Oral surgery II: Part 6. Oral and maxillofacial trauma

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In brief

Oral and maxillofacial trauma is common and has several aetiological causes.	Oral and maxillofacial injuries are especially common in cases of polytrauma, such as road traffic accidents.	Initial assessment and care should consist of examining and protecting vital functions and should be carried out systematically.

Oral and maxillofacial trauma can range from an avulsed tooth as a result of a simple fall, to pan-facial injuries in the context of a polytraumatised patient involved in a road traffic accident. Regardless of aetiology, similar principles apply to all oral and maxillofacial injuries, and this chapter broadly outlines the more common forms of oral and maxillofacial trauma and the options available for their management. Throughout the chapter all references and values are for adult patients unless indicated.

Aetiology of facial trauma

The aetiology of facial trauma can be complex, and varies considerably in different regions of the world. In the UK, several publications have analysed the distribution of injuries under different categories, commonly including (but not limited to):

- Assault
- Road traffic accidents
- Falls
- Sports injuries
- Industrial accidents
- Ballistic or war injuries.

Variations in social policies, and in some cases political considerations, can significantly affect the distribution of injuries within the different categories. For instance, the ongoing measures that have increased road and vehicle safety have resulted in a demonstrable fall in both the number and severity of injuries sustained as a result of road traffic accidents. Conversely, the increased availability of cheap alcohol and the culture of drinking to excess have contributed to a large increase in the number of individuals sustaining fractures, both through interpersonal violence (an increase of over 350% in the last 30 years)[1] and through falls due to intoxication. Continuing research in the area of the aetiology is important because the cost of facial injuries to the NHS and wider economy is considerable, and simple measures such as using unbreakable glass in bars and clubs can contribute greatly to reducing injuries.

Finally, the aetiology of the injury is important in assessing a patient – especially in heightening the index of suspicion for the possibility of other injuries – and this begins with the primary survey. For example, a fall from height with facial injuries would also raise the suspicion of a spinal injury.

Primary survey

Following the principles of Advanced Trauma Life Support (ATLS), all victims of trauma on presentation should automatically receive a primary survey. Dependent on the nature and severity of the injury this may precede any history taken from the patient. The pertinent points of the oral and maxillofacial trauma history are shown in Table 1.

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ORAL SURGERY II*

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Table 1 Key elements of oral and maxillofacial trauma history

- Mechanism of injury: gives an idea of velocity and nature of force, with implications for other injuries
- Loss of consciousness: if positive there should be high suspicion of a head injury
- Dizziness or nausea: if positive there should be high suspicion of a head injury
- Amnesia: if positive there should be high suspicion of a head injury
- Any difficulties with function since injury, eg opening mouth, vision
- Any sensorimotor disturbance since injury, eg numb lip, weak eyelid
- Usual medical history, including most recent date of tetanus prophylaxis

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The primary survey aims to identify and manage life-threatening injuries in order of importance. It is remembered by the mnemonic ABCDE:

- Airway and cervical spine
- Breathing
- Circulation
- Disability
- Exposure

Airway and cervical spine

For patients with extensive oral and maxillofacial trauma, the possibility of cervical spine (C-spine) trauma must be given prime consideration. If in doubt, or if the patient is unable to cooperate owing to either confusion, intoxication or distracting injury, in-line immobilisation should be established until the patient is able to cooperate fully with a full clinical examination. Any doubt over C-spine injuries should be addressed by plain radiographs or advanced imaging.

The airway can also be threatened in extensive oral and maxillofacial trauma. A simple way of assessing it is to ask the patient a question; if they respond in a clear voice it is unlikely their airway is compromised. Various methods are available to help improve the airway. These include jaw thrust (in C-spine injury); chin tilt (contraindicated in C-spine injury); a nasopharyngeal airway (caution if suspicion of base of skull fracture); or a Guedel airway (patient must be un/semiconscious; Fig. 1). A definitive airway can be secured using a cuffed endotracheal tube situated in the trachea above the carina with the cuff inflated.

