

FRACTURES OF THE FACIAL SKELETON

second
edition



MICHAEL PERRY
ANDREW BROWN
PETER BANKS

WILEY Blackwell

Table of Contents

[Cover](#)

[Title Page](#)

[Copyright](#)

[Preface](#)

[Acknowledgements](#)

[Chapter 1: Facial trauma: incidence, aetiology and principles of treatment](#)

[Incidence](#)

[Aetiology](#)

[Principles of treatment](#)

[Further reading](#)

[Chapter 2: Emergency management of facial trauma](#)

[Current concepts in trauma care](#)

[The multiply injured patient with facial injuries](#)

[Further reading](#)

[Appendix](#)

[Chapter 3: Clinical features of facial fractures](#)

[Fractures of the mandible](#)

[Fractures of the midface and upper face](#)

[Fractures of the zygomatic complex](#)

[Isolated orbital floor fractures](#)

[Fractures of the nose and naso-orbito-ethmoid complex](#)

[Central midface fractures involving the dentoalveolar component \(Le Fort type fractures\)](#)

[Further reading](#)

Chapter 4: Imaging

Imaging in the initial management of the trauma patient

Imaging modalities

Imaging for specific facial fractures

Further reading

Chapter 5: Treatment of dentoalveolar injuries

Classification

Clinical assessment

Treatment

Review and further management

Further reading

Chapter 6: Treatment of fractures of the mandible

Fractures of the tooth-bearing section of the mandible

Fractures of the mandible in children

Fractures of the condylar region

Fractures of the edentulous mandible

Comminuted and complex mandibular fractures

Factors affecting method of treatment of mandibular fractures: general summary.

Further reading

Chapter 7: Treatment of fractures of the midface and upper face

Surgical approaches to the midface and upper face

Treatment of midface fractures

Treatment of frontal sinus and craniofacial fractures

Further reading

[Chapter 8: Soft tissue injuries and fractures associated with tissue loss](#)

[Soft tissue injuries](#)

[Fractures associated with tissue loss](#)

[Further reading](#)

[Chapter 9: Postoperative care](#)

[Immediate postoperative care](#)

[Intermediate postoperative care](#)

[Late postoperative care](#)

[Further reading](#)

[Chapter 10: Complications](#)

[Delayed treatment](#)

[Complications arising during or soon after primary treatment](#)

[Late complications](#)

[Further reading](#)

[Index](#)

[End User License Agreement](#)

List of Illustrations

Chapter 1: Facial trauma: incidence, aetiology and principles of treatment

[Figure 1.1 Anatomical specimen showing the bones of the mid and upper face separated and mounted to show their complex inter-relationship. Note that the bones of the midfacial skeleton are all relatively fragile. From above downwards they are the perpendicular plate of the ethmoid, with paired lacrimal bones, nasal bones, palatine bones, maxillae and inferior conchae. The zygomatic bones are shown](#)

laterally. The midline vomer is missing. (Courtesy of the Wellcome Museum of Anatomy and Pathology, Royal College of Surgeons of England.)

Figure 1.2 Diagrammatic representation of the relative strength of the skull and facial bones. The 'matchbox' like structure of the midface cushions the force of impact (B), whereas a blow to the skull is transmitted directly to the intracranial contents (A). An impact to the mandible (C) is transmitted indirectly to the cranial base. Damage to the brain may be prevented by protective fracture of the condylar neck, which is represented here as the handle of a bent baseball bat.

Figure 1.3 Transilluminated skull and facial bones demonstrating the thick buttresses of bone that distribute the forces of mastication within the skeleton of the midface. The much stronger bone of the mandible is also clearly evident. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 1.4 View of the anterior cranial base showing the cribriform plate of the ethmoid with the olfactory nerve foramina and midline crista galli. This fragile bone is fractured in high midface Le Fort type and severe naso-orbito-ethmoid injuries. Damage to the underlying dura may result in cerebrospinal fluid rhinorrhoea.

Figure 1.5 The importance of accurate anatomical reduction to restore all three dimensions of the facial skeleton. Representation of a three-dimensional CT scan of a complex facial fracture that has been reduced and treated with miniplate fixation of the main buttress areas. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 1.6 Diagram to illustrate sequencing of multiple facial fracture repair. The outer circle defines the 'frame' of stronger bones that are reduced and immobilized first (frontal bone, lateral orbital margins, zygomas and mandible). The middle circle contains the 'contents' of this 'frame' (essentially the maxillae) that are reduced and repaired next, and finally the nasal complex (inner circle) is restored.

