

# Open tibial fractures

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## Abstract

Open fractures of the tibia are potentially life-changing injuries with huge costs to both patients and healthcare systems. These injuries require early coordinated interventions by senior orthopaedic and plastic surgical teams (orthoplastic) to reduce the risk of long-term complications and improve outcomes. Here we review clinical guidelines and developments in the evidence base to highlight key aspects of the coordinated care of open fractures of the tibia.

**Keywords** lower limb reconstruction; lower limb trauma; open fracture

## Introduction

Fractures of the lower limb are extremely common injuries in both the civilian and military populations; 85% of major trauma patients sustain serious limb injuries.<sup>1</sup> Survivors of major trauma with orthopaedic injuries of the lower limb have poor functional status and quality of life.<sup>2–4</sup> Amongst the most severe of these injuries are open fractures, which have a reported incidence of 11.5/10<sup>5</sup>/year and 40% of these involve the lower limb.<sup>5,6</sup> Open fractures refer to a spectrum of injury where the fracture itself, or the fracture haematoma, is exposed to the external environment via a break in the skin (see Figure 1). They are a significant cause of morbidity and mortality affecting a diverse demographic, ranging from young patients sustaining high energy trauma (e.g. road traffic accidents), the military from high energy blast injuries through to fragility fractures in older patients with poor soft tissues in whom low energy trauma (e.g. a fall from standing) results in an open fracture. Open fractures are particularly devastating since the rates of infection

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and fracture non-union can be as high as 50% and 18%, respectively.<sup>7</sup> These injuries require coordinated specialist management from both plastic and orthopaedic surgeons to reduce bacterial contamination, stabilize the fracture, and restore the soft tissues.<sup>8</sup> Multiple surgical interventions are often required, including complex soft tissue reconstructive procedures in order to achieve stable soft tissue coverage. In patients with the most severe open fractures, and indeed in those who suffer complications (e.g. infection, chronic pain, fracture non-union), amputation of the affected limb is often required, which not only imposes significant morbidity for patients but also carries huge healthcare costs.<sup>9</sup>

## National guidelines and audit

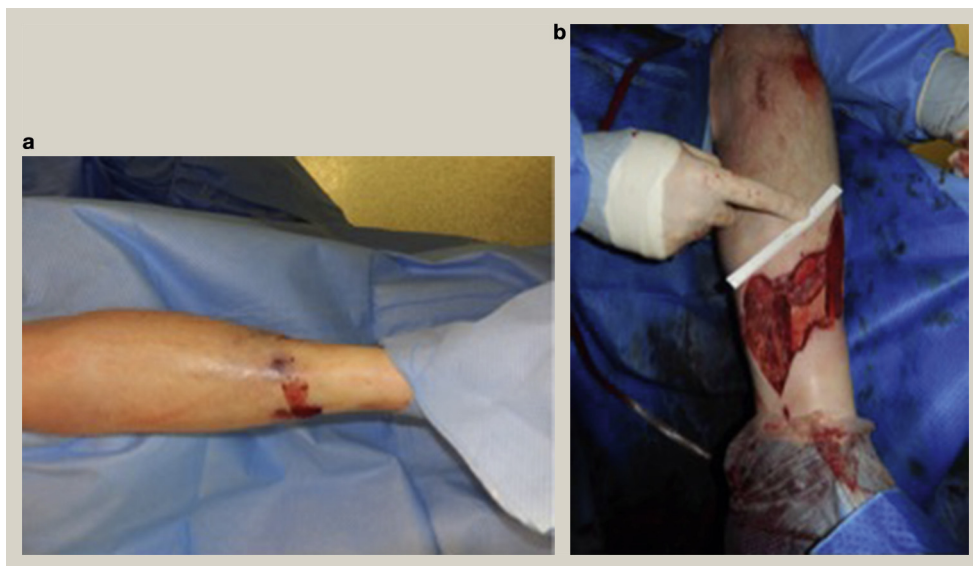
Guidelines for the management of open fractures of the tibia in the UK (Appendices 1 and 2) have been published by the National Institute of Clinical Excellence (NICE)<sup>10</sup> and by the combined national specialty associations for orthopaedic and plastic surgery (The British Orthopaedic Association and The British Association of Plastic, Reconstructive and Aesthetic Surgeons).<sup>8,11</sup> In the UK, compliance with BOAST4 guidelines is collected at a national level by The Trauma Audit and Research Network UK (TARN).<sup>1</sup>

