Fractures of Lower Extremity
Neck-Shaft Angle:
In the anteroposterior roentgenogram, it is the angle between the long axis of the femoral neck and the axis of femoral shaft.

normal: 110-140 degree
mean: 127 degree
Anteversion angle: 
On the sagittal plane, the femoral head is anterior to the shaft of the femur with the angle of 12-15 degree.
blood supply to the proximal end of the femur

- extracapsular arterial ring located at the base of the femoral neck
- ascending cervical branches of the arterial ring on the surface of the femoral neck
- arteries of the ligamentum teres
blood supply to the proximal end of the femur
Classification

In the AO classification system, fractures of the femoral neck are classified as subcapital with no or minimal displacement (type B1), transcervical (type B2), or displaced subcapital fractures (type B3).
Subcapital with no or minimal displacement (Type B1) fractures may be

- impacted in valgus of 15 degrees or more (type B1.1),
- impacted in valgus of less than 15 degrees (type B1.2),
- or nonimpacted (type B1.3).
Transcervical (type B2) fractures may be

- basicervical (type B2.1),
- midcervical with adduction (type B2.2),
- or midcervical with shear (type B2.3).
subcapital fractures (type B3) may be

- moderately displaced in varus and external rotation (type B3.1),
- moderately displaced with vertical translation and external rotation (type B3.2),
- or markedly displaced (type B3.3).

Type B3 fractures have the worst prognosis.
AO classification system
Diagnosis

- history of falling
- clinical features
  - pain, limitation of hip joint,
  - external rotation deformity: 45-60 degree, tenderness, shorting of involved limb:
  - change of Bryant triangle and Nelaton line
- x-ray
Treatment

We prefer manipulation and closed reduction of femoral neck fractures and perform open reduction only when anatomical, closed reduction is not attainable and the patient is not a good candidate for a hemiarthroplasty with a femoral head prosthesis.
WHY HEALING DIFFICULT

- Femoral neck fractures usually are entirely intracapsular, and, common to all intracapsular fractures, the synovial fluid bathing the fracture may interfere with the healing process.
- Because the femoral neck has essentially no periosteal layer, all healing must be endosteal.
- Angiogenic-inhibiting factors in synovial fluid also can inhibit fracture repair.
These factors, along with the precarious blood supply to the femoral head, make healing unpredictable and nonunions fairly frequent.

With anatomical reduction and stable fixation, the incidence of nonunion should be acceptably low.
Non operative treatment

1. Fractures have no obvious displacement
2. Stable fracture, such as adduction or impacted type
3. The patient is too old
4. General situation is too poor or combined with cardiac, pulmonary, renal or hepatic malfunction

Method: skin traction for 6-8 weeks—sitting on bed—standing on crutches after 3 months without weight-bearing on foot—giving up crutches after 6 months
INDICATION OF SURGERY

1. adduction type with obvious displacement
2. age over 65 and the type of fracture is subcapital
3. adolescence femoral neck fracture
4. delayed fracture and nonunion, malunion that interfere with function, avascular necrosis of femoral head or combined with arthritis of hip
Internal fixation

currently two are commonly used

- multiple cannulated screws
- collapsible compression screw

and side plate combinations

typically used with an additional antirotation screw
Internal fixation with cannulated screws (AO technique)
Rehabilitation after operation

- For internal fixation: bed rest for 2-3 weeks, then can sit on the bed. Can walk with crutches without weight-bearing after 6 weeks. After fracture healing, can give up the crutches.

- For arthroplasty: can stand on the ground after 1 week of operation.
Anatommy

The calcar is a dense, vertical plate of bone extending from the posteromedial portion of the femoral shaft under the lesser trochanter and radiating laterally to the greater trochanter, reinforcing the femoral neck posteroinferiorly. The calcar is thickest medially and gradually thins as it passes laterally.
The calcar
Orientation of the trabeculae

- It is along the lines of stress, with thicker trabeculae coming from the calcar and passing superiorly into the weight-bearing dome of the femoral head.
- Smaller trabeculae extend from the inferior region of the foveal area across the head and the superior portion of the femoral neck and into the trochanter, and hence to the lateral cortex.
Evans classification of intertrochanteric fractures based on direction of fracture. He further divided the unstable fractures into those in which stability could be restored by anatomical or near anatomical reduction and those in which anatomical reduction would not create stability.
In an Evans type I fracture, the fracture line extends upward and outward from the lesser trochanter.

In type II, the reversed obliquity fracture, the major fracture line extends outward and downward from the lesser trochanter.