Chapter 2: Emergency management of facial trauma

Figure 2.1 MR scan of an elderly female patient taken five days after falling onto her face. In addition to the facial injuries there was also some mild weakness in the right hand. MRI confirmed a central cord syndrome. The clue is the mechanism of injury that resulted in hyperextension of the neck. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 2.2 Patient with severe facial injury resulting in multiple facial fractures. Extensive swelling develops rapidly within the first few hours. In addition the periorbital haematoma and deformity due to disruption of the naso-orbito-ethmoid complex is obvious. Close monitoring of the airway is essential to detect the onset of possible obstruction. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 2.3 (a) Lateral radiograph showing a bilateral fracture of a very thin mandible with a severe 'bucket handle' type of displacement. (b) Probable mechanism resulting in 'bucket handle' displacement by the suprahyoid musculature. The fracture occurs in the thinnest area of the mandible, anterior to the

posterior attachment of the mylohyoid muscle, where bone contact is minimal.

Figure 2.4 The jaw thrust technique used to improve the airway in supine patients. The fingers are placed behind the angle of the mandible to push the jaw forwards and upwards while the thumbs push down on the chin or lower lip to open the mouth. Displacement of the mandible pulls the tongue forward and prevents occlusion of the oro-pharynx. In patients where there is no concern about any cervical injury the neck can be extended and the chin lifted to attain the same end. (John Wiseman, 1986.)

Figure 2.5 Nasopharyngeal airway tubes in place in a patient who has suffered a major facial injury. The ends of the tubes sit behind the tongue base in order to improve upper airway patency but regular aspiration is still mandatory to prevent blockage or pooling of blood and secretions. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 2.6 Tracheostomy tube being inserted through a cricothyroidotomy incision. Note the use of tracheal dilator forceps to facilitate passage of the slightly smaller than normal tube through the cricothyroid membrane. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 2.7 Postero-anterior cervical radiograph showing missing avulsed teeth identified in the oro-pharynx and upper trachea. Chest radiographs alone are inadequate when looking for missing teeth in the upper aerodigestive tract. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 2.8 Young baby with deep scalp laceration in left fronto-temporal region. Blood loss from maxillofacial injuries in very young patients can be the cause of significant hypovolaemia which should not be underestimated. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 2.9 (a) Proptosis of the left eye following an orbital fracture. (b) Axial CT scan of the orbits showing significant anterior displacement of the globe. Not all cases of proptosis following trauma are due to retrobulbar haemorrhage. Many result from retrobulbar oedema, sometimes referred to as 'orbital compartment syndrome'. (Reproduced with kind permission of Springer Science+Business Media.)

Chapter 3: Clinical features of facial fractures

Figure 3.1 Classification of mandibular fracture sites. A dentoalveolar; B condylar; C coronoid; D ramus; E angle; F body (molar/premolar area); G parasymphysis; H symphysis.

Figure 3.2 Diagrammatic representation of condylar fractures that may cause disruption of the temporomandibular joint meniscus. (a) Coronal view of normal condyle and meniscus. (b) Impaction injury causing intracapsular fracture haemarthrosis and damage to the meniscus. (c) Medial fracture dislocation with tearing of the meniscus.

Figure 3.3 (a) Vertically favourable and (b) vertically unfavourable fractures of the left angle of the mandible. The classical terminology used here and in Figure 3.4 is mainly of historical interest. It ignores the stabilizing effect of the periosteum across the fracture line and has little practical relevance now that open reduction and internal fixation is the

normal mode of treatment. When mandibular fractures are displaced it is usually as a result of the impact force stripping the periosteum and not muscle pull.

Figure 3.4 (a) Horizontally favourable and (b) horizontally unfavourable fractures of the left angle of the mandible. (See caption for Figure 3.3.)

Figure 3.5 Diagram to illustrate the mechanism of airway obstruction in an unconscious supine patient with posterior displacement of the symphysis. This is rarely a problem in a conscious patient even with significant injuries. In this situation the hyoglossus muscle and the intrinsic musculature, aided by the patient's upright posture, will allow control of the airway in almost all cases.

Figure 3.6 Occlusal disturbance produced by a unilateral displaced fracture of the left condylar neck. There is effective shortening of the ipsilateral ramus height leading to premature contact of the molar teeth. Deviation of the mandible to the affected side is also evident.

Figure 3.7 A young patient with bilateral displaced condylar neck fractures leading to an anterior open bite. In addition there is swelling over both fracture sites and painful limitation of all jaw movements.

Figure 3.8 Haematoma in floor of mouth as a result of an anterior mandibular fracture. This can be considered as a pathognomic sign of an underlying fracture when there is a clear history of an external blow.

Figure 3.9 Bilateral fracture of the parasymphysis with significant posterior displacement of the anterior mandibular segment. Despite this there was

no evidence of airway embarrassment, demonstrating the innate ability of a conscious patient to maintain an airway in most situations. An unconscious supine patient would almost certainly obstruct with this type of injury.

