An Overview about Management of Distal Tibial Fractures

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Abstract

Background: The tibia is one of the long bones of the lower limb and lies medial to the fibula. Tibial fractures are one of the most frequent long-bone fractures encountered. They usually occur due to high energy trauma like motor vehicle accidents, sports or falls from height. The patient's medical history should be reviewed because of systemic problems. Patient characteristics, such as smoking, alcoholism, peripheral vascular disease, diabetes and metabolic bone disease may affect treatment planning. The initial radiographic evaluation of all fractures of the tibial diaphysis should involve antero-posterior (AP) and lateral radiographs. Distal tibia fracture management is difficult due to wound infections and poor wound healing caused by unstable blood supply. Different surgical procedures, including closed intramedullary nailing, open reduction, internal fixation with conventional plate osteosynthesis, and external fixation, have been tried. There are benefits and drawbacks to each type of treatment. The goal of surgical management for distal tibia fracture is anatomical reduction with stability, prevention of deformity and early mobilization. Conservative management may play a role in stable and non-displaced fractures or in displaced fractures if they are patients with a high surgical risk. Tibial diaphyseal fractures and distal extra-articular fractures are treated with intramedullary nailing; however, distal fractures that are close to the joint or extend into the joint surface should not be treated in this way. External fixation Used either for temporary stabilization or for definitive fixation, is indicated in some cases as extensive comminution of both articular and periarticular fractures. Conventional open reduction and internal fixation (ORIF) has better fracture reduction, better fixation and early mobilization, but needs extensive soft tissue dissection and also has higher rate of complications like infection, delayed union due to drainage of fracture hematoma, non-union and big scar marks. To minimize disruption of soft-tissue envelope and periosteal blood supply. Minimal invasive precutaneous plate osteosynthesis (MIPPO) was developed to maintain a more biologically favourable environment for fracture healing. Historically, tibial pilon fractures were managed by antero-medial approach but one of the major disadvantages in taking this approach is the risk of wound breakdown with exposure of the implant. Implant prominence with antero-medial plating has modulated implant removal as a revision surgery. Antero-lateral area of distal tibia has shown better soft tissue coverage along with a better direct exposure to the antero-lateral fragment.

Keywords: Distal Tibial Fractures, LCP, MIPPO.

Introduction

The tibia is one of the long bones of the lower limb and lies medial to the fibula. Its shaft is triangular in section and has expanded ends. One of the most common long-bone fractures seen is the tibial fracture. Distal tibia fractures include the extra-articular distal shaft fractures as well as the tibial plafond and intra-articular fractures .Distal tibia fractures pose a special challenge because they are prone to complications and need careful management. External fixators, intramedullary nailing, and internal fixation are among the surgical options for treating distal tibial fractures. There is no agreed-upon which method that is superior in treating these types of fractures because each method of fixation has benefits and drawbacks **[1] .**

Classification of Distal Tibial Fractures

Ruedi-Allgower classification :

Based on the degree of comminution and the displacement of the articular surface, the Ruedi-Allgower classification is used .It divides fractures into three categories:

- Type I: which is a split fracture of the distal tibia without significant displacement of the articular surface.
- Type II: which involves significant joint surface displacement but not comminution
- Type III: which involves impaction and comminution of the distal tibia **[2].**

AO/OTA classification:

The OTA/AO classification system describes the fractures based on specific numbers and letters that refer to the location, type and group of fracture, as will be explained:

- Location:
    - The anatomical location of the fracture is designated by two numbers, one for the bone and one for its segment:

Number of Distal tibial fracture is (43):

- Number (4) means tibia
- Number (3) means distal segment of tibia

- types:
    - Letter (A) means extra articular fracture type (43A)
    - Letter (B) means partial articular fracture type (43B)
    - Letter (C) means complete articular fracture type (43C).
- Groups:
    - The fracture pattern of extra articular fracture (43A):
        - Simple (43A1)
        - Wedge (43A2)
        - Multifragmentary (43A3)
    - The fracture pattern of partial articular (43B):
        - Split (43B1)
        - Split depression (43B2)
        - Depression (43B3)
    - The fracture pattern of complete articular (43C):
        - Simple articular,simple metaphyseal (43C1)
        - Simple articular, multifragmentary metaphyseal (43C2)
        - Multifragmentary articular and multifragmentary metaphyseal (43C3) **[3].**

