Closed fractures of the tibial shaft in adults

Hussein Taki
Arman Memarzadeh
Alex Trompeter
Peter Hull

Abstract

Diaphyseal tibial fractures are the most common long bone fracture. There are a variety of treatment options, both operative and non-operative, and satisfactory outcomes are reliant on a thorough understanding of the strengths and weaknesses of the different treatment modalities and their appropriate application. Certain fracture patterns present particular difficulties and these must be recognized preoperatively so that a suitable surgical strategy can be executed.

Keywords adult; diaphysis; tibia; tibial fracture

Introduction

This review focuses primarily on the management of closed diaphyseal tibial fractures in adults. The essential anatomy of the tibia is considered along with the principles of initial management and surgical options for definitive treatment.

Epidemiology

Fractures of the tibial shaft are the most common long bone fracture.[1] The majority of these fractures are closed, with one large study putting the proportion of open fractures at 23.5%.[2] A recent Danish epidemiological study found that the most common fracture pattern was the spiral fracture (AO-type 42-A1), representing 34% of all tibial shaft fractures.[3] Estimates for the average annual incidence range from 16.9 to 22 per 100 000 patient years,[3–5] although this may be falling.[4]

Men have the highest incidence of 21.5 per 100 000 patient years, compared to women with an incidence if 12.3 per 100 000 patient years. The mean age of injury is 38.5, with men tending to present in their 20's and women between the ages of 30-40.[3]

The commonest mechanisms are falls, sporting and transport accidents, with higher energy mechanisms such as football and motorcycle collisions seen more commonly in younger patients, especially men.

***Hussein Taki** MBChB MRCS (eng) Junior Trauma Fellow at Addenbrooke's Hospital, Cambridge, UK. Conflicts of interest: none declared.*

***Arman Memarzadeh** MBBS MRCS PGCert Specialty Registrar, Trauma and Orthopaedic Surgery, Addenbrooke's Hospital, Cambridge, UK. Conflicts of interest: none declared.*

***Alex Trompeter** MBBS BSc FRCS (Tr+Orth) Consultant Trauma and Orthopaedic Surgeon, St Georges University Hospitals, London, UK. Conflicts of interest: I have a consultancy contracts as follows: Smith and Nephew (Education), Orthofix (Education / R+D), Stryker (Education/R+D). Education consultancy includes organisation / chairing educational meetings, speaking at symposia, or advising on educational matters relating to course content and delivery. R+D consultancy relates to product design and development. Neither of these conflicts with the content of the work provided for these articles, or my clinical approach in management of these conditions.*

***Peter Hull** FRCS (Trauma & Orthopaedics) Consultant Trauma and Orthopaedic Surgeon, Addenbrooke's Hospital, Cambridge, UK. Conflicts of interest: none declared.*

Anatomy and blood supply

Osteology and compartments

The tibia is the second largest long bone in the body. The proximal tibia is characterized by a tibial plateau that forms the lower half of the knee joint. The diaphyseal segment is triangular in cross-section, with the medial border of the tibia being subcutaneous, making it susceptible to open fractures. Distally, the tibial shaft narrows and finally expands slightly to form the superior articular surface of the ankle joint. The medial end of the tibia has a malleolar process, which also forms part of the tibiotalar joint.

The leg is divided into four osseo-fascial compartments. These relatively restricted compartments make the leg susceptible to compartment syndrome after high-energy trauma.

Deforming forces

The deforming forces acting on the tibia after fracture include the extensor mechanism, which promotes an apex-anterior deformity. The gastrocnemius flexes the distal fragment. The pes anserinus and anterior compartment muscles promote a valgus deforming force. Avoiding flexion and full extension during fixation therefore helps to maintain the reduction by neutralizing these deforming forces.

Blood supply

The tibia receives its blood supply proximally from metaphyseal vessels arising from the genicular arterial anastomosis. The blood supply of the tibial diaphysis is derived from a nutrient artery and periosteal vessels.

The nutrient artery arises from the posterior tibial artery and enters the posterior tibial cortex in its middle third at the origin of the soleus muscle, along the soleus ridge. It then divides into three ascending branches and a single descending branch, each of which gives off multiple small vessels to supply the endosteal surface of the tibial cortex.

The periosteal vessels arise from the anterior tibial artery and supply the outer surface of the tibial cortex. There is an anastomosis between the endosteal and periosteal blood supplies. The normal blood flow is centrifugal, with the endosteal supply accounting for around two thirds of cortical blood flow.