Figure 3.10 Missile injury to the lower face and anterior mandible. Despite the loss of soft and hard tissue, and comminution of the remaining bone, the airway remained intact in this patient who was not rendered unconscious by his injury.

Figure 3.12 (a) Diagram to show how the orbital plate of the frontal bone and the sphenoid bone form an inclined plane which lies at approximately 45° to the occlusal plane. (b) In Le Fort II and III type fractures there may be infero-posterior displacement of the midfacial skeleton along this plane resulting in premature contact of the posterior teeth and an anterior open bite. Rarely, with extreme displacement, occlusion of the oral airway can occur due to retroposition of the soft palate. (c) More commonly, the complex of bones is comminuted on impact producing a 'dish-face' deformity with lengthening of the midface. This often gives the impression of greater posterior displacement than has actually occurred.

Figure 3.11 The classical lines of midface fracture as described by Le Fort (a) Frontal view, (b) Lateral view. *Red*: Le Fort I, Guérin or low level transverse fracture. *Blue*: Le Fort II, mid level pyramidal or infra-zygomatic fracture. *Green*: Le Fort III, high level transverse or supra-zygomatic fracture. Although this terminology has a venerable history in the maxillofacial literature modern imaging techniques

confirm that injuries are usually considerably more complex than this 'monobloc' pattern suggests.

Figure 3.13 Patient with a high level midface fracture involving the cribriform plate with breach of the dura mater and cerebrospinal fluid (CSF) rhinorrhoea. The mixture of CSF (which does not coagulate) and blood (which does) results in a so-called 'tramline' pattern of discharge from the nose, as seen on the patient's left side. Note also the classical signs of a high level fracture including bilateral circumorbital ecchymosis ('panda eyes') and early gross facial swelling.

Figure 3.14 Superior orbital fissure syndrome due to fracture involving the left posterior orbit. (a)

Paralysis and ptosis of upper eyelid. (b)

Ophthalmoplegia with lack of movement of left eye in all positions of gaze (attempted downward gaze shown here). The patient also had anaesthesia of the left cornea and supra-orbital region. All these signs and symptoms usually resolve spontaneously with time.

Figure 3.15 Skull transilluminated from behind to show the relative strengths of the orbital bones. The extreme thinness of the floor and medial wall contrasts with the dense bone of the zygoma and orbital rim.

Figure 3.16 Typical zygomatic fracture lines. These rarely coincide exactly with the suture lines of the zygomatic bone, particularly medially, hence the more accurate terms 'zygomatic complex fracture' or 'orbito-zygomatic fracture'. Note the usual proximity of the medial fracture line to the infraorbital foramen that explains the frequent finding of sensory loss over the cheek area and lateral nose.

Figure 3.17 Severe orbito-zygomatic injury with periorbital haematoma, flattening of the cheek, vertical separation of the frontozygomatic suture and consequent increase in orbital volume. The resulting enophthalmos, drop in position of the globe (hypoglobus) and pseudoptosis ('hooding') are obvious despite the swelling and haematoma.

Figure 3.18 Diagram illustrating possible locations of haemorrhage in the orbital area following trauma. 1. Lid ecchymosis. 2. Subperiosteal haematoma. 3. Haemorrhage posterior to the orbital septum (including subconjunctival haemorrhage). 4. Haemorrhage within the muscle cone (retro-bulbar haemorrhage). (Adapted from Soll (1977). Reproduced with permission of American Academy of Ophthalmology and Otolaryngology.)

Figure 3.19 Diagram illustrating how inferior displacement of Whitnall's tubercle with the attached Lockwood's suspensory ligament leads to alteration in the level of the globe.

Figure 3.20 (a) Acrylic model produced from an impression of both orbital cavities viewed from above. Note that the medial walls are parallel whilst the lateral walls diverge at approximately 40-45° from the sagittal plane. (b) Oblique sagittal sections of both orbits as illustrated by red lines in (a). The normal sigmoid contour of the floor is demonstrated on the right. The typical loss of contour caused by a fracture involving the orbital floor is shown on the left. The stippled area represents the increase in orbital volume that results.

Figure 3.21 (a) Marked indentation of right cheek due to an isolated fracture of the zygomatic arch. (b)

Occipitomental radiograph demonstrating the depressed 'V-type' triple fracture of the arch.

Figure 3.22 Forced duction test under general anaesthesia in a young patient with an isolated ('blow-out') fracture of the right orbital floor. A traction suture has been passed round the insertion of each inferior rectus muscle. The lack of passive upward movement of the right eye due to tethering is clearly seen.

