CASE REPORT

High-velocity facial gunshot wounds: multidisciplinary care from prehospital to discharge

J D Sinnott,¹ G Morris,² P J Medland,¹ K Porter³

¹East Sussex Healthcare Trust, Eastbourne, UK

²St Mary's Hospital, London, UK

³University Hospital Birmingham, Birmingham, UK

Correspondence to

Dr PJ Medland,
p.medland@nhs.net

Accepted 9 January 2016

SUMMARY

A case is presented in which a high velocity rifle (shotgun) was fired into the inferior part of a patient's face in an attempted suicide causing widespread trauma to the inferior and left side of the patient's face. He presented to his general practitioner where an ambulance was called. The patient is followed from prehospital care (air ambulance) to resuscitation in accident and emergency and through the first stages of reconstructive surgery. The article focuses on the multidisciplinary approach to the patient's prehospital care and initial resuscitation at a major trauma centre. CT reconstruction images of the patient's skull allow visualisation of the extent of bone damage at presentation. Medical photography allows visualisation of the extent of the initial damage and shows how reconstructive surgery was undertaken early and in progressive stages. A literature review was performed allowing discussion of the current evidence and best practice in the management of facial gunshot wounds.

BACKGROUND

Facial gunshot injuries are rare in the UK, which dilutes expertise and makes their management more challenging. In 2011, there were 43 successful suicide attempts in the UK, using long-barrelled guns.¹ Those with access to these sorts of weapons in the UK tend to be game-keepers and farmers, although this is not exclusively the case. There also seems to be a bias towards men in this type of injury.² Although this method of attempted suicide is often fatal, the mortality is not as high as one might expect. This is due to the difficulty in aiming a long rifle with an arm stretched to reach the trigger mechanism, and the patient sometimes needing to tilt their head. It has been shown that the mandible is a commonly fractured bone in these cases.³ Where death is not instant, the chance of mortality is drastically decreased provided that the airway is kept patent and haemorrhage controlled.²

Firearms can be split into handguns, rifles and shotguns. Handguns typically have a velocity of 210–450 m/s. Rifles have a velocity of 600 m/s and shotguns of 360 m/s. Shotguns, however, cause a massive amount of damage at a short distance due to the nature of the 'shot'.⁴ The focus of the article is mainly on close range gunshot wounds (GSWs) from a shotgun or high velocity rifle.

Following resuscitation and transfer to a trauma centre, the next problem to be solved is the massive facial structural damage. The extent of damage is dependent on numerous factors: magnitude of

energy transferred, bullet distance, type of device and structures met. High-energy gunshots fired at close range cause catastrophic damage due to vital structures lying within a compact area around the face and neck. Damage to tissue and surrounding structures is both from direct force from the shot or bullet, secondary projectiles such as bone or teeth and dissipated energy transfer. Treatment becomes more complex when fragments of the blast become lodged within the vicinity of vital structures.

Initial care of the patient conforms to the basics of trauma resuscitation pro forma (ATLS) developed by the American College of Surgeons.

Timing and method of surgical treatment remains an issue of debate in facial gunshot wounds. Owing to the extensive mechanics of the injury, some believe primary reconstruction may not be ideal, and opt for conservative methods followed by secondary reconstruction. Others share the view that early operative management of injured soft tissues and bone fragments are closely

Figure 1 The extent of tissue damage to the left side of the patient's face can be seen. Note that the lateral aspect of the patient's tongue is completely exposed and the left side of the mandible is absent.

CrossMark

To cite: Sinnott JD, Morris G, Medland PJ, et al. *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2015-213268

related to improved outcomes. In this case, early closure was performed and mandible fixation performed.