Classification of tibial fractures

Surgeons usually classify tibial fractures using simple descriptive terms. Anatomical location (proximal, middle, distal) and fracture pattern (transverse, oblique, spiral, segmental, comminuted,

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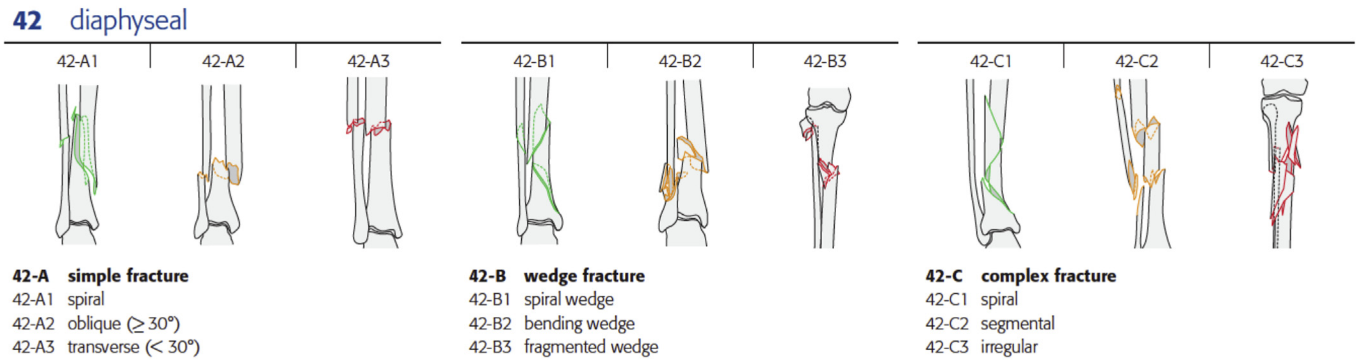

Figure 1 AO/OTA classification of tibial diaphyseal fractures.[6]

or butterfly etc.) are commonly used to describe the variety of possible injuries. These terms are well understood and facilitate communication between colleagues, but are too ambiguous and subjective for research and publication purposes. The most commonly used classification system is the AO/OTA (Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association) classification (Figure 1), which uses an alpha-numeric code to describe firstly, which bone has been injured and secondly, which segment of the bone is involved and thirdly, the fracture pattern and complexity.[6]

For the tibial diaphysis (bone 4, segment 2) the patterns of fracture are described as simple (A), wedge (B) and complex (C) with further subdivisions as per Figure 1.

Soft tissue injury classification

Of equal importance when classifying tibial fractures is the extent of the soft tissue injury, which for closed injuries is best described using the Tscherne classification.[7] This grading scale has been shown to have a strong correlation with outcome (see Table 1).[8]

Initial management

Tibial shaft fractures can present as either an isolated low energy injury or a high-energy injury, typically seen in the polytraumatized patient. Patients with high-energy injuries often have other serious injuries with multiple systems involved. These patients should therefore be managed in accordance with Advanced Trauma Life Support (ATLS) protocols in order to identify and treat life-threatening injuries first, before moving on to manage less serious injuries.

The history should be focused and include details of the precise mechanism of the fracture, since this will indicate the potential extent of the injury as well as likely coexisting injuries.

15% of patients with a tibial shaft fracture will have other musculoskeletal injuries and 4% of tibial shaft fractures are bifocal, with associated fractures of the tibial plateau, plafond, or ankle.[9] These injuries must be sought actively if they are not to be missed.

If a fracture is identified or suspected, the examination should focus on the extent of the soft tissue injury, associated musculoskeletal injuries, neurological or vascular injury and the possibility of compartment syndrome. In the obtunded patient it can be difficult to assess for compartment syndrome and as per the 'BOAST 10' guidelines[10] each unit should have their own policy on managing these patients, with a policy on the use of compartment pressure monitors.

Initial management should include correction of any gross deformity and application of an above knee plaster backslab. The injured limb should be elevated to minimize swelling and pain.

Tscherne classification of tibial soft tissue injuries[7]

Tscherne classification	Description
Type 0	Minimal soft-tissue damage due to an indirect mechanism of injury and a simple fracture
Type 1	Superficial abrasion or soft-tissue contusion due to pressure from the bone injury and a mild to moderately severe fracture pattern
Type 2	A deep and contaminated abrasion with local skin and muscle contusion, an impending compartment syndrome, and a high-energy fracture pattern
Type 3	Extensive skin contusion, severe muscle damage, compartment syndrome, and a severe fracture pattern

Table 1

Imaging

Orthogonal antero-posterior (AP) and lateral radiographs are usually sufficient for diagnosis and pre-operative planning. They should include the ipsilateral knee and ankle in order to check for intra-articular extension and associated injuries. Computed tomography (CT) is rarely required, but may be useful to clarify possible intra-articular extension and may also include angiography in cases of suspected vascular injury.

Magnetic resonance imaging (MRI) may be required to diagnose associated ligamentous injuries of the knee and ankle.

Non-operative treatment

There is no strong consensus on the optimal management of minimally displaced closed midshaft tibial fractures, with both cast treatment and intramedullary nailing (IMN) having strong support.[11]

Papers that have looked at the outcomes of cast treatment suggest that the indications for non-operative treatment are

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