Figure 3.23 Diagrammatic representation of the three possible planes of nasal fracture. 1. Nasal tip only. 2. Nasal bones. 3. Naso-orbito-ethmoid complex. (Adapted from Stranc 1979. Reproduced with permission of L&W)

Figure 3.24 Fracture of nasal bones and inter-orbital region following frontal impact (plane No. 3 in Figure 3.23). Note broadening and flattening of nasal bridge with inferior displacement of right inner canthus.

Figure 3.25 'Rule of fifths' showing the assumed ideal proportions of the face on frontal view. This may be of use in assessing traumatic telecanthus and naso-orbito-ethmoid deformity once swelling has resolved.

Figure 3.26 Normal intercanthal and interpupillary measurements (Caucasian).

Figure 3.27 Testing for maxillary mobility by grasping the anterior alveolus, or placing fingers in the palatal vault, and 'rocking' the maxilla (a-c). Lack of simultaneous palpable mobility at the nasal bridge denotes a low level maxillary fracture (Le Fort I) whilst coexistent mobility at the infra-orbital rims or nasal bridge denotes a high level monobloc fracture (Le Fort II or III type).

Figure 3.28 Mid-line laceration of the palatal mucosa in a patient with a split Le Fort I type fracture. The traumatic diastema between the central incisor teeth is also obvious.

Figure 3.29 Intubated patient with multiple midface fractures showing the gross facial oedema and bilateral circumorbital ecchymosis typically seen soon after this type of injury.

Figure 3.30 Patient with Le Fort III type fracture following a lateral blow to the midface. There is separation of the fronto-zygomatic sutures, lengthening of the face and deviation of the naso-maxillary complex to the left. The ocular level on the right has fallen with the upper lid following it to produce a pseudoptosis known as 'hooding'.

Chapter 4: Imaging

Figure 4.1 Reformatted three-dimensional image generated from CT scans showing a Le Fort II type fracture with dental injuries. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 4.2 A correctly taken orthopantomogram gives an excellent image of the whole mandible from condyle to condyle, although the clarity of the anterior region may be affected by the overlying shadow of the cervical spine. Accurate assessment of the dental status requires additional intraoral radiographs.

Figure 4.3 An oblique lateral radiograph of the mandible may occasionally be helpful to image a suspected fracture of the mandible, although this is normally indicated only where an OPT is unavailable. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 4.4 Postero-anterior radiograph showing a fracture of the right angle and anterior region of the mandible. The overlying shadow of the cervical spine obscures accurate assessment of the anterior region. If this is still unclear on an OPT a rotated PA view and/or occlusal view may be indicated.

Figure 4.5 Coronal CT scans showing (a) overriding fracture of right condylar neck and (b) comminuted fracture of right condylar head. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 4.6 (a) Diagram to show the four search lines (Campbell's lines) that can be systematically followed as an aid in interpreting occipitomental radiographs. The fifth line was described later by Trapnell. (b) OM radiograph of patient with Le Fort II and III type fractures. The arrows denote fracture sites which lie on Campbell's lines.

Figure 4.7 Coronal CT scan of a complex midface fracture demonstrating the comminution which may not be immediately obvious on plain radiographs. Note the midline split of the palate.

Figure 4.8 The 'elephant's head' approach to the assessment of zygomatic fractures. Fracture lines are commonly seen at (1) the infraorbital rim, (2) the frontozygomatic suture region, (3) the lateral wall of the maxillary antrum (zygomatic buttress) and the zygomatic arch ('trunk'). (Reproduced with kind permission of Elsevier.)

Figure 4.9 Three-dimensional CT image of an impacted fracture of the right zygomatic complex. Note particularly the medial displacement at the frontozygomatic suture region. (Reproduced with

kind permission of Springer Science+Business Media.)

Figure 4.10 'Hanging drop' sign. The rounded opacity seen in the left maxillary antrum is due to herniation of orbital contents following an isolated fracture of the left orbital floor ('blow-out' fracture).

Figure 4.11 Coronal CT scan of a patient with clinical signs of tethering of the right inferior rectus following orbital injury. This subtle evidence of an isolated orbital floor fracture would not be seen on a plain radiograph. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 4.12 Coronal CT scan demonstrating the normal sigmoid outline of the orbital floor giving a so-called 'posteromedial bulge'. Orbital floor fractures frequently involve this area with loss of contour. Accurate identification of the defect and restoration of this shape is essential if secondary enophthalmos is to be minimized. (See also Figure 3.20.)

Chapter 5: Treatment of dentoalveolar injuries

Figure 5.1 Injuries to the dental hard tissues and pulp as classified in Table 5.1. (a) Crown infraction. (b) Enamel fracture. (c) Enamel + dentine fracture. (d) Enamel + dentine + pulp fracture. (e) Vertical crown-root fracture. (f) Oblique crown-root fracture. (g) Root fracture.