CASE PRESENTATION

A 60-year-old game-keeper with a medical history of mild depression presented to his local primary care centre with a high-velocity GSW to his face, following an attempted suicide with a shotgun. The practice immediately called for an ambulance and the air ambulance and ground team were mobilised. The first responder was at the scene 7 min after the call and air ambulance arrived 33 min after the call. At the scene, the patient was maintaining his own airway. He maintained a Glasgow Coma Scale (GCS) of 15/15 and required no analgesia. He was brought via air ambulance to the Queen Elizabeth Hospital, Birmingham, which is a major trauma centre. The patient arrived 1 h and 18 min after the first call. He was sat upright with his head extended for comfortable breathing. Airway intervention was not necessary at the scene nor in the accident and emergency (A&E) resuscitation department. Figures 1 and 2 show the patient maintaining his airway in the A&E resuscitation department. They also demonstrate the extensive tissue damage to the left hand side of the patient's face.

At the major trauma centre, the patient was received by a trauma team with the addition of ear-nose-throat (ENT) and maxillofacial surgery doctors. A primary survey was performed and the patient then taken to theatre 1 h and 31 min after the

first call to the ambulance. In theatre, a surgical tracheostomy was performed. The mandible was fixed, and primary closure was performed. The subsequent CT scan is shown in figure 3.

TREATMENT

On-scene management, resuscitation and stabilisation were performed, as described above. There was an open wound with discontinuity of the mandible on the left hand side, which could potentially threaten the patient's airway. The patient was taken straight to theatre and a reconstruction plate used to stabilise the mandible allowing correction of the deformity and for soft tissue drape.

Following this, there were multiple trips to theatre for reconstruction with the intent of improving function and form. Day two postinjury, left midface wound debridement, intraoral wound washing, left eyelid foreign body removal and facial dressing were performed. At this point, anterior mandibular mucosa was blanching well. On day 7, the left side of the patient's mandible was reconstructed with a plate. There was sufficient soft tissue over the plate and it was possible to achieve full mandible coverage using the patient's own skin, as shown in figure 4. A skin graft was used to complete closure of the wound. Three weeks later, the patient was taken back to theatre for a dressing change and examination under anaesthesia. There was healthy granulation and satisfactory take of skin graft. A small dehiscence in the left neck, which did not communicate with the oral cavity, was packed with bismuth iodoform paraffin paste (BIPP) dressing. A small left cheek dehiscence with fistula oral cavity was freshened and closed with 3-0 vicryl. Intraoral examination showed healthy gingivae over the anterior mandible and no evidence of a neck fistula. Feeding continued through the naso-gastric route. One month and 4 days postinjury, the patient was discharged home. The appearance of the patient before nasal reconstruction and construction of a neo-mandible is shown in figure 5.

Figure 2 The patient maintains his airway during initial resuscitation. Note the full thickness skin flap including part of the patient's mandible protruding from under the lower half of the mask. The integrity of this tissue allowed this part of the mandible to be fixed back into position using a small plate, and the skin was salvaged to allow a good amount of primary wound closure.

Figure 3 Three-dimensional CT reconstruction image showing tracheostomy, bilateral nasopharyngeal and nasogastric tubes in satisfactory position. The small plate used to fix a mandibular fragment in place can be seen (the same mandibular fragment is shown displaced in figure 2). The image also demonstrates the large defect remaining on the left side of the patient's mandible. There are multiple other bony fractures. Shotgun fragments can also be seen within the soft tissue.

Figure 4 First of a series of images showing how the appearance of the injury improved throughout the management. A great deal of closure was achieved without the use of grafts. Soft tissue and skin cover of the mandible was achieved without the use of a graft. Nasogastric and bilateral nasopharyngeal tubes in position.

Figure 5 The patient's appearance when he was brought to outpatients before nasal reconstruction and construction of a left neomandible. The right alar is largely intact whereas the left alar is scarred and retracted. There is extensive cheek scarring and, apart from the skin graft, the left lateral nasal border and dorsum are absent.

