

Malunion of long bones



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Definition

A malunited fracture is one that has healed with the fragments in a non-anatomical position



Acceptability of fracture reduction

alignment

rotation

normal length

actual position of fragments
(least important)



Classification

Based to location

Intrarticular

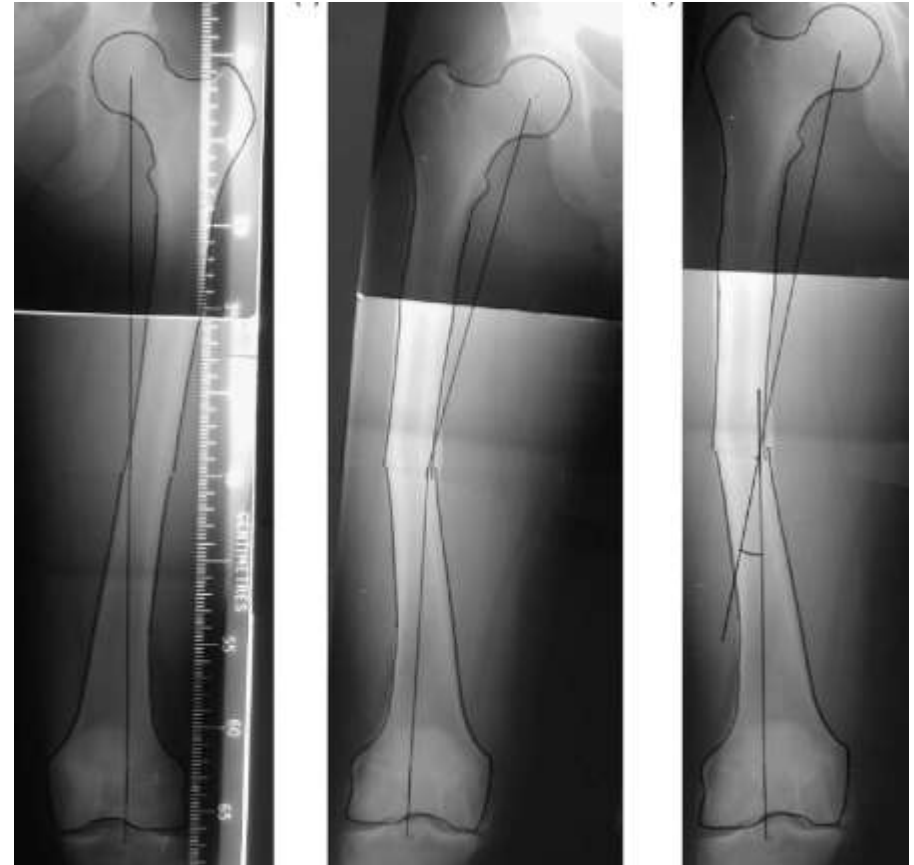
Metaphsial

Diaphysial

Based to complexity

Simple (one plane) e.g. valgus-varus

Complex (multi planes)



However, some malalignments are better tolerated from the neighboring joints than others (e.g. malunions of the upper extremity)

Also lower leg valgus is more acceptable than varus



This means there are both relative and absolute indications to correct deformities and leg length discrepancies

Absolute Indications

- Presence of disabling pain
- Severe functional disability

Relative Indications

- Cosmetic reasons
- No response to nonoperative treatment

The object of surgery for malunion is to restore function

Operative treatment for malunion of most fractures should not be considered until **6 to 12 months** after the fracture has occurred.

However, in intraarticular fractures, surgery may be required sooner if satisfactory function is to be restored

When considering surgical correction of the malunion we should take in account:

1. Age of the patient
2. Socio-economic factors
3. The function of the joint
4. The bone stock and the degree of osteoporosis
5. The state of the soft tissue envelope



Corrective surgery at the site of malunion is not always feasible.

In some instances, a compensatory procedure may be necessary to restore function; in others, pain may be the predominant symptom and may require fusion of a joint.