Rarely, the only safe way to protect the airway is by using a direct surgical approach using a tracheostomy, while emergency access can be gained with a cricothyroidotomy.

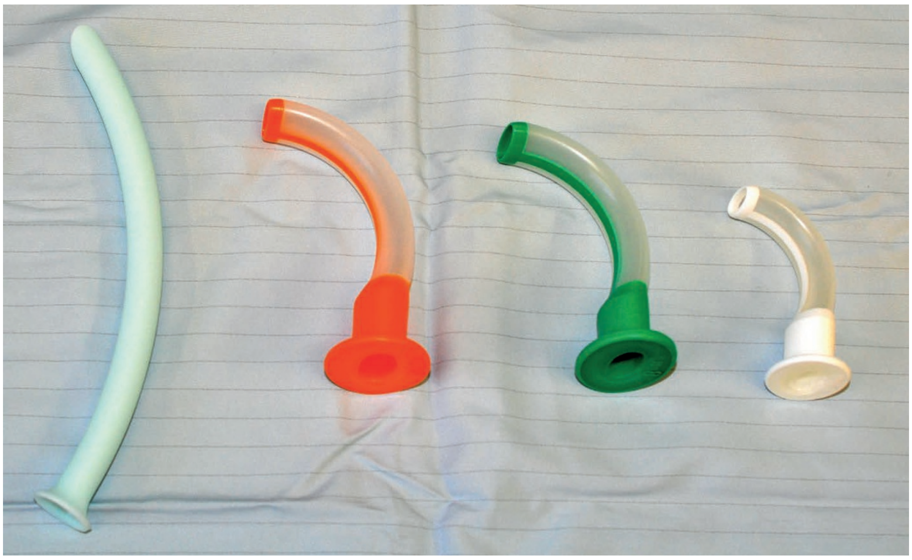


Fig. 1 Nasopharyngeal and Guedel airways. On the left is a nasopharyngeal airway. These are sized to the diameter of the patient's little finger and passed into the nose parallel to the occlusal plane. They can be used in conscious patients. On the right are three sizes of Guedel airway, which are sized by holding them up to and measuring them against the commissure of the lips and the angle of the mandible. They are introduced in adults by holding them by the flange with the concave surface uppermost, passing them along the palate in this orientation and then at the soft palate rotating them 180 degrees so the concave surface fits snugly over the tongue. This results in the flange being anterior to the incisors and the end point of the Guedel in the oropharynx, overlying the tongue without displacing it posteriorly. They are only suitable in unconscious patients or semiconscious patients whose gag reflex is absent

Breathing

Observe the movement of the patient's chest, the respiratory rate and any signs of cyanosis, and auscultate to detect any abnormalities. Breathing can be supplemented by the use of:

- high-flow oxygen via a non-rebreathing mask;
- bag and mask ventilation; or
- intubation and mechanical ventilation.

If none of the above proves satisfactory, the possibility of a pneumothorax, haemothorax, ruptured diaphragm or cardiac tamponade should be considered. Breathing and airway problems also tend to be more serious with middle-third fractures, for anatomical reasons, and these may only be resolved totally when definitive treatment is completed.

Circulation

The oral and maxillofacial region is extremely vascular, and relatively large volumes of blood can be lost as a result of oral and maxillofacial trauma. The source of bleeding can usually be identified without difficulty but bleeding into the pharynx or infratemporal fossa can be both occult and significant. Such bleeding is usually the result of middle-third fractures and may also result in further airway compromise.