Three months after discharge, the patient returned to theatre for the first stage in a total reconstruction of his nose, using a paramedian forehead flap. As can be seen in [figure 5](#), the right alar was intact, whereas the left alar was only partially intact with retraction and scarring. The nasal dorsum and lateral wall were absent with significant cheek scarring. Nasal subunits were marked and scar tissue was used as internal lining. The left cheek was undermined and medialised. Conchal cartilage grafts were used as dorsal and columellar struts and lower batton grafts bilaterally. The nasal bones were exposed, the deficient area was filled with cartilage and the irregular margins were rasped. A paramedian forehead flap was taken, thinned distally and sutured into place. The forehead was undermined and the glabella scored. Additionally, a dog-ear was excised within the hairline. On the same trip to theatre, an iliac crest bone harvest and construction of a neomandible were also performed. Grafts were cut with a NaCl-cooled saw and osteotome, and cancellous bone was harvested and bone wax applied. A left neck incision was made with dissection down to the reconstruction plate. The graft was trimmed with burr and fixed onto the reconstruction plate completing the neomandible.

In the following 3 months, the patient returned to theatre on two separate occasions for the final stages of nasal reconstruction. These involved pedicle division with tinning of the flaps followed by tissue undermining and debridement to create the alar crease.

Below is a summary timeline of the reconstruction.

19/11/13 Examination under anaesthesia, closure of facial wound, internal fixation of mandible, bilateral nasopharyngeal airway, temporary tracheostomy
21/11/13 Left midface wound debridement, left eyelid foreign body removal, facial dressing replaced
26/11/13 Left side of jaw reconstructed with plate
16/12/13 Examination under anaesthesia, head and neck wound redressed
23/12/13 Discharged home
19/03/14 First stage reconstruction of nose. Paramedian forehead flap. Iliac crest bone graft and construction of left neomandible
09/05/14 Second stage reconstruction of nose
21/07/14 Third stage reconstruction of nose

A multidisciplinary team was involved throughout the course of the patient's treatment, although different specialties were added and subtracted as the treatment progressed. Teams involved included prehospital medical team/air ambulance, A&E, anaesthetics, trauma, multiple trauma service, psychiatry, maxillofacial surgery, plastic surgery, ophthalmology and ENT.

OUTCOME AND FOLLOW-UP

As can be seen from the series of images in [figures 4–6](#), the appearance of the injury greatly improved throughout the management. At the time the photo shown in [figure 5](#) was taken, the patient was being booked for an outpatient septorhinoplasty and his psychological state was also greatly improved.

Figure 6 The patient following satisfactory take of skin graft on the left cheek/left lateral nasal wall. Tracheostomy and nasogastric remain in place.

He received psychiatric assessment on the intensive therapy unit (ITU) soon after his first trip to theatre, and was assessed as being low risk for a repeat attempt. The assessment revealed that he had recently undergone a marital separation but regretted the suicide attempt. He continued to be assessed during his stay in hospital before being discharged, when he moved back into his family home with his wife. Although the patient was assessed as low risk, the guns were removed from the property.

DISCUSSION

It is speculated that difficulty aiming a rifle in order to commit suicide together with an altered mental state results in a lower than expected mortality from high-velocity gunshot wounds.² The difficulty in aiming a rifle at oneself is perceived to be due to the long distance between the trigger and muzzle, meaning a person may have to stretch and tilt their head to reach the trigger. In 1973, Nordenram and Freiberg³ showed that it is mainly men who choose this method of suicide. In a case series of 15 patients, all were male, and the authors also found that, due to the difficulty in aiming a rifle, the lower half of the face—the mandible in particular—was most commonly involved.

Much of the literature on facial gunshot wounds has examined low-velocity wounds and facial handgun wounds. It is important to distinguish the type of facial GSW when looking at guidelines/recommendations for early management. In a large series in Southern California, Demetriades *et al* showed that many patients with facial gunshot wounds could be managed conservatively.⁵ However, their series included low velocity

firearms and people who were shot from a distance. However, with the blast from a shotgun at extremely close range, as in this case, there is extensive damage and conservative management is not an option.

In terms of immediate management and resuscitation, ATLS guidelines are for airway management first. However, with recent evidence coming from major trauma centres and military experience, a new algorithm of C-ABC is being taught in a number of institutions, with the initial 'C' representing catastrophic bleeding. In this case there was no torrential bleeding at initial presentation and therefore the airway was secured.

Despite the extensive damage to the lower half of the patient's face, the airway was initially stable, allowing transfer to hospital with only a mask supplying supplementary oxygen. However, there are multiple options for securing an airway depending on case, situation and expertise.