Type II fractures have a tendency toward medial displacement of the femoral shaft because of the pull of the adductor muscles.
Evans classification
Diagnosis

- history of falling
- clinical features: swelling, pain, subcutaneous ecchymosis, limitation of hip joint, tenderness, External rotation deformity: 90 degree, shorting of involved limb
- x-ray
Treatment

Nonoperative treatment

Closed methods of treatment of intertrochanteric fractures have largely been abandoned.
Operative treatment

Two broad categories of internal fixation devices are commonly used:

- Sliding compression hip screws with side plate assemblies
- Intramedullary fixation devices
sliding compression hip screws with side plate
intramedullary fixation devices
Aftertreatment

- The patient is allowed to sit in a chair the day after surgery, and active exercises of the upper and lower extremities are begun.
- Depending on the patient’s condition and the stability of the internal fixation, partial weight-bearing is begun using a walker.
Most patients can bear weight to tolerance, although some with more unstable fractures require approximately 6 weeks of protection with touch-down weight-bearing.
FRACTURE OF THE SHAFT OF FEMUR
Introduction

- Fractures of the shaft of the femur are the most common fractures encountered in orthopaedic practice.
- The femur is the largest bone of the body and one of the principal load-bearing bones in the lower extremity, fractures may result in prolonged morbidity and extensive disability unless treatment is appropriate.
- Fractures of the femoral shaft often are the result of high-energy trauma and may be associated with multiple system injuries.
Diagnosis

- history of trauma
- clinical features: swelling, pain, ecchymosis, deformity, tenderness, bony crepitus, pseudoarthrosis, limitation of hip and knee joints, even shock
- x-ray
- rule out the injury of popliteal artery and vein, tibial and common peroneal nerve
Treatment

Several techniques are now available for the treatment and the orthopaedic surgeon must select the proper treatment for each patient. The type and location of the fracture, the degree of comminution, the age of the patient, the patient’s social and economic demands and other factors may influence the method of treatment.
Treatment methods

- Closed reduction and spica cast immobilization
- Skeletal traction
- Femoral cast brace
- External fixation
- Internal fixation
Internal fixation

- Intramedullary nail
  1. Open technique
  2. Closed technique

- Interlocking intramedullary nail
  1. Reamed
  2. Unreamed

- Plate fixation
principles of treatment

Regardless of the method of treatment chosen, the following principles are agreed upon:

- **restoration of alignment, rotation and length**
- **preservation of the blood supply to aid union and prevent infection**
- **rehabilitation of the extremity and thereby the patient.**
Interlocking intramedullary nailing is currently considered to be choice for most femoral shaft fractures.

Open femoral shaft fracture stabilized with small diameter (10-mm) interlocking nail using unreamed technique.
FRACTURES OF THE PATELLA
Introduction

Fractures of the patella constitute almost 1% of all skeletal injuries, resulting from either direct or indirect trauma.
Classification

Fractures of the patella can be classified as undisplaced or displaced and further subclassified according to fracture configuration.
Diagnosis

- history of trauma
- clinical features:
  - swelling, pain, subcutaneous ecchymosis, localized tenderness, a palpable defect, limitation of knee joint, Hemarthrosis: floating patella test(+)
- X-ray
Inability of the patient to actively extend the affected knee usually indicates a disruption of the extensor mechanism and a torn retinaculum, which require surgical treatment.
Treatment

The initial treatment of acute patellar fractures

- splinting the extremity in extension or slight flexion
- applying ice to the knee. To prevent soft tissue damage, the ice should not be applied directly to the skin.
Nonoperative treatment

- Closed fractures with minimal displacement (3-4mm), minimal articular incongruity (2-3mm) and an intact extensor retinaculum can be treated nonoperatively.
- Immobilizing the knee in extension in a cylinder cast from ankle to groin for 4 to 6 weeks, with weight-bearing allowed as tolerated.
Operative treatment

Fractures associated with retinacular tears, open fractures, and fractures with more than 2 to 3 mm of displacement or incongruity are best treated operatively.
Types of patellar fixation
FRACTURES OF THE TIBIAL SHAFT
Introduction

By its very location the tibia is exposed to frequent injury.

Because one third of its surface is subcutaneous throughout most of its length, open fractures are more common in the tibia.

Blood supply to the tibia is more precarious than that of bones enclosed by heavy muscles.
High-energy tibial fractures may be associated with compartment syndrome or neural or vascular injury.