Assessment of the circulation requires inspection of the patient, examining for pallor, perspiration, increased respiratory rate, increased capillary refill time (>2 seconds for blanching to resolve when nail-bed pressure is released), tachycardia and a pulse that is both weak and of poor volume. Blood pressure can also be measured, and one of the earlier signs of hypovolaemic shock is a slight rise in the diastolic blood pressure as the body attempts to compensate for the ongoing blood loss. This rise in diastolic blood pressure causes a decrease in the pulse pressure (the difference between systolic and diastolic blood pressure). A narrowing (decrease) of the pulse pressure is a worrying sign as it means that the body's compensatory mechanisms for the blood loss are almost exhausted. A fall in diastolic and systolic blood pressure is a late sign and normally follows a narrowing of the pulse pressure. A very sensitive mechanism related to ongoing blood loss is the patient's water homeostasis, so a decreased urinary output with increased thirst is a worrying sign. The management of all haemorrhage in the first instance is to reduce blood loss with direct pressure, followed by replacement of blood volume through the use of crystalloid or packed red cells. In reality, controlling bleeding can occasionally be extremely difficult and may require a surgical approach in controlled conditions.

Disability

This relates to the patient's consciousness level and is measured by the Glasgow Coma Scale (GCS).[2] The GCS is measured on a 15-point scale in three categories: best verbal (5); best motor (6); best eye response (4). The minimum score is 1 in each category (score 3), and the maximum score and normal GCS is 15. The definition of coma is GCS 8 or below, and this normally mandates intubation to protect the

Fig. 2 Snellen chart. Visual acuity is measured in each eye separately. The eye not being tested is covered and the line of the smallest letters that the patient can read with the uncovered eye is recorded. A version to be used at a distance of 1 m is available for patients who are unable to stand

Table 2 'Red flag' signs and symptoms following oral and maxillofacial trauma

'Red flag' signs and symptoms	Possible diagnosis
• Proptosis • Intense retrobulbar pain • Paralysis of eye movements (ophthalmoplegia) • Pupil dilatation • Diminishing visual acuity	Retrobulbar haemorrhage
• Bilateral circumorbital ecchymosis (panda eyes) • Battle's sign (postauricular haematoma) • Haemotympanum • Cerebrospinal fluid otorrhoea or rhinorrhoea	Base of skull fracture
• Pupil dilatation • Diminished Glasgow Coma Score	Intracranial haematoma

airway. However, the best use of the GCS is to monitor the scores over a period of time, with changes indicating whether a patient's level of consciousness is improving or deteriorating. A diminished GCS should never be purely attributed to an intoxicated state, and efforts must be made in this situation to exclude any intracranial injury. Specific guidelines on the imaging and management of head injury are available from the National Institute for Health and Care Excellence.[3]

Other measures of injury severity exist but all have shortcomings. The advantages of the GCS are its simplicity and relative ease of use; its disadvantage with respect to maxillofacial trauma is that the injuries sustained may themselves cause difficulty in making the assessments, for example significant periorbital swelling. There is also evidence of poor inter-assessor reliability.

Exposure

This relates primarily to a full exposure of the patient to examine for other injuries. In addition, consideration should be given to the aetiology of the injury and any conditions that a traumatised patient may have been exposed to, for example extremes of temperature, smoke or noxious chemicals.

While the primary survey is being conducted, any problem identified is managed as it is found and the survey does not progress until the problem is managed. It is also important that regular monitoring and review is maintained to ensure the stability of vital signs, as the trauma patient is often in a dynamic and evolving state. Various electronic aids (eg a pulse oximeter) can assist in this but are no substitute for clinical vigilance.

Once the patient has been cleared from the primary survey the clinician can then move onto the secondary survey, which consists of a series of area-specific examinations of the whole body. In this chapter, the focus is solely on the oral and maxillofacial region, and so only includes the examination of this area. A more detailed treatise on the subject is provided by Macpherson et al. for readers who may wish to study this subject more extensively.[4]

Examination for trauma

The examination process begins from the minute that the clinician first meets the patient. The process begins with an inspection of the patient, examining their general state and for obvious ecchymosis, deformity, lacerations etc. It is important to develop a systematic approach to examining the oral and maxillofacial region for trauma. One method is to start at the back of the scalp and work up and forwards over the scalp and then work systematically down the face, palpating all bony structures for deformity, testing the range of movement of the mandible, and testing all sensorimotor functions. Specifically, eye movements, pupillary reaction, visual acuity, sensory function of the trigeminal dermatomes, and motor function of the facial nerve should all be tested as a minimum.

