TIBIAL SHAFT FRACTURES

Epidemiology

26 fractures per 100,000 populations per year

3 times more frequent in males
The average age: 37 years
Generally attributed to higher energy trauma such as motor vehicle accidents.

CLASSIFICATION

Classification for **tibial** shaft fractures [Orthopaedic Trauma Association (OTA)]

Type A fractures are unifocal and the subdivision into groups is based on the orientation of the **fracture** line and the presence or absence of a fibula **fracture**.
Type B fractures are wedge fractures and are subdivided into spiral bending or fragmented wedges.
Type C fractures are more complex fractures and include complex spiral fractures, comminuted fractures, and segmental fractures.

OTA Classification
Group A: A1: Spiral
A2: Oblique
A3: Transverse
[subclassification: intact fibula; fracture at different level; fracture at same level of tibia and fibula]

Group B
Subgroups B1.1 Intact fibula
B1.2 Tibia and fibula fractures at different level
B1.3 Tibia and fibula fractures at same level

Group B2 Intact bending wedge fractures
Subgroups B2.1 Intact fibula
B2.2 Tibia and fibula fractures at different level
B2.3 Tibia and fibula fractures at same level

Group B3 Comminuted wedge fractures
Subgroups B3.1 Intact fibula
B3.2 Tibia and fibula fractures at different level
B3.3 Tibia and fibula fractures at same level

Type C: Complex fractures (multifragmentary, segmental, or comminuted fractures)

C3.1 Spiral wedge fracture

C3.2 Segmental fracture

C3.3 Comminuted fracture

Validating Classification Systems

Swiontkowski found that while overall functional impairment was higher at 6 months in those patients who had a C type injury, there was variability in this correlation, with the C type injuries being worse than those patients with a B type injury but not necessarily worse than those patients with an A type injury. They suggest that, "This classification may not be a good predictor.

Gustilo classification used for classifying open fracture [see under open fracture. Tscherne classification of closed fracture is used to assess soft tissue damage.

MECHANISM OF INJURY

High-energy and low-energy: High-energy injuries are typically caused by motor vehicle accidents, falls from height, direct blows, and gunshots, both civilian and military.
Sporting injuries, falls from standing height, and twisting injuries, usually causes lower-energy injuries. They may also be associated with pathologic conditions of bone.
Complications such as compartment syndrome compared to the low velocity injury.
Low-velocity injuries associated with a muzzle velocity of less than 2000 feet per second are more commonly seen in civilian practice.

Lower-Energy Injuries (Sports-Related Injuries)

Court-Brown has identified soccer-related injuries as the largest contributor to sports-related **tibial** shaft fractures, accounting for 80% of sports-related **tibial** diaphyseal fractures.

DIAGNOSIS

1. Mechanism of injury
2. ?high-or low-energy
3. Tcherne soft tissue classification
4, Open or closed
5. Compartment syndrome
6. Neurovascular system
7. Polytrauma

MANAGEMENT

1. Back slab
2. Pain medication
3. If open fracture: follow protocol
4. Elevate and watch for any compartment syndrome

5. Radiographic Evaluation

Fracture patterns.

Joint extension [may require CT]

Assessment of the canal size

If there is evidence of any vascular compromise, referral to a vascular surgeon.

	Advantages	Disadvantage	Best use
Casting	Non-invasive Inexpensive	Difficult to maintain MU high	Undisplaced #
EF [power 4; predrlll]	Minimal invasive Quick procedure	Pintrack infection[50%] Not rigid ➔ MU Patient dissatisfactn	Open Type IIIC Polytrauma
Ring fixator	Pintrack infection less Complex metaphyseal fractures	Expertise Patient dissatisfactn	Complex metaphyseal and epiphseal # Schatsker VI
ORIF	Stable fixation and Early ROM	Not as strong as nail in shaft	Metaphyseal fracture
IM Rod	Closed technique and Early healing Stable fix	Metaphyseal fracture Radiation	Shaft #

CURRENT TREATMENT OPTIONS

1. Long leg casting, patellar tendon bearing casting, or functional bracing.
2. Plate fixation: Open or miniml invasive; traditional or locking plates; compression plating or bridge plating.
3. Intramedullary nailing, undertaken with or without reaming, and either statically or dynamically locking the
intramedullary nail.
4. External fixation using either a uniplanar, multiplanar, or circular tensioned fine wire fixator.