Figure 5.2 Injuries involving the periodontal tissues as classified in Table 5.1. (a) Concussion. (b) Subluxation. (c) Intrusion. (d) Extrusion. (e) Lateral luxation. (f) Avulsion.

Figure 5.3 Injuries of the alveolar bone as classified in Table 5.1. (a) Comminution of socket. (b) Fracture

of one socket wall. (c) Fracture of either both socket walls or alveolus. (d) Fracture of jaw involving socket.

Figure 5.4 Maxillary dentoalveolar injury. The luxated central incisors have been displaced posteriorly with their fractured supporting bone, causing associated vertical lacerations of the fixed gingivae. There is also a laceration on the inner surface of the upper lip due to the impact.

Figure 5.5 Subluxed lower incisors immobilized by a simple soft wire loop splint with interdental tie wires.

Figure 5.6 Thin vacuum-formed plastic splint being filled with cold-cure acrylic resin prior to cementation for stabilization of loose teeth.

Figure 5.7 (a) Dentoalveolar fracture in which a block of alveolar bone containing three lower incisors has been displaced posteriorly. (b) Reduction of the fractured segment and fixation with a heavy wire splint bonded to the displaced teeth and to sound teeth either side. Excellent oral hygiene needs to be maintained to promote uncomplicated healing of the contused and lacerated gingivae. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 5.8 Dentoalveolar fracture of maxillary alveolus and tuberosity as a result of attempted extraction of ankylosed teeth with bulbous roots. The fragment has been dissected free prior to repair of the resulting oro-antral communication.

Chapter 6: Treatment of fractures of the mandible

Figure 6.1 Typical example of different shapes and sizes of plates available for the fixation of fractures of the facial skeleton. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 6.2 Open reduction and internal fixation (ORIF) of a bilateral fracture of the mandible using an intraoral approach and titanium miniplates with monocortical screws. (a) Fracture of right angle fixed with a single plate adapted to lie along the upper border and external oblique ridge. (b) Left parasymphyseal fracture. In this area two plates are needed to achieve stable fixation. A temporary 'bridle wire' is visible in the upper part of the picture. This was placed around a number of firm teeth either side of the fracture in order to stabilize the reduction during application of the plates.

Figure 6.3 (a) Extra-oral approach used to treat a comminuted fracture of left mandible caused by a blow from a baseball bat. A rigid non-compression plate has been placed at the lower border. The head of a single lag screw inserted from the lower border across an oblique fracture can also be seen. (b) PA radiograph of reduced fracture with plate *in situ*.

Figure 6.4 Diagram to represent the theory of compression plating. During final tightening of the screw head in the eccentric pear-shaped hole (a) there is inward movement as it slides into the wider part and (b) thus pushes the bone fragments together.

Figure 6.5 Diagram illustrating the major problem with compression plating of the mandible. (a) A single plate near the lower border tends to open up the fracture at the alveolar level unless a 'tension band' is also placed; either (b) an arch bar or (c) a second smaller plate.

Figure 6.6 Diagram to illustrate the principle of lag screws. The thread only engages the deeper section

of bone (a) and thus compression is applied as the screw is tightened (b).

Figure 6.7 Immobilization of a fractured mandible in a young patient by bonding small brackets onto teeth and applying intermaxillary fixation with orthodontic elastics.

Figure 6.8 Diagram illustrating the steps involved in the application of an eyelet wire.

Figure 6.9 Incorrect (a) and correct (b) method of tightening intermaxillary tie wires. Breakage is common if the wire is held in the forceps at right angles to the loop as it is pulled and twisted tightly. It is better to position the twisted portion close to an eyelet as shown to minimize sharp angulation of the wire.

Figure 6.10 Elastic 'guiding' IMF applied using modified eyelet wires. A few extra twists to the eyelet portion increases the length allowing them to be bent as a hook for the elastic band.

Figure 6.11 (a) Mandibular fracture treated with IMF using Jelenko pattern arch bars ligated to upper and lower teeth. (b) Models demonstrating the use of simple half-round arch bars. Small notches cut into the bars will prevent lateral slippage of the IMF wires. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 6.12 IMF screw being inserted between the upper right canine and first premolar. Care is needed to avoid damage to the adjacent roots. If IMF screws are simply to be used for intraoperative stabilization they can sometimes be placed in the safer area beyond the apical region. However, difficulty of subsequent access and problems with ulceration

preclude this location for longer term use. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 6.13 One method of external fixation, used here for an infected fracture of the left mandible. Two screw pins have been inserted into each fragment and a length of endotracheal tube pushed over the protruding ends prior to the injection of self-curing acrylic resin. External fixation is rarely indicated and has been superseded in most situations by internal fixation techniques.