To assess eye movements the patient should be seated in front of the examiner and asked to follow the examiner's finger with their eyes as the clinician moves a finger systematically through the full range of ocular movements. The patient should be asked if they have any double vision (diplopia) and if so this should be recorded as 'II' in a 3 × 3 grid. Pupillary reaction to accommodation and light should be tested. To test accommodation, the patient should be asked to fix on an object like a pen held in front of them and concentrate on it. Once a few seconds have elapsed, ask the patient to look past the object at the examiner. If accommodation is present, the pupils will dilate as the patient looks past the pen to the examiner in the distance. The pupillary reaction to light should be checked by a swinging flashlight test. This test will identify both the direct and indirect (consensual) reaction to light; both pupils should constrict when the light is shone in one eye. A sluggish reaction to light or a dilated ('blown') unresponsive pupil should raise concerns over raised intracranial pressure, among other possible causes. Both pupils should be tested with the light.

Visual acuity is tested using a Snellen chart (Fig. 2). Snellen charts are available to be read at different distances, but most commonly at 6 metres. The subject covers one eye, keeping it open but obscuring its vision, and the unobstructed eye's acuity is checked, followed by the contralateral eye. Normal acuity is such that at 6 metres line 6 can be read; this is noted as 6/6 (metres read at/line read), and if it were line 9 it would be 6/9.

Table 3 Signs and symptoms of oral and maxillofacial trauma

Injury	Signs and symptoms*
Dentoalveolar fracture	• Teeth move 'en bloc' • Tear in gingival and subgingival mucosa with associated haematoma • Malocclusion
Fractured mandible (excluding condyle)	• Sublingual haematoma • Step in occlusion • Step at inferior border of mandible • Malocclusion • Gingival tear and diastema • Paraesthesia or anaesthesia of inferior alveolar nerve
Fractured condyle	• Unilateral - Open bite on contralateral side - Deviation towards side of fracture on opening • Bilateral - Anterior open bite - Markedly decreased range of opening
Fractured zygoma	• Subconjunctival haematoma with no posterior limit • Loss of antero-posterior prominence of cheek • Epistaxis • Step(s) at buttress, arch, infraorbital rim • Restricted mouth opening • Paraesthesia or anaesthesia of infraorbital nerve
Orbital blowout fracture	• Enophthalmos (sunken-in eye) • Altered pupillary level • Restricted eye movements • Diplopia • Plus many of signs and symptoms of fractured zygoma
Le Fort fracture	• Buccal and palatal haematoma • Malocclusion • Cracked sound on percussion of teeth • Paraesthesia or anaesthesia of infraorbital, nasopalatine or greater palatine nerves • Mobility of maxilla at Le Fort 1, 2 or 3 level • Le Fort 2 and 3 may demonstrate eye signs as in zygomatic complex fractures • Epistaxis • Dependent on type of Le Fort fracture, cerebrospinal fluid leak

*Virtually all oral and maxillofacial trauma results in ecchymosis, pain, swelling, deformity and limitation of function. Not all signs and symptoms given in the column will always be present.

Fig. 3 Sites of fracture of the mandible. The percentages represent the range of incidence of fracture

Oral and maxillofacial 'red flag' signs and symptoms are shown in Table 2, and other signs and symptoms of oral and maxillofacial trauma are shown in Table 3.

Management options for trauma

When managing oral and maxillofacial trauma, consideration should be given to tetanus and/or antibiotic prophylaxis. Decisions should be made on the basis of the patient's medical history, the nature of the trauma and the level of contamination experienced by the patient.

