

Diagnosis and immediate care of open fractures

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DEFINITION AND PRINCIPLES

Any fracture in which the fracture haematoma communicates with the outside world is an 'open fracture'. All open fractures must be treated as a surgical emergency with a clear treatment protocol using a team approach. The accident and emergency (A&E) department forms the initial part of that team. The guiding principles for the team are to prevent infection, unite the fracture and restore function – it is in the first of these that A&E plays an important role. The A&E team will also need an understanding of subsequent management to ensure good initial treatment and communication with the orthopaedic surgeons, patient and relatives.

Surgical debridement of the wound should be performed in the operating theatre within 6 hours of injury. Time saved by good management in the A&E department is therefore critical. This timeframe is set by the rapid increase in bacterial counts within the wound. Two-thirds of open fractures are contaminated with bacteria (*Table 1*). A bacterial count of more than 100 000/g is required to cause infection. The bacterial count rises from 100/g at 2 hours to more than 100 000/g at around 5 hours.

TABLE 1.
Bacterial contamination in open fractures

	n	positive cultures (%)
Gustilo and Anderson (1976)	158	110 (70)
Patzakis and Ivler (1977)	581	356 (62)
Kreder and Armstrong (1994)	86	53 (63)

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ABCS

Open fractures are associated with major trauma in 30% of cases (Gustilo et al, 1990) – any patient with an open fracture should be managed according to advanced trauma life support principles in the first instance. A full primary survey with simultaneous resuscitation and treatment of any possible life-threatening injuries forms the first step in the management of an open fracture. *Table 2* gives the mechanisms of injury.

Only when the patient is stable should the fracture be addressed. A thorough secondary survey will detect less obvious injuries in addition to the open fracture. X-rays can be taken at this stage.

PRIMARY SOFT TISSUE MANAGEMENT

The aim is to achieve an environment around the fracture that is free of bacteria and that prevents further contamination. For all open fractures the following steps should be followed:

- Control haemorrhage using direct pressure
- Remove gross contamination
- Photograph wound
- Apply a sterile dressing
- Check the neurovascular status of the injured limb
- Realign and splint the fracture (with adequate analgesia)
- Recheck the neurovascular status
- Administer intravenous antibiotics and tetanus prophylaxis.

The wound should not be disturbed again until the patient is taken to the operating theatre for further management. This reduces contamination.

CLASSIFICATION

An understanding of the classification of open fractures gives an indication of the severity of injury and the risk of infection and loss of limb (*Table 3*). In A&E it provides a guide to the choice of antibiotic prophylaxis. Type I injuries should not be treated with any less urgency than type III injuries.

ANTIBIOTICS

One of the three principle aims is to prevent infection. The basic steps outlined above cannot be missed but antibiotics must be given. Approximately two-thirds of open fractures are contaminated at the time of injury. The choice of antibiotic will be dictated by local policy and advice from the microbiologists, but the following principles may be helpful.

TABLE 2.
Aetiology of open fractures

Cause	Frequency
Motorcycle	28%
Car	24%
Fall	13%
Pedestrian/car	12%
Crush	8%
Other	15%

From Dellinger et al (1988)

TABLE 3.
Classification of open fractures

Type I	Simple fracture, wound <1 cm	
Type II	Simple fracture, wound >1 cm	
Type III	Complex fracture, even with apparently small puncture wound	Type IIIA Adequate soft tissue cover
		Type IIIB Soft tissue loss with exposed bone. Soft tissue reconstruction required
		Type IIIC Arterial injury requiring repair

From Gustilo and Anderson (1976); Gustilo et al (1984)



Figure 1. a. Segmental open tibial fracture following motorcycle accident. b. Wound following primary treatment and debridement – grade IIIB open fracture. c. After fracture stabilization the wound was covered by the plastic surgeons with a microvascular free muscle flap and split skin graft. d. Fracture healing progressing.

- Always give a cephalosporin (cephradine 1g is used in the authors' centre)
- Add gentamicin for type IIIB and IIIC injuries
- Add penicillin for farmyard injuries to cover *Clostridium perfringens*.

TETANUS PROPHYLAXIS

The disease is caused by tetanospasmin, an exotoxin of the anaerobic gram-positive rod, *Clostridium tetani*. This organism is widespread and grows well in wounds containing necrotic tissue. Prophylaxis should follow the Department of Health guidelines (1996) summarized in Table 4.

If the patient was not previously immunized and a course is commenced arrangements should be made for the GP to complete this.

NEUROVASCULAR COMPLICATIONS

These must be actively excluded and the presence of pulses, motor and sensory

function clearly recorded in the notes. If distal perfusion is in doubt the opinion of an orthopaedic and vascular surgeon should be sought urgently. Any arterial injury requiring repair (type IIIC) should be performed with a coordinated approach between the orthopaedic and vascular or plastic surgeons.

Nerve injuries generally do not require immediate repair.

COMPARTMENT SYNDROME

Compartment syndrome is tissue hypoxia caused by an increase in pressure in a closed osseo-fascial space. This must be actively excluded. It is a mistake to assume an open injury has already decompressed the compartment. Pain is the main symptom of compartment syndrome. Ongoing pain after adequate analgesia should alert to this diagnosis. The first clinical sign is pain on passive stretch of muscles within the appropriate compartment. Distal pulses are usually present unless

an arterial injury has occurred. Therefore extra vigilance is required in patients with altered conscious levels as a result of head injury, alcohol or drugs. Any constricting bandages or casts should be split down to skin and the limb held level with the heart. Urgent open fasciotomy is required.

FURTHER MANAGEMENT

The patient will now undergo surgical wound debridement under anaesthesia in the operating theatre. Large volumes of fluid are used to clean the wound and all dead tissue and foreign material must be removed. The fracture will be stabilized with external or internal fixation as this provides the best environment for soft tissue and fracture healing. In general, all open wounds should be left open and the patient returned to theatre at 24–48 hours for repeat surgical debridement and delayed wound closure using direct suture or an appropriate technique from the reconstructive ladder. The patient should remain on antibiotics until definitive wound closure is achieved.

CONCLUSIONS

Osteomyelitis or infected non-union is a disastrous outcome following open fractures. The primary management of the fracture should focus on the prevention of infection. The wound and soft tissues are a very important factor in the management of fractures. Open fractures are a surgical emergency and must be referred early to the orthopaedic trauma team. **HM**

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TABLE 4.
Need for tetanus prophylaxis

	Simple wound	Tetanus-prone wound
Full course + booster within 10 years	Nil required	TTB
Full course + booster more than 10 years ago	TTB	TTB + HATI
Not immunized/unknown	TTB	TTB + HATI

From Department of Health (1996). HATI = 250 units intramuscularly human anti-tetanus immunoglobulin administered at a separate site to the booster; TTB = 0.5 ml tetanus toxoid booster.