conservatively as long as the orbital rim and floor is not involved.*

Emergency management

Most maxillary fractures are managed conservatively with soft diet and analgesia (Fig. 3). For fractures of the orbital rim with step deformity, eye injury must be excluded and the patient referred for outpatient review within one week.[11,22] Patients with mobile maxillary fractures require admission and timely surgical review.[11,22] Antibiotics are not required except in open fractures or tissue emphysema from sinus wall disruption.[18,48]

Zygomatic fractures

Fracture patterns

Fractures of the zygoma range from isolated arch fractures to complex fractures through the arch, lateral orbital wall and zygomatic root. In some cases, the zygomatic body may be displaced medially with an intact but distorted arch.[17,18,22,44,46] As the zygoma forms a significant part of the orbit, occular trauma may occur with these injuries.[10,17,18,22,41]

Assessment

Signs of zygomatic fracture include infraorbital nerve (cheek) paraesthesia and periorbital haematoma, which may mask malar flattening, orbital rim step deformity and deformation of the zygomatic arch contour.[17,18,22,44]

Lateral subconjuctival haemorrhage is indicative of disruption of the lateral

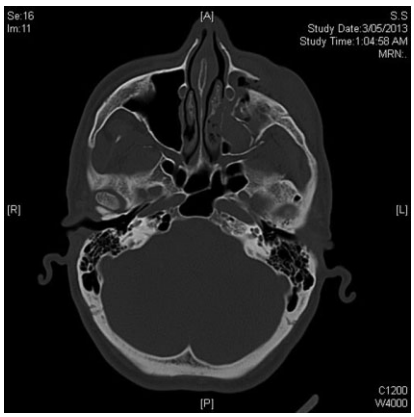

Figure 4. *Zygomatico-maxillary complex fracture. Note the displaced body of zygoma with bowing of an intact zygomatic arch.*

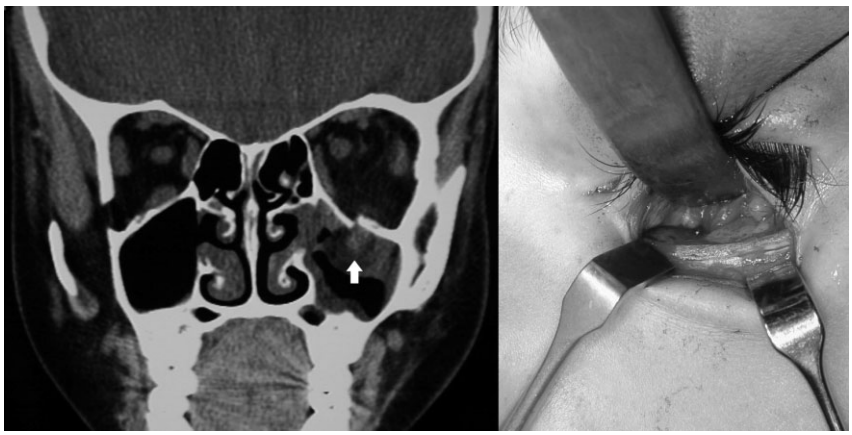

Figure 5. *Tear-drop sign suggestive of extra-occular muscle entrapment after orbital floor blowout fracture. At operation significant entrapment was observed.*

orbital wall and should prompt examination for other signs of zygomatic fracture. Trismus may occur in arch fractures due to impingement of the underlying temporalis muscle.[17,18,22]

Imaging

Submentovertex views will show the entire zygomatic arch but care must be taken to compare both sides, especially anteriorly as an intact but asymmetrical arch curved inward or bowed outward may be the only sign of a displaced fracture of the zygomatic body (Fig. 4).[17,18] CT imaging is required when there are orbital signs, malar flattening or the zygomatic body is displaced.[17,18,44,46]

Emergency management

Ophthalmological opinion is required if there is suspected eye injury or visual disturbance.[17,18] In the absence of vision-threatening injuries, the patient should be referred for outpatient assessment within a week.[17,44]

Orbital fractures

Fracture patterns

Orbital blowout fractures result from raised intraorbital pressure due to compression of the globe, which causes the thin medial and inferior walls adjacent to the sinuses to fracture outwards and may lead to herniation of the perioccular fat and extra-ocular muscles.[17,18,22,40]

In paediatric patients, elastic recoil of the bone can cause entrapment and ischaemia of the herniated contents (white-eyed blowout) leading to stimulation of the occulocardic reflex resulting in nausea, vomiting and bradycardia as well as necrosis of the extraoccular muscles, stricture and permanent diplopia.[17,18,44,57]