Management of distal tibial fractures

Clinical Picture and Initial Evaluation:

History:

The event may provide some information as to the magnitude of the injury and the likelihood of associated injury. Vertical loading from falls or high-speed deceleration may result in axial compression injuries to the foot, ankle, and spine. Twisting usually results in external rotation injury. The patient's medical history should be reviewed because of systemic problems. Patient characteristics, such as smoking, alcoholism, peripheral vascular disease, diabetes and metabolic bone disease may affect treatment planning **[4].**

Mechanism Of Injury:

1- Low energy

Caused by twisting or falls from standing height, etc. Result of indirect, torsional injury leads to spiral fracture pattern with fibula fracture at a different level more likely to be associated with a lower degree of soft tissue injury.

2- High energy

Caused by RTA, fall from height, athletics, etc. Result of direct force leads to wedge or short oblique fracture that may have significant comminution with fibula fracture at same level, more likely to be associated with severe soft tissue injury **[5].**

General Evaluation:

All patients admitted following high-energy trauma require initial management following advanced trauma life support (ATLS) guidelines. Once life-threatening injuries have been addressed, or ruled out, lower limb injuries can then be assessed. It is critical to examine the soft tissues overlying any bony injury and the neurovascular status of the distal limb **[5].**

Local Evaluation:

Odema and deformity of the ankle is often apparent on initial examination. Care must be taken to accurately assess the neurovascular status of the extremity, the degree of swelling and the condition of surrounding soft tissue. The physical examination should also include circumferential Inception of the foot and ankle for a communication open wound. Initial radiographs are then obtained to determine the severity of the fracture. A preliminary reduction should be performed if there is significant deformity and the fracture immobilized in a well-padded splint with the limb moderately elevated **[6].**

Compromised Skin can occur in association with both open and closed fractures of the tibia and fibula. Any areas of skin tenting or puckering should be relieved by restoration of the normal anatomic alignment and splinting once the initial limb assessment is completed. In some cases, reproduction of the injury displacement is necessary to relieve skin puckering at the fracture site to avoid irreversible full thickness skin necrosis which can occur within hours **[6].**

- **Vascular examination:**

A comprehensive distal vascular examination should be performed both before and after reduction. Some patients with significantly displaced tibial and fibular fractures will have diminished or absent pulses distal to the injury because of kinking of the arteries of the leg. In most of these cases, palpable pulses will return once normal anatomic alignment is restored. **[7].**

If the pulses do not return to normal after bony reduction then further investigations such as angiography, CT angiography, or arterial Doppler studies should be performed to rule out a vascular injury. Attention should also be paid to swelling, pallor, capillary refill, temperature, and venous congestion during the vascular examination of the limb **[8].**

- **Neural examination:**

The evaluation of motor function in a patient with a tibial fracture should include strength grading of all of the muscles in the injured leg. It is important to keep in mind that motor function can be altered for multiple reasons including pain, muscle or tendon rupture, nerve injury, limb ischemia, compartment syndrome, spinal cord or brain injury, or any combination of these. In severely displaced fractures a motor examination should be performed both before and after fracture reduction as results can vary significantly **[9].**

Distal sensory examination of the ipsilateral foot performed including the territories of the deep peroneal nerve (first dorsal interspace), the superficial peroneal nerve (the dorsum of the foot), the sural nerve (lateral ankle and heel), the saphenous nerve (medial ankle and heel), and the tibial nerve (plantar aspect of foot). Care should be taken to determine whether sensation is present in each zone and whether it is normal or diminished **[10].**

Radiology of distal tibial fractures:

Plain radiographs:

