The emergency control of traumatic maxillofacial haemorrhage
Tim Harris\textsuperscript{a}, Scott Rice\textsuperscript{b}, Beverley Watts\textsuperscript{c} and Gareth Davies\textsuperscript{a}

Maxillofacial trauma is common and may lead to haemorrhage that is associated with actual or impending airway compromise. This study briefly discusses the aetiology of midfacial haemorrhage and describes a simple effective technique of midface splintage for haemorrhage control, which may be applied in the prehospital and emergency environments. This technique has been used successfully by the London Helicopter Emergency Medical Service. European Journal of Emergency Medicine 17:230–233 © 2010 Wolters Kluwer Health | Lippincott Williams & Wilkins.

Epidemiology
Eighty percent of all multitrauma patients have injury to the head, face and/or neck [1]. The commonest cause of blunt facial trauma remains road traffic accidents, followed by assault, falls, suicide attempts and industrial accidents [2]. The American College of Surgeons reports a 10% incidence of maxillofacial injuries in most major trauma centres in the US [3] and in the authors’ centre it represents 24.4% of admissions. Facial trauma accounts for 6% of all gunshot wounds [4].

There is some debate surrounding the definition of life-threatening haemorrhage in the literature. It is reported as occurring secondary to blunt facial trauma in 0–24.4% of patients (Table 1). The large variance reflects the lack of a standardized definition.

Over a 5-year period to 2007 London Helicopter Emergency Medical Service, a dedicated trauma primary response physician-led service, managed 380 patients with an Abbreviated Injury Score of at least 1 for maxillofacial injuries. Of these, 37 (9.7%) required midfacial splintage prehospital for haemorrhage control. A retrospective review of these patients’ notes revealed no technical failures and no adverse events, either in prehospital or hospital. All doctors using the technique had received dedicated training and followed a defined system operating protocol, as described below. All were at least 5 years post registration, had a trauma interest and background in Emergency Medicine or Anaesthesia.

Facial anatomy and blood supply
The complex anatomy of the facial skeleton and associated soft tissues imparts unique characteristics to the definitive management of facial haemorrhage. In particular, the paths of many of the facial vessels are encased in bony canals making access difficult.

To the midface is composed of paired maxillary bones that are fused in the midline and articulate with the frontal bone superiomedially, the zygoma laterally and the palatal bone posteriorly. These bones are relatively thin but form focal areas of strength termed buttresses, which transmit forces applied to the facial skeleton. The midface contains a number of air-filled paranasal sinuses, which may serve as ‘crumple zones’ dissipating force and shielding the cranium. Together these components prevent disruption of the facial skeleton until a critical level is reached and then fractures occur.

Midfacial fractures were first classified by LeFort in 1901. His classification is widely known but many fractures are complex and do not conform to this system.

Profuse haemorrhage may arise as a result of severe trauma involving the midface and can be difficult to control. Commonly, it is a result of multiple comminuted fracture fragments that lacerate the periosteum, mucosa and one or more major vessels. The exact source of bleeding is difficult to define as the vascular supply of the midface involves branches of the external and internal carotid arteries. The most commonly disrupted vessels include the branches of the external carotid artery, usually the maxillary artery and particularly its intraosseous branches [12]. In addition, the ethmoidal vessels are particularly vulnerable as are branches of the internal carotid [13]. There are several anastomoses between the internal and external carotid systems and significant

Keywords: haemorrhage, maxillofacial injuries, trauma

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collateralization of the blood supply from the opposite side of the face [14]. This also contributes to difficulty in managing haemorrhage.

The maxillary artery is one of the two terminal branches of the external carotid. It is the major source of blood to the midface through the infraorbital, superior alveolar, sphenopalatine, greater and lesser palatine arteries. Many of the terminal branches of these arteries anastomose with other terminal branches, producing a diffuse vascular supply [15]. Branches of the internal carotid artery also supply blood to the midface. The ophthalmic artery supplies the nasoethmoidal complex through the anterior and posterior ethmoid arteries. This may be damaged in severe trauma resulting in profuse and persistent haemorrhage [15]. Midfacial venous drainage is principally through the facial veins and the pterygoid plexus through the maxillary and retromandibular veins. The latter has a variety of connections including the cavernous sinus. These drain to both internal and external jugular veins. Finally, traumatic facial bleeding originates from hard and soft tissue either individually or simultaneously, adding to the difficulty of targeting the exact source of bleeding [14]. Much of the blood system supplying the midface is relatively inaccessible, located within intraosseous canals, making proximal control of haemorrhage difficult.

### Midfacial haemorrhage control

Controlling blood loss is an important part of trauma care. Superficial vessels may be compressed or tied off and fractures reduced or splinted to minimize blood loss. Midfacial bleeding threatens to compromise patients both through airway obstruction and haemorrhagic shock [16]. The requirement for spinal precautions in many trauma patients reduces their ability to clear their airway and most consequently require intubation.

We use a technique of splinting the midface thus reducing and stabilizing midfacial fractures combined with nasal cavity tamponade to aid haemostasis. This is suitable for intubated patients. The technique is adapted from that described by Cannell et al. [2]. It aims to reduce the midfacial fractures and control haemorrhage by providing a line of fixation from the clavicles through the rigid cervical collar, upper and lower teeth through bite-blocks and inflatable nasal balloon catheters (Epistats, Medtronic, Xomed, Jacksonville, USA).