Preoperative Planning

X-rays (contralateral normal side) , CT imaging/3D reconstruction, MRI scans (measurement of alignment)

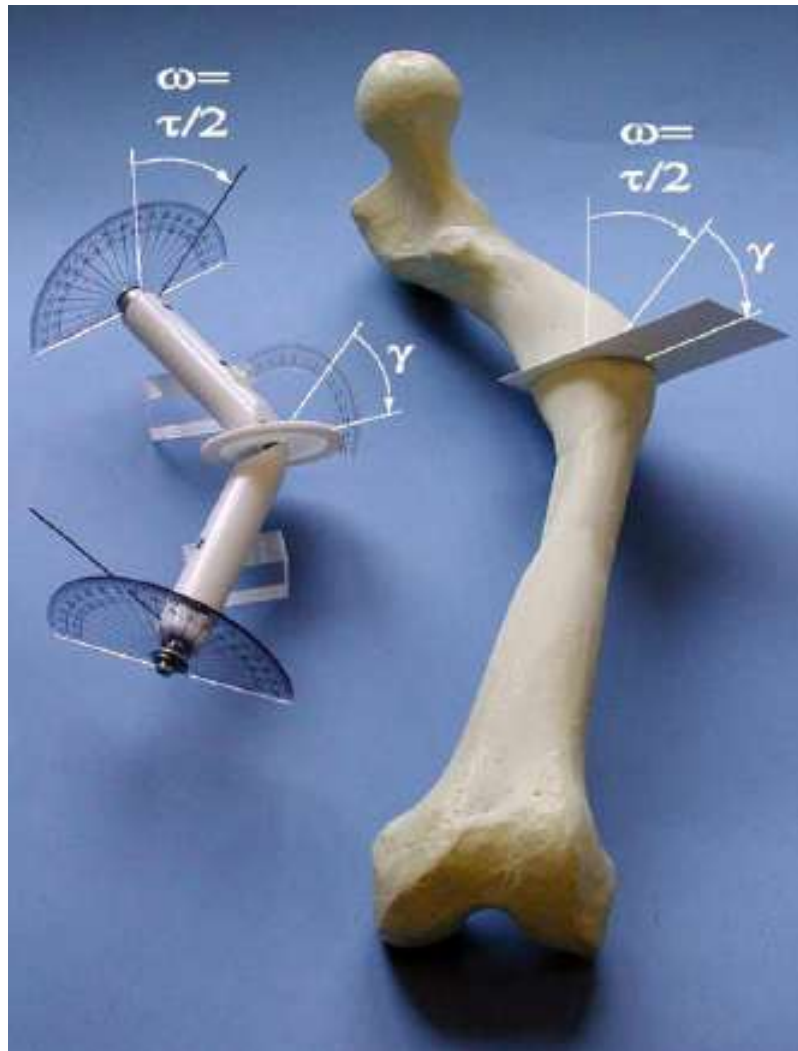
Evaluation of the soft tissue and bone condition

Throughout physical examination and history

A new methodology for the planning of single-cut corrective osteotomies of mal-aligned long bones

D.C. Meyer ^a, K.A. Siebenrock ^b, B. Schiele ^c, C. Gerber ^{a,*}

Clinical Biomechanics 20 (2005) 223–227



Implant Choices

Plates and screws

- Grants intrafracture compression & anatomical reduction
- Is mandatory to be covered adequately from soft tissues
- The implant of choice in case of periarthritic & metaphyseal areas

External fixation devices

- Useful to avoid soft tissue irritation,
- Better to be used at the supramalleolar areas & tibial plafond

Intramedullary devices

- The implant of choice in case of the diaphysis of the long bone

Proximal Humeral Malunion

TYPE I, malposition of the greater or lesser tuberosity of >1 cm;

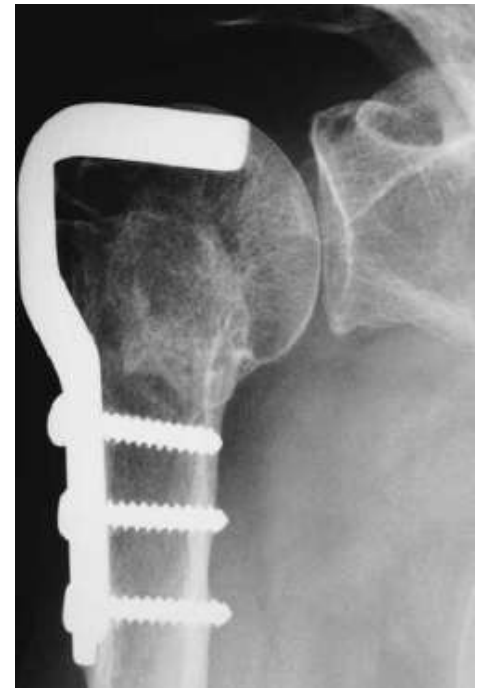
TYPE II, intraarticular incongruity or step-off of the articular surface >5 mm