Soft tissue injury

Important anatomical structures in the vicinity should have their function assessed to ensure there has been no damage, for example the facial nerve or the parotid duct (overlies masseter superficially). Any soft tissue wound should then be anaesthetised and thoroughly explored to determine the extent and visualise any underlying bony injuries. The wound should then be thoroughly debrided and irrigated using surgical preparations such as aqueous chlorhexidine or povidone-iodine. The oral and maxillofacial region has excellent powers of recuperation and healing, and therefore it is generally worth giving even the smallest of tissue tags the benefit of the doubt rather than sacrificing them.

Wounds should be meticulously closed in layers with a resorbable undyed suture in the deep tissues, and a fine nylon of the order of 5/0 to 6/0 in the skin.

Important anatomical boundaries such as the vermillion border merit a tacking suture in the skin to align them prior to closing the rest of the wound from the deep tissues outwards.

Dentoalveolar fractures

The management of dental trauma is covered in Part 1 of this *BDJ* series.

Mandibular fractures

The mandible is the only articulated bone of the face and is often (erroneously) regarded as an easy bone to repair if fractured (Fig. 3). The difficulties that can be encountered during repair are largely a result of the anatomy of the mandible, as different areas produce different challenges in access, reduction and immobilisation. The management of condylar fractures remains especially controversial.

In general, the options for managing a fracture of mandible include:

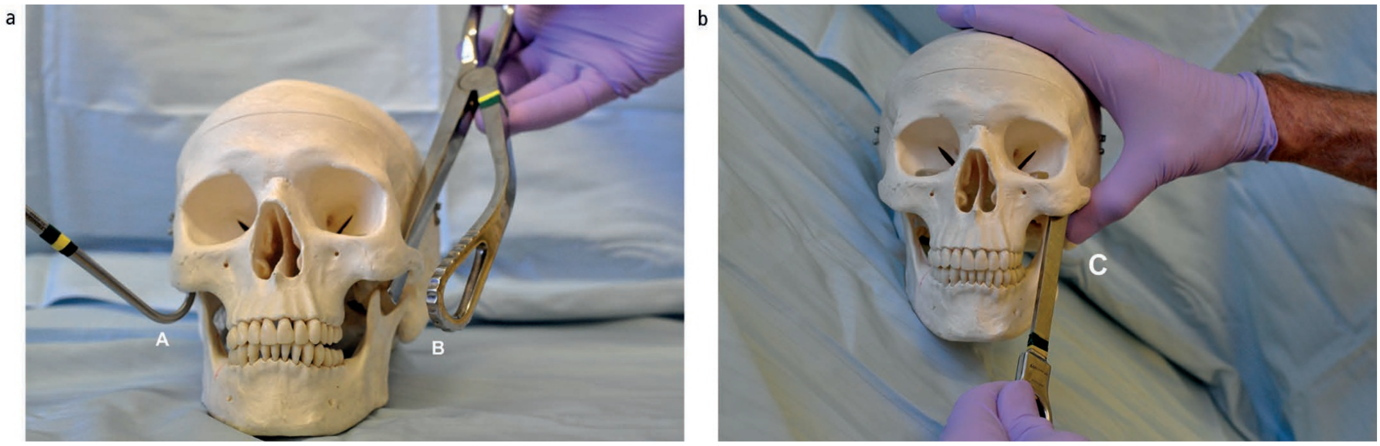


Fig. 4 Differing approaches to reduce fractured zygoma. A: Poswillo hook using an intraoral incision or a skin stab incision to position the hook tip under the body of the zygoma. B: Gillies temporal approach using the plane between the superficial temporal fascia and temporalis muscle to slide a Rowe elevator below the zygomatic arch or body. C: Keen's intraoral approach using a sulcal incision to slide a Bristow (shown) or Rowe elevator under the zygomatic arch or body[6]

- Conservative (no surgical intervention)
- Intermaxillary fixation
- Open reduction and internal fixation (ORIF)
- External fixation.

Intermaxillary fixation using eyelet wires or arch bars as a closed reduction of a fractured mandible has now largely fallen into disuse. A modern variant using specially formed orthodontic brackets and elastic bands is occasionally useful, however.