Delayed union, nonunion, and infection are relatively common complications of tibial shaft fractures.
Diagnosis

- history of trauma
- clinical features: swelling, pain, subcutaneous ecchymosis, eformity, tenderness, bony crepitus, etc
- x-ray
Prognosis

- The amount of initial displacement: more than 50% of the width of the tibia at the fracture site was a significant cause of delayed union or nonunion
- the degree of comminution
- whether infection has developed
- the severity of the soft tissue injury excluding infection
Treatment

Closed reduction and casting for stable, low-energy tibial fractures
Operative treatment

- unstable, comminuted, segmental or bilateral fractures
- floating knee injuries
- intraarticular extension of the fractures
- fractures in which the initial reduction is not achieved or is lost
- open fractures
- fractures associated with compartment syndrome and involving vascular injury
Locked intramedullary nailing currently is the preferred treatment for most tibial shaft fractures requiring operative fixation.
Open tibial fracture stabilized with Russell-Taylor intramedullary nail.
Open tibial fracture stabilized with monolateral external fixator
Fracture of tibia fixed by compression plate and screws
TIBIAL PLATEAU FRACTURE
Classification

1. Minimally displaced
2. Local compression
3. Split compression
4. Total condyle
5. Bicondylar
Treatment

Goals

restoration of articular congruity, axial alignment, joint stability, and functional motion.

Nonoperative treatment

undisplaced fractures: a few days of splinting followed by early active knee motion. Weight-bearing should be delayed until fracture healing is evident, generally at 8 to 10 weeks.
Surgical treatment

- fractures associated with instability, ligamentous injury, and significant articular displacement
- open fractures
- fractures associated with compartment syndrome
Plate and screw fixation of fracture of medial tibial plateau
Ligament repair

- Ligamentous injuries have been reported in 4% to 33% of tibial plateau fractures.
- Collateral and cruciate ligament injuries occurring with tibial condylar fractures are much more common.
- The medial collateral ligament is most commonly injured.
FRACTURE OF ANKLE
Introduction

- The ankle joint is easily injured at plantar flexion posture.
- Injuries about the ankle joint cause destruction of not only the bony architecture but also often of the ligamentous and soft tissue components.
Ankle fractures can be classified purely along anatomical lines as:
- monomalleolar
- bimalleolar
- trimalleolar
Treatment

- Nondisplaced fractures usually can be treated with cast immobilization.
- In individuals with high functional demands, internal fixation may be appropriate to hasten healing and rehabilitation.
- Displaced fractures should be treated surgically.
X-ray after reduction

- The normal relationships of the ankle mortise must be restored.
- The weight-bearing alignment of the ankle must be at a right angle to the longitudinal axis of the leg.
- The contours of the articular surface must be as smooth as possible. The best results are obtained by anatomical joint restoration.
FRACTURES OF CALCANEUS
Bohler angle
Diagnosis

- history of falling from high
- clinical features
  - swelling, subcutaneous ecchymosis, pain, limitation of walking sign:
  - tenderness, deformity
- x-ray
X-ray should include five views

- A lateral roentgenogram: to assess height loss (loss of the Bohler angle) and rotation of the posterior facet.
- The axial (or Harris) view: to assess varus position of the tuberosity and width of the heel.
- Anteroposterior and oblique views of the foot to assess the anterior process and calcaneocuboid involvement.
A single Brodén view, obtained by internally rotating the leg 40 degrees with the ankle in neutral, then angling the beam 10 to 15 degrees cephalad, to evaluate congruency of the posterior facet.

External rotation view is taken at 45 degrees of external rotation and 30 degrees of roentgenographic tube angulation.
single Brodén view
Treatment

- conservative treatment for nondisplaced or minimally displaced fractures with early range of motion
- axial fixation with a metallic pin for tongue-type fractures
- open reduction and internal fixation for joint depression fractures
INJURY OF MENISCI
Function of menisci

The menisci act as a joint filler, compensating for gross incongruity between femoral and tibial articulating surfaces.

The menisci prevent capsular and synovial impingement during flexion-extension movements.
The menisci have a joint lubrication function, helping to distribute synovial fluid throughout the joint and aiding the nutrition of the articular cartilage.

They contribute to stability in all planes but are especially important rotary stabilizers and are probably essential for the smooth transmission from a pure hinge to a gliding or rotary motion as the knee moves from flexion to extension.
Mechenism

- Traumatic lesions of the menisci are most commonly produced by rotation as the flexed knee moves toward an extended position.
- The most common location for injury is the posterior horn of the meniscus, and longitudinal tears are the most common type of injury.
Diagnosis

- The diagnosis of internal derangement of the knee caused by a meniscal tear is difficult.
- Using a careful history and physical examination and supplementing standard roentgenograms in specific instances with special imaging techniques and arthroscopy.
Diagnostic tests

- Clicks, snaps, or catches, either audible or detected by palpation during flexion, extension, and rotary motions of the joint
- McMurray test
- Apley grinding test
- Magnetic resonance imaging (MRI)
- Arthroscopy acts as the method of diagnosis and therapy