TYPE III, rotational malalignment of the articular segment >45 degrees in the coronal, sagittal, or axial plane



Operative procedures for proximal humeral malunions

1. **acromioplasty -osteotomies** of the tuberosities or surgical neck, if the blood supply to the humeral head is maintained and the articular surface is preserved
2. **hemiarthroplasty** or total shoulder arthroplasty
3. **arthrodesis**, rarely, if a severe neurological deficit or previous infection is present





Malunion of the humeral shaft

Malunited humeral shaft fractures rarely need surgical correction

The same principles are used in correcting this malunion as in those of other long bones:

The deformity is corrected by osteotomy, a compression plate is applied, (Cancellous grafts)



Malunions of the distal humerus

As the result of the following fractures:

- (1) supracondylar fractures (more common in children),
- (2) T-fractures of the condyles,
- (3) fractures of the distal condylar articular surface



The most common is the **cubitus varus deformity** associated with :

ulnar nerve neuropathy

snapping of medial head of the triceps

avascular necrosis of humeral epiphysis,

elbow instability



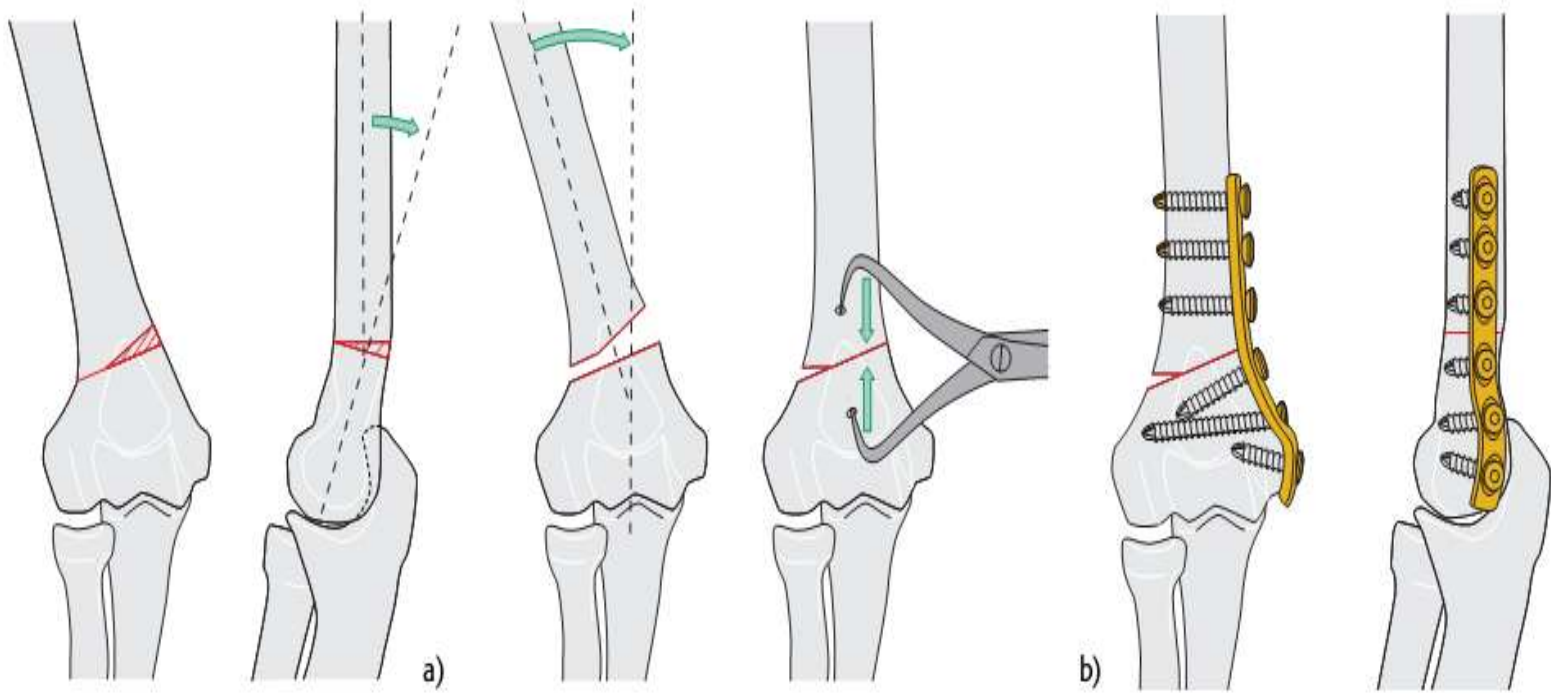
O'Driscoll et al, *J Bone Joint Surg* 83A:1358, 2001