An epistat is an inflatable device with two balloons (Fig. 1). The balloon at the tip secures the device in the posterior nasal space and the second balloon (midway along the shaft) compresses the walls of the nasal space. For the balloons to provide tamponade in this area it is important that the hard palate is braced against the lower jaw with dental bridges (bite-blocks) (Fig. 1). Failure to do this will result in a mobile maxilla being pushed off the base of the skull and increasing the space for haemorrhage. Finally, the mandible must be braced against a fitted rigid cervical collar which itself is fixed by the clavicles and trapezius (Fig. 2).

<table>
<thead>
<tr>
<th>Author</th>
<th>Cases with life-threatening bleeding (%)</th>
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<tbody>
<tr>
<td>Sakamoto et al. [5]</td>
<td>24.4</td>
</tr>
<tr>
<td>Cannell et al. [2]</td>
<td>11.2</td>
</tr>
<tr>
<td>Holmes et al. [6]</td>
<td>20.0</td>
</tr>
<tr>
<td>Shimoyama et al. [7]</td>
<td>0.96 (9.61% of all patients with LeFort fractures)</td>
</tr>
<tr>
<td>Frable et al. [8]</td>
<td>9.4</td>
</tr>
<tr>
<td>Thaller and Beal [9]</td>
<td>1.25</td>
</tr>
<tr>
<td>Bynoe et al. [10]</td>
<td>1.2</td>
</tr>
<tr>
<td>Lucie et al. [11]</td>
<td>0</td>
</tr>
</tbody>
</table>

**Table 1** Percentage of life-threatening bleeding following facial trauma

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![Fig. 1](image_url) Epistat and dental bite blocks.
Equipment

(1) Secured endotracheal tube or surgical airway.
(2) Rigid cervical collar.
(3) Two epistats.
(4) Two appropriately sized dental bridges (bite-blocks). (Trimmed Guedel airways provide an acceptable alternative).
(5) Two 20 ml syringes and saline.

Methods

(1) Patients with torrential facial haemorrhage require their airway secured with a cuffed endotracheal tube and definitive airway management is the first step in stabilization.
(2) A rigid cervical collar is applied post intubation.
(3) The lubricated epistats are inserted along the floor of the nose into each nostril (similar to a naso-pharyngeal airway) but are not inflated at this stage, care must be taken to direct these posteriorly and not allow the tips to angle cranially as this may result in intracranial placement. The epistats may require the aid of Spencer Wells forceps for insertion. The dental bridges (bite-blocks) are inserted into either side of the endotracheal tube, between the upper and lower molars with the point of the wedge facing towards the back of the mouth.
(4) Both epistat balloons in the posterior nasal space (white valve) are inflated slowly with approximately 10 ml of saline (enough to prevent removal of the epistat with light traction) until light resistance is felt. The epistat may migrate either anteriorly or posteriorly at this point.
(5) Both epistat balloons in the nasal space (green valve) are now slowly inflated with 20–30 ml of saline until haemorrhage is controlled. Inflating the balloons simultaneously allows for an even pressure distribution and similar volume of saline to be entered into each.

Complications of the technique

Control of haemorrhage is essential to the immediate management of midfacial trauma. However, there are reports in the literature of morbidity and mortality as a result of poor technique in the application of epistats [6,17]. These include (wrongly) inflating the balloons before the placement of the collar and dental bridges, which causes fracture separation rather than tamponade; midpalatal distraction; migration of the balloons into or out of the nasal cavity and intracranial placement of the epistat resulting in death [6]. Indeed the authors have witnessed one case of intracranial placement when this technique was used by a junior doctor with no specific training and very limited trauma experience.

Tips for safe practice

To ensure success with this technique it is important to ensure the collar through the dental bite blocks secures the plane of fixation to prevent fracture separation [5]. The dental bite blocks help to maintain reduction, a technique comparable to limiting haemorrhage in the reduction of an ‘open-book’ pelvic fracture [17]. If distraction occurs, the balloons are deflated, repositioned and slowly reinflated until some movement is felt. The volume of both the balloons may require sequential adjustment. Where there is evidence of midpalatal splitting, a transpalatal circumdental wire should be applied before the inflation of the epistat [6]. The maxilla may have been displaced posteriorly during impact and may require disimpaction and forward traction before placement of the bite blocks.

The commonest problem in our practice is that of migration of the epistats during balloon inflation. The balloons should be inflated slowly and simultaneously until some resistance is felt. Gentle traction may be applied anteriorly and the volume of water adjusted to hold them snugly into the posterior nasal space. Maintaining traction may be required to prevent inferior-posterior migration during inflation of the anterior balloons. A pair of forceps may be required to be clamped over the epistat at the nares to prevent inward migration.

Summary

We have highlighted the use of a simple technique for the splintage and haemorrhage control of midfacial fractures. While easy to apply there are risks of malplacement which may cause significant harm. We have used this technique in our service for over 10 years with good results and no malplacement or complications.
References


