Fractures of the tibial shaft in adults

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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 most useful applications. Certain fracture patterns present particular difficulties and these must be recognized pre-operatively so that an appropriate surgical strategy can be planned. Compartment syndrome can be a devastating complication, and must be kept in mind at all times.

Keywords adult; diaphysis; tibia; tibial fracture

Introduction

This review will focus primarily on the management of closed diaphyseal tibial fractures in adults. This will include a review of the essential anatomy of the tibia, the initial management of patients, surgical options for definitive treatment and a discussion on compartment syndrome. High-energy fractures and those that are open have been covered in a recent review article.[1] Another recent review has covered early total care versus damage control orthopaedics and the physiological effects of reaming[2] and these topics are therefore not discussed again. Paediatric fractures, fractures with associated vascular injuries and the management of non-unions are beyond the scope of this article.

Epidemiology

Fractures of the tibial shaft are the most common long bone fracture,[3] with 23.5% being open injuries in one large study.[4] Estimates of the average annual incidence range from 17 to 22 per 100,000 patient years,[5,6] although the incidence may be falling.[5] The peak incidence is in young men, with a second peak in the elderly population.[3] The commonest mechanisms are falls, sporting and transport accidents, with higher energy mechanisms seen more commonly in younger patients, for example as a result of soccer or motorcycle collisions.

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Anatomy and blood supply

The tibia is the second largest long bone in the body, after the femur, and is the major weight-bearing bone of the lower leg. It consists of proximal and distal extremities, connected by the diaphysis. The proximal extremity (metaphysis) is expanded in both the coronal and sagittal planes and is characterized by a medial and lateral condyle and the intercondylar eminence, collectively known as the tibial plateau, which forms the lower surface of the knee joint. The diaphysis is triangular in cross section and has three distinct corners: anterior, posteromedial, and posterolateral (interosseous). These corners are linked by three surfaces: medial (subcutaneous), lateral, and posterior. Distally, the tibial shaft narrows and ultimately expands slightly to form the superior articular surface of the ankle joint. The medial end of the tibia has a malleolar process which forms part of the tibiotalar joint. The subcutaneous location of the medial border of the tibia makes the tibia susceptible to injuries, especially open fractures.

The leg is divided into four myofascial compartments with attachments to the three borders of the tibia and to the fibula. These tight compartments make the leg susceptible to compartment syndrome, whereby the intra-compartmental pressure exceeds the capillary perfusion pressure. The resulting anaerobic metabolism in skeletal muscle, due to lack of oxygen supply to its cells, causes severe pain and, if unchecked, leads to cell death and permanent loss of function in the leg.

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. Following reaming of the medullary canal of the tibia, this centrifugal flow is reversed in order to maintain cortical perfusion following damage to the endosteal blood supply.[7] Endosteal vessels are seen to re-grow within 3–6 weeks in animal studies. Reaming has no long-term detrimental effect on the blood flow within the fracture callus.[8]

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, 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 Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification (Figure 1), which uses an alpha-numeric