Figure 6.14 Lower border wiring. The reduced fracture has been stabilized by a direct interosseous wire and a separate 'Figure of eight' wire around the lower border. Although this technique has been superseded by the use of plates and has the added disadvantage of requiring an external approach it can still achieve excellent fixation. It may occasionally have a place in situations where plating equipment is not readily available.

Figure 6.15 Diagram illustrating the steps in a retromandibular approach to the mandibular condyle. (a) 1.5-2.0 cm vertical incision just behind the posterior border of the mandible. (b) The cutaneous incision is essentially parallel to the main lower division of the facial nerve and subsequent blunt dissection to reach the mandible avoids damage to this structure. (c) Wide subperiosteal dissection exposes the fracture site. (See text for details.)

Figure 6.16 (a) Direct fixation of right condylar neck fracture using a retromandibular approach. The patient is supine with the earlobe to the left of the picture. Note two plates in position to resist displacing forces. (b) A similar technique using a

slightly more anterior transparotid dissection. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 6.17 (a) Young patient who had sustained an intracapsular fracture of the left condyle some years previously. Note the smaller left hemi-mandible with deviation of the chin point to the left. This was associated with an increasing limitation in mouth opening. (b) Exposure of the left temporomandibular joint using a pre-auricular incision with a temporal extension. The condylar neck has been sectioned prior to removal of the deformed condylar head (arrowed). In this case the ankylosis was mainly fibrous.

Figure 6.18 Primary bone grafting to fracture of a thin edentulous mandible. (a) Displaced fracture of left body exposed. (b) Reduction and alignment with the help of a small miniplate. This is insufficient for effective stable fixation because the screws only engage lightly in thin and atrophic bone. (c) Segments of split rib graft applied to superior and inferior surface and held in place with tightly tied circum-mandibular polydioxanone resorbable sutures. (d) Postoperative OPT showing reduction and stabilization with the help of the rib graft (faintly visible at the lower border). Healing was uneventful.

Figure 6.19 In the past many fractures of the edentulous mandible were treated by closed reduction and fixation with the help of Gunnings type splints. These are no longer in common use but are illustrated here for historical interest. (a) Model demonstrating how splints are held in place with circum-mandibular and per-osseous wires. (b) Clinical application.

Chapter 7: Treatment of fractures of the midface and upper face

Figure 7.1 Axial CT scan showing extensive extravasated air in the soft tissues of the face (surgical emphysema) as a result of vigorous nose blowing following a fracture involving the paranasal sinuses.

Figure 7.2 Intraoral vestibular incision used to expose the whole anterolateral aspect of the maxilla prior to bone plating. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 7.3 CT scan showing a midline split of the palate repaired with an H-shaped miniplate to restore normal maxillary width. Access to this area can be through a pre-existing palatal laceration or a judiciously placed incision. A full palatal flap should be avoided if a vestibular incision is also required. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 7.4 Diagram illustrating various incisions used for surgical access to the orbito-zygomatic region. (a) Coronal or hemi-coronal. (b) Extended preauricular. (c) Lateral brow. (d) Supratarsal fold. (e) Lateral canthus. (f) Subciliary. (g) Midtarsal. (h) Transconjunctival. (i) Paranasal.

Figure 7.5 A straightforward approach to the frontozygomatic suture region is through an incision just above the lateral aspect of the eyebrow. Although commonly used it can leave a visible scar, particularly in young people.

Figure 7.6 Supratarsal incision used to expose a fracture in the region of the right fronto-zygomatic suture. The laxity of the soft tissues of the upper

eyelid region allows enough retraction to give wide exposure and the scar is essentially invisible. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 7.7 An extended preauricular incision showing the exposure achieved for repair of fractures involving the left zygomatic arch and inferior aspect of the lateral orbital rim. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 7.8 Diagram to illustrate various approaches to the inferior orbital rim using eyelid skin incisions. (a) Midtarsal incision with stepped post-orbicularis dissection. (b) Subciliary incision with pre-orbicularis dissection. (c) Subciliary incision with post-orbicularis dissection.

Figure 7.9 Transconjunctival approach to the inferior orbital rim. (a) Pre-septal dissection that minimizes herniation of orbital fat into the operative field. (b) Post-septal dissection that is considered technically easier.

Figure 7.10 Transconjunctival approach with lateral canthotomy for access to the inferior orbital rim and orbital floor. Note globe protection by insertion of a soft eye shell. (a) Insertion of scissors into the lateral fornix prior to division of skin and lateral canthus. (b) Conjunctiva being divided by scissors after undermining in the pre-septal plane along the marked incision line. (c) Elevation of the conjunctival mucosa with the help of traction sutures. (d) Incision of periosteum over the orbital rim and initial stages of elevation of the periorbita to expose the orbital floor. (e) Closure of lateral canthotomy skin incision with two fine resorbable sutures. (Courtesy of

Kenneth Sneddon, Queen Victoria Hospital, East Grinstead.)