The initial radiographic evaluation of all fractures of the tibial diaphysis should involve antero-posterior (AP) and lateral radiographs **[11].** Ideally, these standard views should include the entire length of both the tibia and fibula. However, this is sometimes difficult to achieve in tall patients. Standard views of the ipsilateral knee (AP and lateral) and ankle (AP, lateral, and mortise) should also be obtained. These additional radiographs may show involvement of the proximal or distal tibial articular surfaces, the lateral and medial malleoli, the proximal or distal tibiofibular joints, and adjacent bones such as the talus, distal femur, and patella **[12].**

Computed tomography

CT scans are routinely obtained for many or most distal tibial fractures They provide excellent detail of the fracture pathoanatomy and plan for operative approaches and fixation techniques. CT typically demonstrates more articular displacement and comminution than is apparent on plain films **[13]**

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is perfectly suited for the assessment of musculoskeletal damage due to its unique capacity to visualize injuries to bone, cartilage, bone marrow, and supporting soft tissue structure. Additionally, magnetic resonance imaging provides incredibly precise anatomical details about the musculoskeletal system. It covers traumatic conditions of the musculoskeletal system, including hemarthrosis, occult fractures, cartilage injuries, the muscle and tendon trauma, avulsion injuries, extensor mechanism injuries, and traumatic conditions of joints **[14].**

Treatment of distal tibial fractures

General Treatment Options

Distal tibia fracture management is difficult due to wound infections and poor wound healing caused by unstable blood supply. Different surgical procedures, including closed intramedullary nailing, open reduction, internal fixation with conventional plate osteosynthesis, and external fixation, have been tried. There are benefits and drawbacks to each type of treatment **[15].**

The goal of surgical management for distal tibia fracture is anatomical reduction with stability, prevention of deformity and early mobilization **[16].**

A) Non operative treatment: Conservative management may play a role in stable and non-displaced fractures or in displaced fractures if they are patients with a high surgical risk **[17].**

1) Closed reduction and casting:

Non displaced fractures can be treated in non-weight bearing casts. These frequently need to be long-leg casts for rotational stability. Weight bearing should be restricted 4 to 6 weeks. In elderly or debilitated patients or in patients with metabolic bone disease, closed reduction and casting may be advisable. This is most appropriate for AO type A1, B1, and C1 fractures with less than 2 mm of articular displacement. When in doubt, CT scan aid in determining articular congruity **[18].**

2) Traction:

Traction of the fracture using calcaneal traction may result in satisfactory alignment of comminuted pilon fractures through ligamentotaxis if the central portion of the articular surface is not crushed and impacted. Traction allows direct access to and elevation of the leg and may be combined with early motion and rehabilitation of the joint. The potential complications include pin tract infections and inadequate articular reconstruction. Management by traction dose requires the patient to remain in bed until early evidence of union has occurred, usually a minimum of 6 weeks **[19].**

B) Operative Treatment:

1-Intramedullary nailing:

Intramedullary nailing is used in treatment of tibial diaphyseal fractures and distal extra-articular fractures, However, distal fractures that are close to the joint or extend into the joint surface should not be treated with intramedullary nailing **[1].**

Reamed nails offer a biological and mechanical advantage, however injurious to the endosteal vasculature with subsequent theoretical increase in infection and non-union. Both reamed and unreamed nails have become the accepted standard of care in many institutions ensuring axial alignment, early weight bearing, bony union and early return to pre-injury function with minimal complications **[20] [21].**

✓ **Expert Tibial Nail:**

The expert tibial nail expands the indications for intramedullary nailing far beyond shaft fractures. The implant is suitable for proximal as well as distal metaphyseal fractures .Multidirectional interlocking screws ensure that alignment can be well maintained and stability preserved in short proximal or distal tibial segments. Besides primary fracture treatment, the expert tibial nail can be used in secondary procedures or revision surgery such as non-unions and mal-unions **[22] [23].**

2- External fixation: Used either for temporary stabilization or for definitive fixation. Temporary fixation with a unilateral or "delta" frame spanning the ankle joint is advocated by some as the initial management of distal tibial fractures, particularly in high energy injuries. Unilateral device comprise pins in the calcaneus and talus, connected to pins in the antero-medial tibia. The use of an external fixator for definitive fixation of distal tibial fractures is indicated in cases of extensive comminution of both articular and periarticular fractures **[24].**