Orotracheal intubation is the method of choice when a definitive airway is required. However, this may be difficult due to the distortion of anatomy. The use of fiberoptic nasal intubation has been reported—despite traditional concerns about base of skull injury.⁵ Where oro-tracheal intubation is not possible, emergency cricothyroidotomy, tracheostomy or blind nasal intubation may be required. However, the well documented and known risks of nasal tube insertion with a possible skull base fracture need to be considered and mechanism of airway stabilisation chosen based on the clinical circumstance. Even in patients who seem to be maintaining their airway, a possible emergency could arise suddenly due to oedema, bleeding or aspiration. Chen *et al*⁶ recommend early airway stabilisation especially where there is a mandible fracture.

One common reason for tracheostomy is difficulty getting an endotracheal airway, which may be due to bleeding or distortion of anatomy. Another reason could be concern about imminent swelling.⁷ A tracheostomy is also likely to be helpful, as it was in the case presented, if extensive oral reconstructive surgery is required at a later date. Immediate, emergency tracheostomy or cricothyroidotomy may be necessary but, where possible, tracheostomy should be performed in the controlled environment of theatre.

In a study of 55 patients, Glapa *et al*² showed half the patients were intubated at the scene or in A&E resuscitation; 4% required cricothyroidotomy. Of the patients who were intubated, one-third had an emergency tracheostomy immediately after resuscitation and a tracheostomy was performed on almost all the others at a later date. Of the 23 patients initially managed with a face mask, six underwent tracheostomy later, to facilitate surgical management. Both cricothyroidotomies were later converted to tracheostomies.²

However, bleeding from a facial gunshot wound may be obvious; it sometimes presents with a large or an expanding haematoma. In this case, bleeding was not a major issue. Where active bleeding is present, there are a number of forms of management. Bleeding from the midface can usually be controlled with nasal and oropharyngeal packing. To control haemorrhage from the oral cavity, if an endotracheal tube or tracheostomy/cricothyroidotomy is in place, then oral cavity packing may be required with abdominal swabs. Arteriography and embolisation of the carotid artery branches have repeatedly been shown to be effective in dealing with bleeding from branches of the external carotid.^{4 8} As a last resort, ligation of the external carotid can be performed, although this is rarely necessary.

Facial GSWs represent a complex set of challenges for the trauma team and the full extent of soft tissue damage immediately after injury is typically not wholly apparent. The primary

objective in the management of any gunshot trauma is preservation of life in accordance with the Advanced Trauma Life Support (ATLS) developed by the American College of Surgeons. The recognition of life-threatening injuries is fundamental, with supportive therapy until definitive management with an MDT approach has been established. However, evident and striking facial wounds should not divert or deter an early assessment of the entire patient and a thorough primary survey.

No two facial gunshot wounds are the same—each presents unique management challenges. A great deal of initial deformity is expected in high-velocity facial GSWs, and there is a great deal of complex functional anatomy in a close space including the cranial nerves, equipment for speech, salivary glands, orbits and complex facial bone/sinus structures. It is also important to understand the cosmetic/social importance of achieving a satisfactory aesthetic result.

There is a high incidence of facial nerve injury in these patients. Where possible, the facial nerve should be repaired within 72 h.⁴ However, due to other injuries, this is sometimes impossible. The facial nerve injury and function should be documented at presentation to hospital and attempts at grafting may be attempted later. It has been shown that results of cable graft repair in some instances are comparable regardless of time of repair.⁹

The other cranial nerves (CNs) and the orbits should also be assessed and documented early. Where possible, these assessments should be carried out before the patient is taken to theatre. CNs V and VII in particular.²

Central nervous system and C-spine injury are obviously a major concern and should be ruled out early. In this case, GCS was 15 throughout initial management and resuscitation, and there were no CNS injuries shown on CT. However, CNS injuries are not uncommon in facial GSWs. GCS should be monitored regularly together with a thorough neurological examination plus a CT to rule out occult injury where there is suspicion.