The gold standard for the majority of mandibular body, symphysis or angle fractures is ORIF using titanium miniplates. These are generally placed using an intraoral approach, although occasionally a transbuccal approach has to be employed to secure the screws. In most areas of the mandible one plate suffices with two screws either side of the fracture line. The only exceptions to this rule are: 1) the parasymphysis, where the curvature of the mandible and the direction of muscular force and attachment subject this area to significant rotational forces and two plates, one above and one below the mental foramen, are required; 2) the condyle, where two plates should triangulate to a point towards the condyle; and 3) fractures that are unstable with one plate.

External fixation (rigid pins protruding through the skin with connecting bars) may be used when fractures are grossly contaminated, where there is loss of continuity of bone or when there is significant bone loss (eg gunshot wounds).

As mentioned earlier, the treatment of condylar fractures can be controversial.[5] If the occlusion is undisturbed and the fracture is unilateral, conservative management can usually be adopted whereby the patient takes a soft diet for 4–6 weeks with periodic checks of the occlusion to ensure the fracture has not displaced.

Table 4 Imaging modalities used for oral and maxillofacial fractures

Injury	Imaging modality
Dentoalveolar fracture	• Dental panoramic tomography (DPT) and/or periapical views
Fractured mandible (excluding condyle)	• DPT and postero-anterior mandible view • Lower occlusal view for parasymphysis if difficult to image on DPT
Fractured condyle	• As fractured mandible unless difficult to identify intracapsular fracture, then may also request a reverse Towne's view • CT scans useful for planning surgery
Fractured zygoma	• Two occipitomental views with at least a 30 degree differential • Submentovertex views are infrequently used due to the extent of radiation exposure, particularly to the globe and cranium
Orbital blowout fracture	• Occipitomental views may be of use, but definitive imaging is a CT scan, usually with coronal and sagittal 'fine' cuts
Le Fort fracture	• Combinations of lateral cephalometric skull and occipitomental views have been used, but now the gold standard is becoming CT with 3D reformatting

If a unilateral fracture is minimally displaced and there is a small occlusal discrepancy, a decision should be made regarding the use of elastic intermaxillary fixation to help reduce the discrepancy while the condyle heals. The alternative ORIF option for a unilateral condylar fracture is normally reserved for cases with a large occlusal discrepancy and/or gross shortening of ramus height.

In the case of bilateral condylar fractures, it is more common to treat at least one side with ORIF (although some would advocate bilateral placement), otherwise an anterior open bite is likely to develop. An extraoral approach (preauricular, submandibular, retromandibular or a combination) is generally required for ORIF of a condylar fracture, although innovative minimal access endoscopic approaches have recently been developed.

Zygomatic fracture

These fractures can be managed by either a closed or open reduction, dependent on the level of stability achieved when the fracture is reduced. The method for the reduction of the fracture can be a Gillies temporal approach, Keen's intraoral approach or use of a Poswillo hook (Fig. 4). As the fracture is disimpacted and reduced, the pressure can be released on the elevating instrument to see whether the reduction is stable. If the reduction is unstable the fracture can be opened and plated at the:

- Zygomaticofrontal suture
- Zygomatic buttress (intraorally)
- Infraorbital rim.

Titanium miniplates can be used at any of these sites to achieve fixation and stabilise the fracture. Ideally, a minimum of two screws either side of the fracture are required for stability of the reduction. Figure 5 demonstrates some of the extraoral approaches that can be used to access the zygomaticofrontal suture, the infraorbital rim and the orbital floor.