Surgeon's preference:

Low-energy (96.3 %)

High-energy (96%) fractures of the tibia.

Closed fractures of the tibia that were associated with compartment syndrome 80%

Type I to a type III with 95.5% of surgeons choosing to use an intramedullary nail for type I open fractures and 68.4% and 48.4% choosing to use a nail in type IIIA and IIIB fractures respectively.

ACCEPTABLE REDUCTION

<1 cm of shortening

5° degrees of valgus but no varus malalignment

10° in the anteroposterior plane

5-10° degrees of external rotation but no internal rotation deformity.

Nicoll [1964] described a series of 705 cases: a union time of approximately 15.9 weeks and a malunion rate of 8.6%. Importantly, however, he described a 25% prevalence of residual joint stiffness that increased to 70% in those who had a nonunion associated with an open fracture.

Hooper: randomized 62 patients to receive either an intramedullary nail (29 patients) or cast treatment (33 patients) found a significantly decreased time to union, decreased malunion rate, and less time off work in the intramedullary nail group and concluded that displaced **tibial** fractures should be treated with an intramedullary nail.

Gross identified 145 fractures treated with a long leg cast: a 13.1% incidence of delayed union, a 4.1% incidence of nonunion, and a 31.7% incidence of malunion.

Functional Bracing

Introduced by Sarmiento, is applied after the soft tissue swelling has resolved.

In 1995, Sarmiento reviewed 1000 closed tibiaL diaphyseal fractures that were treated with prefabricated functional braces. They also observed that 90% of their patients had final angular deformity in any plane ≤6 degrees. However, they found that the presence of an intact fibula was more likely to result in an angulatory deformity and suggested that this pattern may not be appropriate for functional bracing. They reported an overall incidence of nonunion of 1.1%.

Alho suggested that there were fewer complications with intramedullary nailing which had a higher rate of excellent and good results as compared to functional brace management. Digby noted 11% had restricted ankle motion and 45% had reduced subtalar motion on bracing.

Diaphyseal Fractures

Experimental Data

Schemitsch found that reaming nailing affected bone blood flow more than nonreaming nailing and that revascularization of the bone took about 6 weeks in the unreamed group compared with 12 weeks in the reamed group. However, they also showed that in the same **fracture** model, reaming had no deleterious effect on the strength of the callus.

Hupel found that there was no significant difference between bone formation and mineral apposition in those tibias that were treated with no reaming, limited reaming, or standard reaming.

Christie has shown that most clinical problems associated with fat embolism were confined to those who received femoral reaming as opposed to **tibial** reaming, even though transesophageal echocardiography identified emboli in 92% of reaming procedures.

Clinical Evidence

Bhandari undertook a meta-analysis of reamed versus nonreamed intramedullary nailing: suggests that reamed nailing would potentially eliminate two thirds of nonunions that occur with nonreamed nailing. The study also found a higher rate of implant failure with nonreamed nails than with reamed nails.

A nonreamed intramedullary nail would increase the chances of nonunion by approximately threefold. They also found an increased incidence of implant failure with the use of unreamed nails compared to reamed nails, but they found no differences in malunion or the risk of compartment syndrome using either technique

PROXIMAL METAPHYSEAL FRACTURES

Locking contoured Plates

The use of AO techniques requires anatomic reduction and rigid fixation with a dynamic compression plate: initially thought to be stress shielding, but it is now thought to be due to localized Avascularity from the plate.

Oh have reported on the use of percutaneous plating techniques in unstable **tibial** shaft fractures They found that of 24 unstable **tibial** fractures, 22 united without secondary surgery.

While intramedullary nailing is advocated as the treatment of choice for diaphyseal fractures, not all proximal or distal fractures permit this technique [when 2 screw fixation cannot be achieved], and locked plating may be a useful technique for these fractures.