Figure 7.11 Exposure of medial wall of right orbit for titanium mesh repair by means of a transcaruncular approach. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 7.27 (a) Local incision used for exposure of a nasofrontal fracture. (b) Careful assessment of the injury is needed prior to using a local approach because the fracture may be found to be more complex than expected. A coronal flap is a safer option in most NOE fractures.

Figure 7.12 Coronal scalp flap raised to expose and plate orbito-naso-frontal fractures. A separate pericranial flap has been raised for protection of any anticipated anterior cranial base repair. Note also the oblique incision through the deep temporal fascia (arrow) to allow dissection superficial to the muscle to avoid damage to the frontal branch of the facial nerve. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 7.13 (a) Skull model and (b) Clinical case to show the position of Walsham's forceps when reducing a nasal fracture. The external blade is usually padded for added skin protection. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 7.14 (a) Internal fixation of a comminuted nasal bone fracture made possible by an overlying laceration. (b) Restoration of nasal form and soft tissue repair.

Figure 7.15 Gillies temporal approach for reduction of a fractured zygoma. (a) Diagram to illustrate how a

zygomatic elevator (Bristow's) is inserted through an incision in the temporal fascia and passed superficial to the temporalis muscle to lie beneath the deep surface of the zygoma. (b) Clinical case using the same technique performed with a Rowe's elevator. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 7.16 Depressed fracture of the left zygoma being elevated with the aid of a malar hook. The point of skin penetration is at the intersection of a horizontal line extending from the alar rim and a vertical line dropped from the lateral canthus. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 7.17 Fixation of fractured zygoma with the aid of a buttress plate. This is a critical site to check the accuracy of reduction in order that any residual rotation or medial displacement are avoided. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 7.18 Sagittal (a) and coronal (b) CT scans of an isolated orbital floor fracture with 'mirror image' superimposition of the normal side (purple). The alteration in the shape of the orbital floor and the extent of the increase in volume is obvious as shown by the arrows. (Courtesy of Jeremy Collyer, Queen Victoria Hospital, East Grinstead.)

Figure 7.19 Typical dimensions relevant to surgical exploration of the adult orbital floor. Mean distance from anterior lacrimal crest to the optic foramen = 42 mm. Distance from infraorbital foramen to inferior orbital fissure = 24 mm. The depth of the orbit is often unappreciated by less experienced surgeons who may not explore far enough posteriorly to

identify the intact bony ledge vital for implant stabilization and restoration of the 'posteromedial bulge'.

Figure 7.20 Inferior marginal orbitomy for improved visualization and access in repair of a large defect of the orbital floor. (a) Bone cuts made with fine saw. (b) Segment of rim removed with infraorbital nerve freed. (c) Repair of the defect, in this case with a calvarial bone graft. (d) Rim segment replaced and plated in position.

Figure 7.21 Three-dimensional CT scan showing a titanium mesh plate in place for reconstruction of the right orbital floor and medial wall.

Figure 7.22 Rowe's disimpaction forceps in position for reduction of the tooth bearing portion of the upper jaw. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 7.23 CT scan of patient with a low level fracture of the maxilla (Le Fort I type). A midline split of the palate is clearly demonstrated. In this situation any reduction using Rowe's forceps needs to be carried with extreme care to avoid further disruption of the fracture and tearing of the overlying mucosa.

Figure 7.24 Operative view of internal fixation of the left side of a Le Fort I fracture. Comminution of the antral walls is a common feature of maxillary fractures and small fragments may become detached and lost. However, it is usually possible to plate the midface 'pillars' at the piriform aperture and base of the zygomatic buttress (arrowed).

Figure 7.25 The significance of accurate zygomatic reduction for midface width and projection. (a) Posterior displacement of the zygomatic complex

usually results in rounding of the arch (red) and loss of the normal straight profile (green). (b) Diagram showing how failure to correct this deformity in complex midface fractures will result in increased zygomatic width and postoperative flattening of the face.

Figure 7.26 The importance of medial canthal anatomy. (a) NOE fracture with flattening of the nasal bridge and infero-lateral displacement of the right medial canthus. (b) Restoration of canthal position after open reduction and fixation using a coronal flap for access.

Figure 7.28 Open reduction and fixation of NOE fracture with frontal bone involvement. Wide exposure allows full assessment of the injury with the best possibility of restoring the complex anatomy.

Figure 7.29 Diagram to illustrate the principle of transnasal canthopexy. (a) An awl or needle is passed through the nasal bones to pick up a braided wire suture attached to the canthal ligament. (b) The procedure may be combined with bone graft or titanium mesh reconstruction of the comminuted medial orbital wall. Even with these procedures post-traumatic canthal deformity is hard to prevent when the ligament has been completely detached.