Treatment Options

Wedge osteotomy alone

Osteotomy combined with ligament reconstruction
(High demands & severe deformity $> 15^\circ$)

Total elbow arthroplasty





Proximal radius & ulna malunions

Malunions of the proximal third of the radius and ulna can be classified:

- (1) of the radial head
- (2) of the radial neck
- (3) of the olecranon
- (4) with anterior dislocation of the proximal radius
(Monteggia fracture)
- (5) with synostosis between the radius and ulna.



7-year old girl with a Bado I equivalent lesion 5 months after trauma



reduction of the radial head and fixation of the ulnar osteotomy with a plate

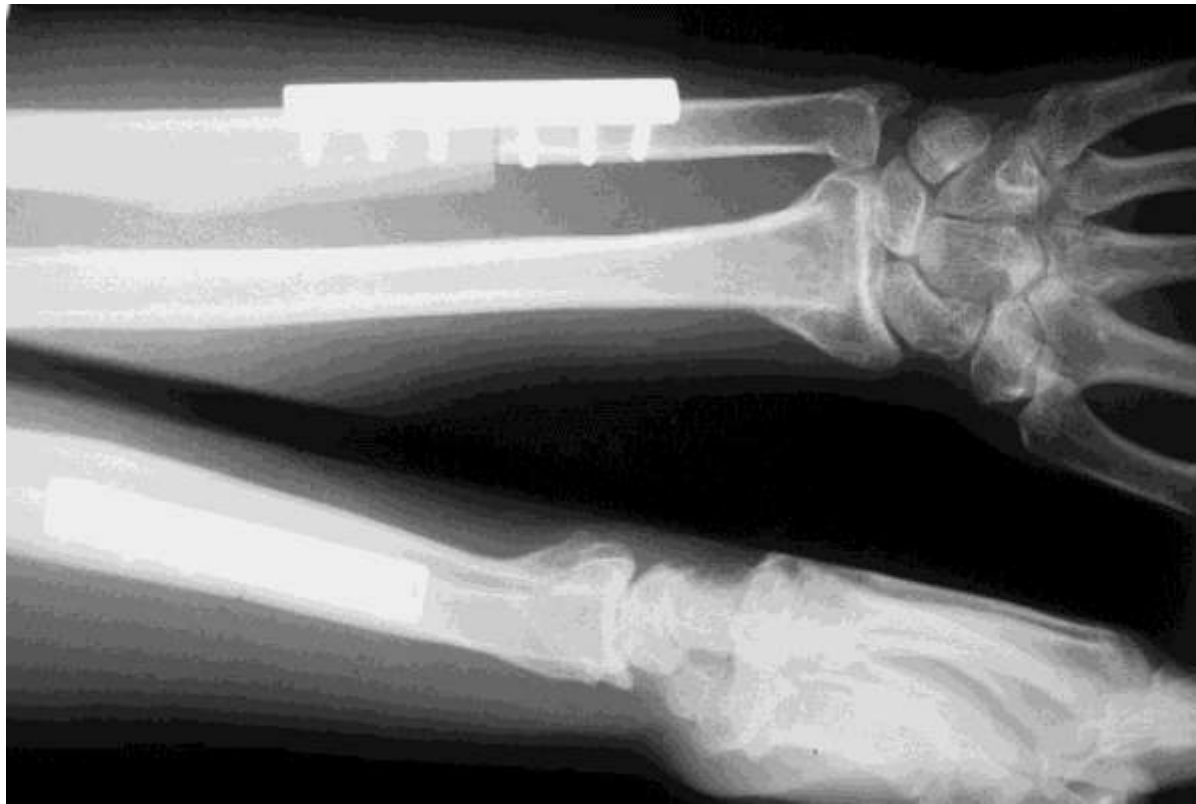
Forearm Shaft Malunions

Malrotation, angulation and loss of the radial bow all have been associated with loss of motion and compromised functional outcomes

Malunited forearm fractures may lead to disturbances of the distal radioulnar joint, and arthritis of the proximal radioulnar joint

In a cadaveric study, Matthews et al. found an insignificant reduction in forearm rotation with a 10° angulatory deformity, whereas a 20° angulation caused a functional loss of pronation and supination.