Parotid duct damage is not uncommon in this type of injury. Assessment of the duct should be carried out early, although any complex reconstruction is better performed on a semielective or elective basis. Sialocele and salivary fistula are complications that should be avoided. Injury to the nasolacrimal duct may also be present.

There is a high incidence of ocular complications in facial gunshot wounds. This highlights the importance of ophthalmology input.^{7 10} Documentation of ocular injury at the time of the trauma is important to avoid the injury being subsequently noted and attributed to an iatrogenic cause. At the time of injury, any decrease in acuity or colour perception should be noted, as traumatic optic neuropathy can be subtle initially but deteriorate over time as swelling progresses. Other indications of orbital injury may include hyphaema, scleral lacerations and deformity of the globe. Extraocular movements should also be carefully assessed. Where there is evidence of orbital swelling/injury, non-urgent surgical procedures may need to be avoided in order to minimise further swelling. The main symptom being epiphora.

In their recent multicentre cohort analysis, Shackford *et al*¹¹ highlighted the importance of early multidisciplinary input to achieve the best outcomes. Kushimo and Onajin-Obembe¹² also highlight the importance of multidisciplinary team working and early operative management.

The gold standard imaging within the trauma setting and, in particular, GSWs, is CT scanning, to determine the nature of the complex head and neck injury. Anatomy of bony injury is

particularly well defined using CT and the modality also helps to detect the presence of ocular or neurovascular trauma. Where three-dimensional reconstruction is available, it can greatly help with visualisation and evaluation of fractures. It is also recommended that one should consider including the cervical spine in imaging, and there should also be a low threshold for performing CT angiography.

Motamedi¹³ advocates early surgical repair of bony and soft tissue, with particular emphasis on the mandible. This is proposed to allow a smooth course of tissue healing, preventing disruptions at a later date.¹³ Steps should be taken to minimise wound tension and later contractures. Hollier *et al*⁷ also support early operative management for best surgical outcomes.

Maxillofacial fractures are extremely common in this type of injury. Often, they are not life-threatening and can be managed later in an unstable patient, whereas others risk airway compromise and bleeding. Such fractures may require communication between teams such as maxillofacial surgery, ENT, ophthalmology and neurosurgery.

There is still controversy over delayed or immediate reduction. There have previously been articles recommending a non-operative approach in the first instance. However, more recently, opinion seems to have moved towards early operative management with repair of bony and soft structures.⁷ The feeling is that early operative management, especially in the presence of fractures, gives the best outcome. Here, it is important to distinguish the difference between high and low-velocity GSWs. Conservative management could be an option in small wounds from low-velocity weapons. In a case such as this, with a high velocity weapon in close range and extensive damage, early operative management to fix the mandible, debride the wound and perform primary closure, was the best option.

Open reductions of facial fractures in GSWs can be performed effectively using similar techniques to those used in routine maxillofacial procedures, provided that soft tissue coverage can be achieved. In this case, the procedure was performed at the same time as debridement and primary closure. Any loose or nonviable teeth in the line of the fracture should be removed as they could cause a focus of infection. However, this should be performed only after fixation.¹⁰ Removal of the teeth before fixation also removes the spacer effect of those teeth and can lead to poor reduction of the fracture.

Conclusive treatment commences after stabilisation, with facial GSW management normally divided into three stages. First, debridement, fracture stabilisation and primary closure. Second, reconstruction of hard tissue (provided soft tissue coverage is adequate) and, finally, rehabilitation and secondary correction of residual deformities and functional ability.

The soft tissue of the lower portion of the face has often been extensively damaged due to the shock waves and ballistic qualities of weapons. Initial wound coverage remains an area of debate. Some advocate temporary coverage with definitive closure later. However, recent trends show success with more immediate definitive treatment within 24–48 h.¹⁴ Owing to the good blood supply to the face, tissues are usually closed in a primary fashion. Careful debridement of devitalised tissue should be performed and wound edges everted. Wound dehiscence is a known early complication of facial GSWs, with incidence of approximately 5%.⁷ Facial GSWs are considered contaminated especially where there is communication with the oral cavity, sinuses or nasal cavity. The optimum length of treatment is unclear but should be at least 24–48 h postoperatively.