## Initial management

The majority of open fractures (>95%) are accurately diagnosed by the pre-hospital team<sup>12</sup> and patients are transported to the nearest major trauma centre or specialist centre for combined orthoplastic care.<sup>10</sup> Initial management follows the established Advanced Trauma Life Support (ATLS) principles<sup>13</sup> before detailed assessment of the open fracture/s is undertaken. The latter includes documentation of the neurovascular status, repeated at intervals and after any splintage or manipulation of the fracture. Vascular impairment and/or compartment syndrome are absolute indications for immediate surgery, as are heavily contaminated wounds.<sup>10</sup> The aim is to restore circulation to devascularised limbs within 3–4 hours of injury and no later than 6 hours of warm ischaemia time. The wound should be photographed to avoid the need for repeated wound inspections and then covered with a saline-soaked gauze and impermeable film. All hospitals receiving patients with open fractures should have information governance policies in place to enable the handling and storage of clinical photographs.<sup>10</sup> The wound should not be irrigated at the scene of injury or in the emergency department to avoid washing in of debris and contamination of deeper structures.<sup>10</sup>

## Antibiotics

The use of prophylactic antibiotics is universal in the management of open fractures in high-income countries to prevent deep infection. Our national guidelines recommend early (within an hour of injury) administration of intravenous antibiotics ideally in the pre-hospital setting or immediately upon arrival in the emergency department if not already given.<sup>10</sup> Tetanus status should be checked and prophylaxis administered if required.<sup>8</sup> The absolute use of antibiotics is supported by a Cochrane meta-analysis of 1106 participants from eight studies which found that antibiotics significantly reduce the incidence of early



**Figure 1** Open midshaft fracture of the left tibia and fibula sustained following a road traffic accident (see associated skeletal injury in [Figure 2](#)). (a) small initial wound with surrounding contused tissue, (b) after thorough debridement and irrigation revealing the true extent of soft tissue damage and the zone of injury.

infection in open limb fractures compared to no treatment or placebo (risk ratio 0.43, 95% CI 0.29–0.65).<sup>14</sup> Evidence for early administration of antibiotics is reported by a number of studies<sup>14–17</sup> but one key study provides the evidence for our current national guideline of antibiotic administration within an hour of injury.<sup>16</sup> In this retrospective cohort study of 137 patients with GA grade III injuries, the authors found time to administration of antibiotics to be a strong and independent predictor of deep infection at 90 days, even after adjustment for age, GA grade, smoking, presence of diabetes, time to debridement and time to cover. The authors report an odds ratio for deep infection of 3.78 (95% CI, 1.26–14.11) for patients waiting longer than 66 minutes for antibiotic administration compared with those administered antibiotics within 66 minutes of injury.<sup>16</sup>

A combined antibiotic regime is recommended to provide both Gram-positive and Gram-negative antibiotic cover as follows: co-amoxiclav (1.2 g) or cefuroxime (1.5 g) 8 hourly continued until wound debridement, and clindamycin 600 mg 6 hourly if the patient is allergic to penicillin.<sup>8,11</sup> At wound debridement co-amoxiclav (1.2 g IV) and gentamicin (1.5 mg/kg) should be administered and continued for 72 hours or until definitive wound closure, whichever is sooner.<sup>8,11</sup> This two-phase antibiotic protocol recognizes the observation that most deep infections following an open fracture are due to nosocomial organisms.<sup>18</sup> In cases where the wound is heavily contaminated with marine, agricultural or sewage matter then the addition of anaerobic cover (e.g. Metronidazole) coupled with urgent surgery is recommended.<sup>10</sup>

### Classification

The most commonly used classification is the Gustilo and Anderson (GA) system which describes three main classes of

injury (with subdivisions) according to the degree of soft tissue disruption, extent of contamination, size of wound and need for vascular repair as follows<sup>7,19</sup>:

- **GA I** Clean wound, wound less than 1 cm, minimal soft tissue injury
- **GA II** Wound greater than 1 cm, moderate soft tissue injury without extensive soft tissue damage, flaps, avulsions
- **GA III** Extensive damage to soft tissues, including muscle, skin, or neurovascular structures or loss or an open segmental fracture. This type also includes fractures over eight hours old, fractures requiring vascular repair, farm injuries with soil contamination.
  - **IIIA** Type III fracture with adequate soft tissue (periosteal) coverage of fractured bone despite extensive soft tissue laceration or damage. Includes highly comminuted fractures
  - **IIIB** Type III fracture with extensive soft tissue loss and periosteal stripping and bony exposure. Usually associated with massive contamination. Will often need further soft tissue coverage procedure (i.e. local or free flap)
  - **IIIC** Type III fracture associated with arterial injury requiring repair irrespective of the degree of soft tissue injury

Despite criticisms on the poor inter-observer reliability of this scale, including amongst orthopaedic surgeons,<sup>20,21</sup> the GA grades have been shown to correlate with outcomes such as mobility<sup>22</sup> and the incidence of infection (0–2% for Type I, Type II 2–7%, Type IIIA 7%, IIIB 10–50%, IIIC 25–50%).<sup>23</sup> The grade of injury should be determined after surgical debridement to provide the most accurate reflection of injury severity.

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