✓ ***Ilizarov:***

Type fixators are often more appropriate for definitive fixation of periarticular fractures with the passage of wires or pins into the distal fragment instead of spanning the ankle joint **[25].**

✓ ***Supracutaneous plate:***

This method preserves extra osseous blood supply and respects osteogenic fracture hematoma. It is a biologically and stable fixation method available for distal tibia fracture. The indirect reduction method and fixation of the plate screws with small skin incisions in the supracutaneous plate fixation technique protect the vascular supply of the bone from iatrogenic damage **[26]**. Supracutaneous plating using a locking compression plate (LCP) as an external fixator in the management of open fractures, non-union, septic arthritis, and even as an adjunct in distraction osteogenesis **[27].**

Limb Reconstruction System:

Shanz pins and sliding clamps make up the unilateral rail system known as the Limb Reconstruction System (LRS). As it offers rigid fixation of fracture fragments, permits early weight bearing, and can also be used for bone lengthening and deformity correction in patients with infective non-union and osteomyelitis, it is specifically made to enable the surgeon to perform simple and effective surgery. It is a simple technique compared to the illizarov ring fixator **[28].**

3- Platting by ORIF versus MIPPO

Plates may be applied in various modes according to the function (Protection, Compression, Bridging, and Buttress). The locking compression plate is a contemporary implant that allows for both conventional screw placement (using nonlocking screws) and locking screw placement (where screw heads lock into the plate at a predetermined angle). This allows for greater versatility in the application of internal fixation. The locking screw-plate interface allows fracture fixation without plate bone adherence thus preserving fracture haematoma, and reducing the risk of nonunion. **[29]**

From Open Reduction Internal Fixation (ORIF) to MIPPO

During the 1950s, the AO (Arbeitsgeminschaft fur Osteosynthesefragen) group in Switzerland introduced standardized surgical treatment of fractures. Surgical treatment allowed the early mobilization of patients with all the associated benefits (reduction of the fat embolism syndrome, decrease of joint stiffness and muscle wasting, early return to function, and reduced length of hospital stay) **[29].**

From 1954 onwards, the AO group developed the concept of absolute stability to treat fractures. Their co-operation with industry gave rise to the generically named large AO set with plates with round holes and these were followed by the small, and mini-fragment sets **[30].**

Osteosynthesis allowed early mobilization and formation of callus, which was initially felt to be associated with joint stiffness. Failure of osteosynthesis due to the development of irritation callus was a beginning of loss of stability **[31].**

conventional open reduction and internal fixation (ORIF) has better fracture reduction, better fixation and early mobilization, But needs extensive soft tissue dissection and also has higher rate of complications like infection, delayed union due to drainage of fracture hematoma, non-union and big scar marks **[32].**

The assessment of the soft tissue envelope was a concept that was slow in being adopted by many surgeons, and in many fractures (especially of the lower limbs), wound breakdown remained a problem **[33].**

The protocol for MIPPO requires initial closed reduction of the fracture. This may be achieved directly with percutaneously reduction forceps or indirectly through manual traction **[34].**

Advantages of MIPPO

(MIPPO) designed as a new approach for a biological osteosynthesis, which rapidly gained superiority over conventional open reduction and internal fixation (ORIF) especially in treating distal tibia. To minimize disruption of soft-tissue envelope and periosteal blood supply, MIPPO was developed to maintain a more biologically favourable environment for fracture healing **[35].**

A considerably decreased rate of deep infection and perfect radiological union are observed in patients who get treatment with the MIPPO approach. The MIPPO technique helps in initiating early mobilization and reduces the risk of ankle stiffness **[36] .**

Complications of distal tibia treatment

During or After different methods was used to treat a distal tibial fracture, a number of complications could develop, including infection, fracture malunion, nonunion, delayed union, ankle pain, wound dehiscence, joint stiffness, posttraumatic arthritis, screw loosening, implant failure, implant discomfort, muscle hernia (tibialis anterior muscle), and sensory disturbance over the anterolateral foot (superficial peroneal neurapraxia) **[37].**

Conflict of Interest: None

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