There is known to be a high recurrence rate in such violent methods of attempted suicide. A Swedish paper looked at a case

series of 15 patients and found that 4 went on to commit suicide at a later date. This highlights the importance of psychiatry as part of the multidisciplinary management.³

Learning points

- ▶ Proper airway management is crucial.
- ▶ Once the airway is secured, resuscitation should follow a normal trauma protocol.
- ▶ C-spine and brain injury should be assessed and ruled out early.
- ▶ Early operative management remains controversial, but in high velocity wounds with extensive damage, early management seems most appropriate.
- ▶ Trauma team coordination and communication need to be effective from prehospital care to theatre.
- ▶ There are many late complications and associated injuries that should be assessed at first presentation and managed appropriately. These may not seem life-threatening at the time of injury, but can cause significant morbidity later. They include cranial nerve damage, and ocular, salivary gland and facial nerve injury.
- ▶ A multidisciplinary approach and coordination between overlapping areas of surgery are required for the best patient outcomes.
- ▶ Psychiatric input is vital and long term importance should not be overlooked.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 Deaths: External Causes of Morbidity and Mortality—Underlying Cause, Sex and Age-group, 2011—GunPolicy.org [Internet]. (cited 29 Sep 2015). <http://www.gunpolicy.org/firearms/citation/quotes/6728>
- 2 Glapa M, Kourie JF, Doll D, et al. Early management of gunshot injuries to the face in civilian practice. *World J Surg* 2007;31:2104–10.
- 3 Nordenram Å, Freiberg N. Suicidal gunshot wounds resulting in severe maxillofacial injury. *Int J Oral Surg* 1974;3:29–33.
- 4 McLean JN, Moore CE, Yellin SA. Gunshot wounds to the face—acute management. *Facial Plast Surg FPS* 2005;21:191–8.
- 5 Moore EE, Feliciano DV, Mattox KL. *Trauma*. McGraw-hill, 2003.
- 6 Chen AY, Stewart MG, Raup G. Penetrating injuries of the face. *Otolaryngol Head Neck Surg* 1996;115:464–70.
- 7 Hollier L, Grantcharova EP, Kattash M. Facial gunshot wounds: a 4-year experience. *J Oral Maxillofac Surg* 2001;59:277–82.
- 8 Demetriades D, Chahwan S, Gomez H, et al. Initial evaluation and management of gunshot wounds to the face. *J Trauma* 1998;45:39–41.
- 9 Chang CY, Cass SP. Management of facial nerve injury due to temporal bone trauma. *Am J Otol* 1999;20:96–114.
- 10 Kihitir T, Ivatury RR, Simon RJ, et al. Early management of civilian gunshot wounds to the face. *J Trauma* 1993;35:569–75; discussion 575–7.
- 11 Shackford SR, Kahl JE, Calvo RY, et al. Gunshot wounds and blast injuries to the face are associated with significant morbidity and mortality: results of an 11-year multi-institutional study of 720 patients. *J Trauma Acute Care Surg* 2014;76:347–52.
- 12 Kushimo OT, Onajin-Obembe BOI. Gunshot facial injury: a multidisciplinary management. *South Afr J Anaesth Analg* 2008;13:13–15.
- 13 Motamedi MH. Management of firearm injuries to the facial skeleton: outcomes from early primary intervention. *J Emerg Trauma Shock* 2011;4:212–16.
- 14 Kaufman Y, Cole P, Hollier LH. Facial gunshot wounds: trends in management. *Craniofacial Trauma Reconstr* 2009;2:85–90.

Copyright 2016 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <http://group.bmj.com/group/rights-licensing/permissions>.
BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- ▶ Submit as many cases as you like
- ▶ Enjoy fast sympathetic peer review and rapid publication of accepted articles
- ▶ Access all the published articles
- ▶ Re-use any of the published material for personal use and teaching without further permission

For information on Institutional Fellowships contact consortiasales@bmjgroup.com

Visit casereports.bmj.com for more articles like this and to become a Fellow