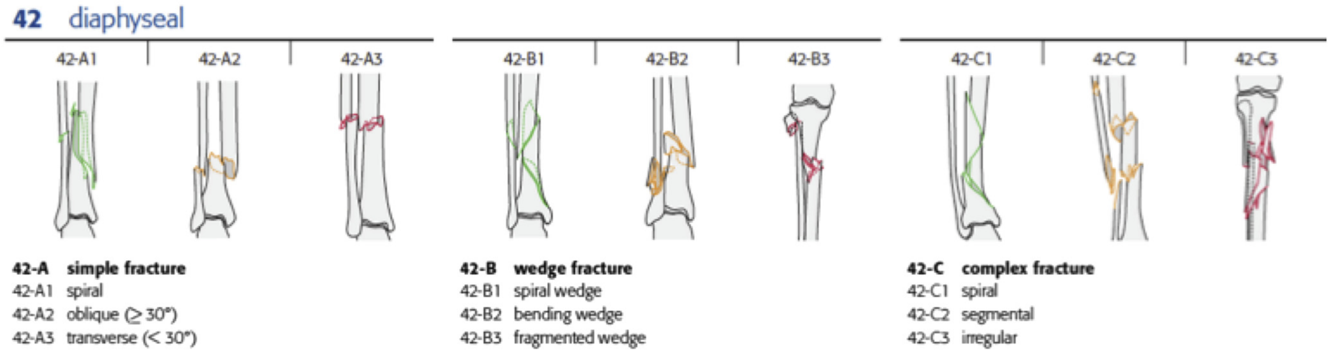

Figure 1 AO/OTA classification of tibial diaphyseal fractures.[9]

code to describe firstly which bone has been injured, secondly which segment of the bone is involved and thirdly the fracture pattern and complexity.[9]

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.

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.[10] Type 0 is minimal soft tissue damage due to an indirect mechanism of injury and a simple fracture. Type I is a superficial abrasion or soft tissue contusion due to pressure from the bone injury and a mild to moderately severe fracture pattern. Type II is a deep and contaminated abrasion with local skin and muscle contusion, an impending compartment syndrome and a high-energy fracture pattern. Type III is extensive skin contusion, severe muscle damage, compartment syndrome and a severe fracture pattern. This grading scale has been shown to have a strong correlation with outcomes.[11]

Assessment and initial management

Tibial shaft fractures are often high-energy injuries and patients may present with a range of musculoskeletal injuries, as well as injuries to other bodily systems. These patients should be assessed and managed according to Advanced Trauma Life Support (ATLS) protocols in order to identify and treat life-threatening injuries first, before moving on to manage less serious injuries. Hypotensive patients should be resuscitated with appropriate blood products or crystalloid: once the blood pressure has normalized it is important to check again for the presence of compartment syndrome. Significant medical comorbidities (e.g. cardiovascular disease, diabetes mellitus) should be addressed; ideally, the patient's physiological condition should be optimized prior to any definitive treatment of the fracture.

History

The purpose of the history is to obtain the relevant information in order to fully assess the patient and their injury and to plan appropriate management. It should 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. It should also cover any comorbid conditions, drugs and allergies, pre-fracture functional level, domestic situation and timing of last ingestion of food and drink.

Examination

Fractures of the tibial shaft are usually obvious, with local pain, swelling and deformity. However, the possibility of a tibial fracture should be considered in all unconscious or severely injured patients and a thorough physical examination should be undertaken. 15% of patients will have other musculoskeletal injuries and 4% of tibial shaft fractures are bifocal, with associated fractures of the tibial plateau, plafond, or ankle.[12] 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. Repeat clinical examination for compartment syndrome must be carried out regularly during pre-operative and immediate post-operative periods.

Initial management

The patient should receive adequate analgesia before the initial radiographs are taken in the Emergency Department. These first images are important when analysing the fracture pattern as Plaster of Paris (POP) and underlying wool can obscure fine details such as fracture extension into the ankle joint.

The patient's injured leg should be gently splinted in an above knee POP half-cast or backslab. Any gross deformity, especially rotational malalignment, should be corrected by applying gentle traction on the injured leg whilst the plaster is setting. This provides excellent analgesia, as well preventing secondary soft tissue injury due to fracture movement or tenting of the skin by displaced fragments. Plain radiographs should be repeated after the splint has been applied to check that the alignment of the fracture is satisfactory: an angulated fracture puts the overlying skin at risk and is more painful than a straightened leg. The injured limb should be elevated to minimize swelling and pain.

Imaging

Anteroposterior (AP) and lateral radiographs are usually sufficient for diagnosis and pre-operative planning (Figure 2). They should include the ipsilateral knee and ankle in order to check for proximal or distal fracture extension, and associated injuries. Computed tomography (CT) is rarely required, but may be useful