Orbital blowout fracture

Approaches to the orbit vary, and many of the incisions in the infraorbital region shown in Fig. 5 can be used to help access the orbital floor. Once the orbital floor is reached, the surgeon painstakingly elevates all orbital connective tissue, fat and muscle that has herniated through the orbital floor and attempts to find a sound posterior margin to the defect in the floor of the orbit. This is performed within the anatomical constraint of the optic nerve, which is usually just over 4 cm from the infraorbital rim. Various materials can be placed to reconstruct the defect in the orbital floor: fine titanium mesh; silicone elastomer; or autogenous bone from the skull, antrum or hip. The aim of the surgery is to release the entrapped orbital tissue and ensure free movement of the globe. Equally important, however, is the restoration of the normal volume of the orbital contents, thereby reducing enophthalmos and restoring pupillary level.

Middle-third (Le Fort) fractures

Fractures of the middle third of the face are relatively uncommon, which is perhaps surprising given the thinness of some of the bones involved. However, the anatomical design of the maxilla and its articulations with the skull, coupled with its protected position, do appear to render middle-third fractures less likely than those of other facial bones.

The standard classification (devised by French surgeon Rene Le Fort[7]), divides fractures into three groups: I, II, III (Fig. 6). Le Fort I fractures are low-level or horizontal fractures at the level of the base of the nose. Le Fort II fractures are also known as pyramidal fractures, and involve the nasal complex and orbital floor and pass anterio-medially to the zygomatic buttress. The Le Fort III fracture (or high-level fracture) involves the nose, the ethmoids, the lateral orbital walls and the whole of the maxilla, which often 'floats' freely when mobilised.

Le Fort I fractures can generally be managed intraorally using a sulcal incision and ORIF with titanium miniplates. Le Fort II and III fractures are also managed with ORIF, with access being gained using a combination of the incisions depicted in Fig. 5, which gives bilateral access to the zygomaticofrontal suture and the infraorbital rim. Further access to the supraorbital rim, nasoethmoid region and frontal bone can be gained with a coronal (bitemporal) approach, which is an incision from just above the ear, over the vertex of the scalp to just above the contralateral ear. One approach to managing Le Fort II and III fractures is the outside-inwards, top-downwards method.

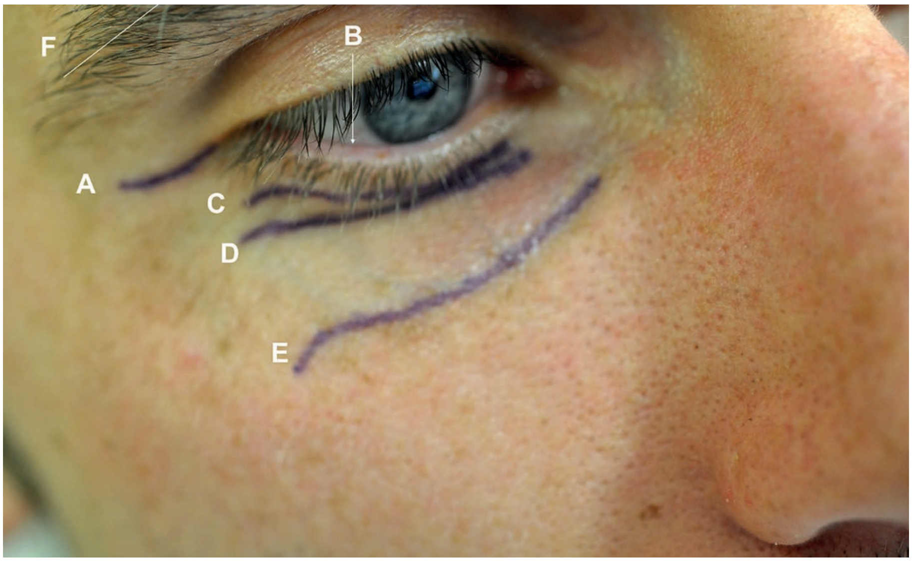
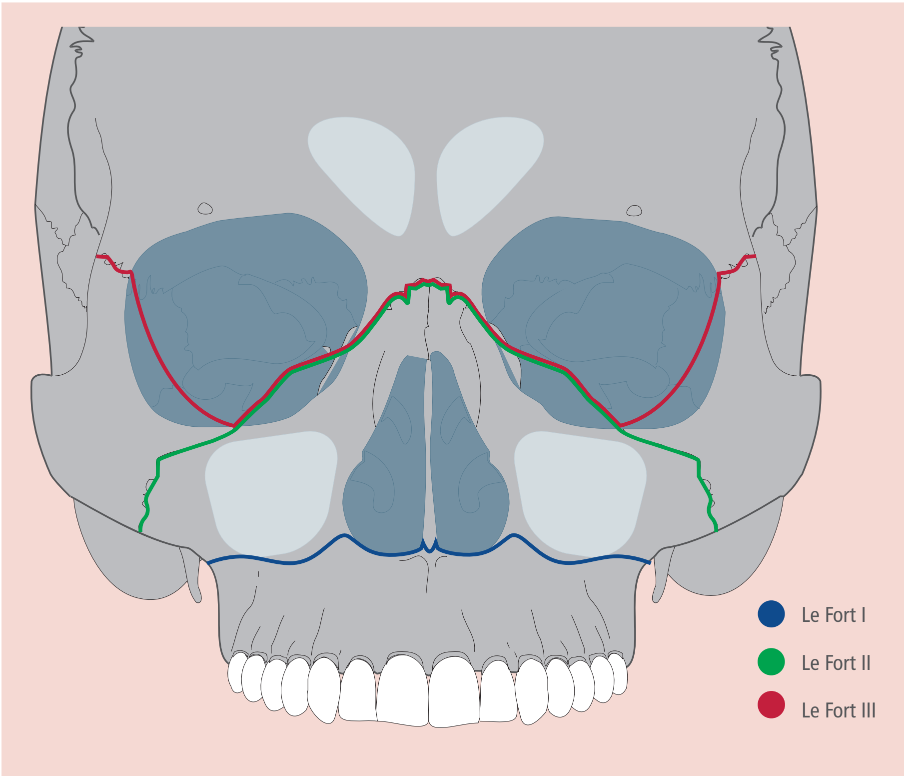