Assessment

Blowout fractures may present with diplopia and limitation of upward gaze (lateral in medial wall injury), visibly sunken eye (enopthalmus) or pupils at differing levels (hypoglobus) due to entrapment or prolapse of orbital contents (Fig. 5).[17,18,40] It is extremely important to assess for visual acuity, penetrating eye injury, retrobulbar haemorrhage and differentiate between monocular and binocular diplopia if it is present. Binocular diplopia is often due to oedema and rarely an indication for surgery while monocular diplopia may result from retinal detachment, lens dislocation or foreign body.[39.40]

Imaging

The presence of eye signs or significant periorbital haematoma is an indication for CT.[10,17,18,22] In the absence of signs, imaging detects many clinically insignificant (usually medial orbital wall) fractures.[46] The 'tear-drop' sign (Fig. 5) is a sensitive indicator for herniated orbital contents.[17,18,46] If retrobulbar haemorrhage is suspected, images must be reviewed urgently as the window for treatment is short.[10,41]

Emergency management

White-eyed blowout should be treated as a medical emergency and requires urgent surgical review.[17,18,44] Once vision-threatening injury is excluded, suspected or confirmed blowout fractures should be discussed with the maxillofacial surgeon on call who may review the patient in the department or recommend outpatient maxillofacial and opthalmology review within the week.[17,22,44]

In all blowout injuries, the patient should be instructed in sinus precautions (avoid nose blowing, air travel) to prevent periorbital tissue emphysema and prescribed antibiotics and nasal decongestants (oxymetazoline nasal spray TDS for three days).[18,47,48] It may also be prudent to observe these patients for a few hours before discharge to exclude delayed haematoma development.[22]

Nasofrontalethmoid fractures

Fracture patterns

Isolated nasal fractures are common after direct trauma while depressed fractures of the external surface of the frontal sinus (anterior table) may occur

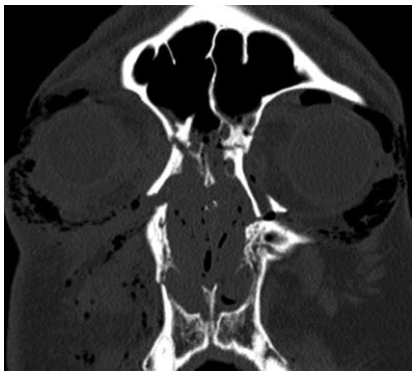

Figure 6. *Comminuted naso-orbito-ethmoidal fracture with periorbital gas emphysema. This patient had telecanthus as a result of disruption of the lacrimal bones. These fractures are at high risk of developing CSF leaks and intracranial communication.*

after a fall or blow to the head.[17,18] In severe injuries, a naso-orbital-ethmoid (NOE) fracture consisting of comminution of the medial orbital walls, nasal and lacrimal bones with displacement of the medial canthal apparatus may be present. In high energy trauma there can be separation of the facial skeleton from the cranial vault (Le Fort III Injury).[17,18,22,46]

Assessment

Fractures of the frontal sinus and nasal bones are identified by palpation of step deformities or mobilisation of nasal segments. The presence of increased intercanthal distance (telecanthus) suggests NOE injury and indicates disruption of the ligamentous attachments or displacement of the underlying lacrimal bones (Fig. 6).[17,18,44]

The medial canthus is normally attached to the lacrimal bone and aligned with the nasal alar. It should not move when traction is applied to nearby skin. Care must be taken to evaluate the lacrimal apparatus as pooling of tears may indicate injury to the lacrimal canal requiring early intervention to prevent stenosis.[17,18,22]

Clear fluid leakage from the nose in any nasofrontal injury may be leakage of cerebrospinal fluid from disruption of the anterior cranial fossa.[17,18,22,44]

Imaging

Isolated nasal bone injuries generally do not require imaging; however, CSF leakage, frontal deformity, significant haematoma and telecanthus are indications for CT imaging.[17,46]

Emergency management

Urgent surgical review is required when CSF leakage or pneumocranium is present from disruption of the anterior cranial fossa.[17,18,22,47,48] Except in severe injury or disruption of the canthal attachments, the patient should be referred for outpatient review.[17,18,22,44] As with other injuries involving the orbit, an ophthalmologist should be consulted early, especially if lacrimal apparatus injury is suspected. Sinus precautions may also be necessary in this group.[17,22,44]

Conclusion

It important for emergency physicians to be able to recognise, diagnose and institute basic management of maxillofacial trauma, especially in rural settings, where access to specialist services may be difficult.

While the majority of fractures in the maxillofacial region are not immediately life threatening, failure to diagnose, manage and refer appropriately can lead to loss of function and development of secondary deformities that may be difficult to correct later with frequently disappointing results.

Not all fractures of the facial skeleton are benign. The face is incredibly vascular and arterial bleeding can quickly lead to large volume of blood loss while comminuted fractures may cause loss of airway patency. One must be vigilant when assessing orbital injuries as these can lead to entrapment and ischaemia of extra-ocular muscles and permanent loss of vision.

Competing interests

None declared.

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