Figure 7.30 CT scan showing fracture of posterior wall of left frontal sinus with an intact anterior wall.

Figure 7.31 (a) Depressed fracture of frontal bone causing obvious cosmetic deformity of forehead. (b) Coronal flap raised to expose fractures. (c) Reduction and fixation. In this case the repair was covered with acrylic bone cement to smooth out minor

irregularities and prevent plate palpation. (d) Lateral view showing post-operative appearance.

Figure 7.32 Diagram to show how a pericranial flap is used to reinforce the repair and separate the cranial cavity from the sinonasal cavity.

Chapter 8: Soft tissue injuries and fractures associated with tissue loss

Figure 8.1 Haematoma of the left ear resulting in elevation of the skin overlying the concha and antihelix in particular. Drainage should be considered to prevent later deformity and possible necrosis of the cartilage. (Reproduced with kind permission of Springer Science+Business Media.)

Figure 8.2 (a) 'Through and through' laceration of the chin. (b) What may appear on cursory examination to be a superficial injury actually extends through all layers to the oral cavity. Careful cleaning prior to repair is essential.

Figure 8.3 Contaminated shotgun wound to left face and jaw. (a) Following initial resuscitation, tracheostomy and packing of the wound. (b) Condition after several days of repeated lavage and wound dressing. A small area of tissue necrosis has become apparent. (c) Delayed primary closure and drainage. Despite initial appearances the final extent of tissue loss is minimal.

Figure 8.4 (a) Shelving laceration of upper lid and cheek. (b) Thorough exploration of the wound is important to retrieve any retained foreign bodies. (Courtesy of Malcolm Cameron, Addenbrooke's Hospital, Cambridge.)

Figure 8.5 Knife wound to left cheek. Possible injuries to the facial nerve and parotid duct need to be

identified in any laceration of this anatomical area. (Courtesy of Malcolm Cameron, Addenbrooke's Hospital, Cambridge.)

Figure 8.6 Full thickness laceration of upper lip involving the vermilion margin. (a) Wounds that involve key 'margins' (e.g. lip, nasal rim, ear or eyelid) require careful matching of anatomical landmarks. (b) In deep lip lacerations repair of the orbicularis muscle is also important. (Courtesy of Malcolm Cameron, Addenbrookes's Hospital, Cambridge.)

Figure 8.7 A crushed and contused wound of the scalp. Primary closure is not possible but a delay in treatment will allow any tissue of doubtful vitality to declare itself. With crush wounds healing by secondary intention or a skin graft may be indicated with revision surgery at a later date. (Perry (in press). Reproduced with kind permission of Springer Science + Business Media.)

Figure 8.8 (a) Shelving upper eyelid laceration. (b) Although quite deep with exposure of the orbital rim, repair was uncomplicated because the lid margin and the levator apparatus were not involved. Specialist referral is indicated for management of complex lid injuries. (Courtesy of Malcolm Cameron, Addenbrooke's Hospital, Cambridge.)

Figure 8.9 Missile injury to right face, neck and mandible. Gross comminution, wound contamination and a variable amount of tissue loss are features of this type of injury.

Figure 8.10 Shotgun injury resulting from an unsuccessful suicide attempt. Note the heavy contamination of soft tissues with fragmentation and

partial loss of both anterior mandible and maxilla. Even though shotgun cartridges are fired at a relatively low velocity this is sufficient at close range, combined with the heavy mass, to result in a 'high energy transfer' injury.

Figure 8.11 War injury resulting from a missile fragment. The patient maintained consciousness unaided and survived 4 days in transit from a remote area to a maxillofacial unit without any medical help apart from a battlefield dressing.

Chapter 9: Postoperative care

Figure 9.1 Patient with a shotgun wound to the right face and mandible resulting in an oro-cutaneous fistula. A soft ultra-thin flexible nasogastric tube has been passed to permit enteral feeding.

Figure 9.2 Patient with a direct penetrating injury of the oropharynx with a PEG in place to allow satisfactory feeding during the healing period.

Chapter 10: Complications

Figure 10.1 Malunited fractures due to late presentation. (a) Child with right parasymphyseal fracture. Union is rapid in this age group but refracture is usually straightforward. (b) Bilateral anterior fractures in an adult. In this situation, precise anatomical reduction by ORIF may be complicated by partial bone healing and remodelling. Arch bars and IMF may be needed instead or in addition.

Figure 10.2 (a) PA radiograph and (b) OPT of an infected fracture of the right mandibular angle that has been inadequately stabilized by lower border wiring. The retained lower molar has also contributed