Fig. 5 Approaches to the zygoma and orbit. A: Lateral canthotomy, used in combination with a transconjunctival incision to gain access to the orbit/inferior orbital rim, or in isolation to decompress retrobulbar haemorrhage. B: Transconjunctival – the arrow indicates the incision is made in and along the inferior fornix. C: Subciliary approach incision. D: Low blepharoplasty approach incision. E: Infraorbital approach incision. F: Zygomaticofrontal approach incision. The incision must be made parallel to the hair follicles to ensure there is no hair loss

Fig. 6 Sites of Le Fort fracture



That is, the zygomaticofrontal sutures are reduced and plated first, and then ORIF progresses inwards and downwards to reconstruct the maxillary skeleton.

Despite the seemingly simple classification, however, the biological nature of the human body dictates that many fractures do not follow conventional lines, and surgeons must adapt their approaches on a case-by-case basis. With the development of modern 3D imaging, however, this process can be planned to quite a considerable extent, even allowing the construction of custom-made titanium plates if necessary.

Rehabilitation

Given the minimal periosteal stripping required, the efficiency and efficacy of surgery involving miniplates, and advances in anaesthesia techniques, postoperative recovery times have significantly reduced over the years. Most postoperative rehabilitation centres on the need for exemplary oral hygiene for any intraoral approaches, a soft diet during the initial healing phase for Le Fort and mandibular fractures and the avoidance of contact sports for all types of fracture for 6–12 weeks. The use of other therapeutic techniques to accelerate healing shows promise, and this is likely to be an expanding area of research in the future.

Summary

Oral and maxillofacial trauma varies in its severity, but the management of all injuries follows the same principles, with a view to rehabilitation and a return to normal function. Careful consideration should be given to the nature of the trauma and the anatomical area affected, as both can make sense of the presenting signs and symptoms and what underlying damage there may be. ORIF is the gold standard for managing bone fractures but it is not always necessary for zygomatic fractures, and extraoral incisions should be avoided if reduced fractures are stable.

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