2. Intramedullary Nailing

Vidyadhara and Sharath reported seven (15.6%) cases of malunion. Their recommendations include using an intramedullary nail with a high proximal bend and static interlocking of proximal screws.

Krettek have described the technique of using blocking screws for proximal and distal fractures. They found a mean loss of reduction of 0.5 degrees in the frontal plane and 0.4 degrees in the sagittal plane..

Nonunion rates for intramedullary nailing were 3.5% compared to 2% for plating and 8% for external fixation. Malunion rates for intramedullary nailing were 20% for plating and 4% (95% CI, 1.5% to 10%) for external fixation.

DISTAL METAPHYSEAL FRACTURES

1. Intramedullary Nailing

Beware malunion
Use blocking screws
Look for associated of posterior malleolar fractures with distal **tibial** spiral fractures.
May need ORIF of fibula

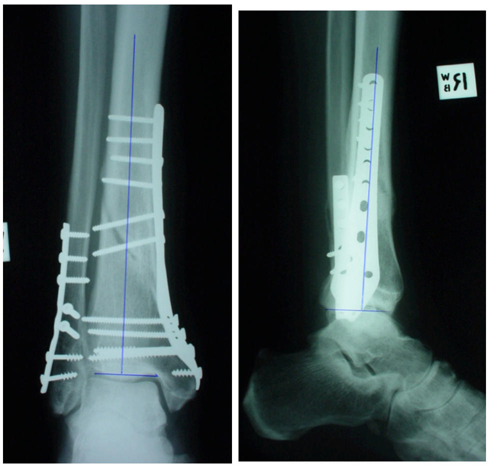
Tae reported on a randomized controlled trial of 64 consecutive distal dia-metaphyseal fractures treated with either an intramedullary nail or plate fixation and found that union rates were similar between groups. They did find that the intramedullary nail group had increased ankle dorsiflexion and the plate fixation group had six superficial infections and one deep infection as compared to one superficial infection in the intramedullary nail group.

Egol have suggested that adjunctive fibular plating in distal **tibial** fractures treated with an intramedullary nail may maintain **fracture** alignment better than those treated with only an intramedullary nail.

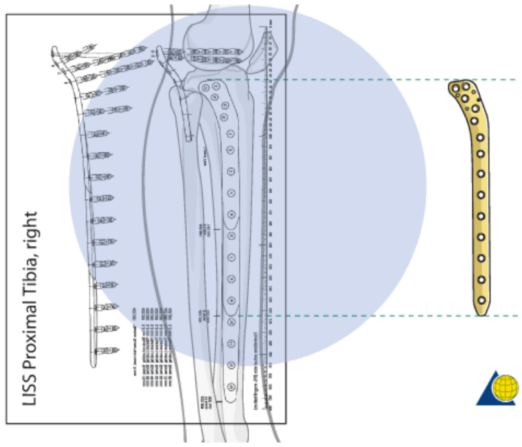
Biological Plating [Minimal invasive]

A systematic review of 1125 fractures was undertaken by Zelle et al. They identified only retrospective observational studies, and of those that were included, they recorded a nonunion rate in those treated with an intramedullary nail of 5.5% whereas in those patients treated with a

Distal Fixation; contoured plate



LISS for Proximal tibia



plate, the rate was 5.2%.

Lateral locked proximal plate in those **tibial** fractures that are too proximal to treat with an intramedullary nail.

A periosteal elevator is then slid underneath tibialis anterior muscle, so that it is submuscular but supraperiosteal, with care taken to not disrupt the anterior neurovascular bundle that lies close to the interosseous membrane deep to the anterior musculature.

The **fracture** is then reduced using indirect reduction techniques with the help of intraoperative fluoroscopy.

A proximal locking plate is then slid down the tibia underneath tibialis anterior and the extensor musculature and placed in an appropriate position on the proximal aspect of the tibia.

It is then important to check distal placement of the plate underneath the muscle.

The superficial peroneal nerve is most at risk around holes 11 to 13, and the anterior **tibial** artery is at risk around holes 9 to 12 .