In a similar study, Tarr, Garfinkel, and Sarmiento showed that angular or rotational deformities of $<10^\circ$ resulted in minimal limitation of forearm rotation; however, with 15° of total deformity, forearm motion was reduced $> 27\%$ except in distal-third fractures



Supination or pronation contractures limiting the use of the forearm can be neutralized by a **rotational osteotomy** of the ulna, thus creating a more functional position of the forearm.

Malunions of the distal radius

Not all distal radial malunions are symptomatic, especially those in elderly patients with low functional demands. In such patients, no further treatment is indicated



Indications for surgical intervention

pain and functional deficits severe enough to interfere significantly with daily activities

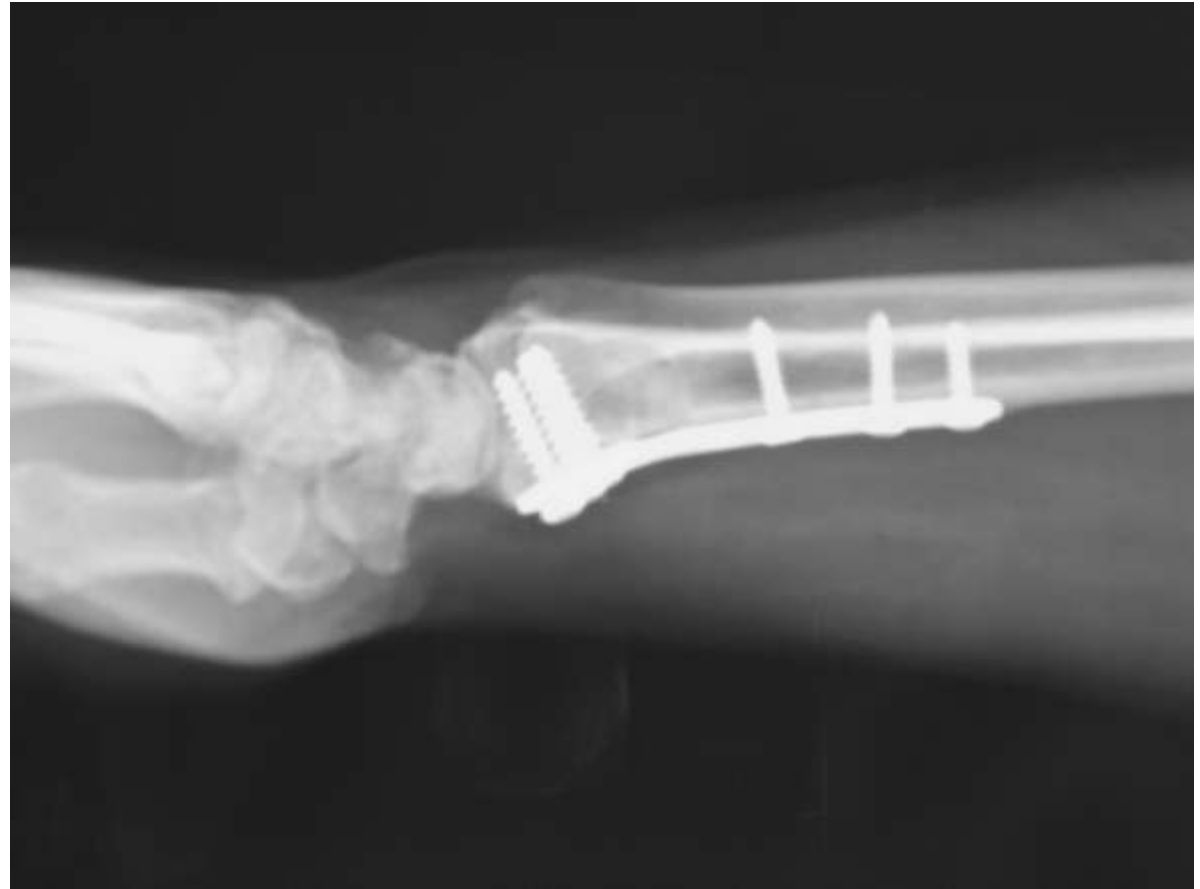
a young, active patient (< 40 years old) with a deformity that is likely to become symptomatic with time:

- articular step-off of > 2 mm
- carpal instability
- > 20 -30° of dorsal angulation
- incongruent distal radioulnar joint)





6 months pop



Proximal Femur Malunions

varus and **rotational** deformities in combination with **shortening** leading to limping and overuse of the neighboring joints.

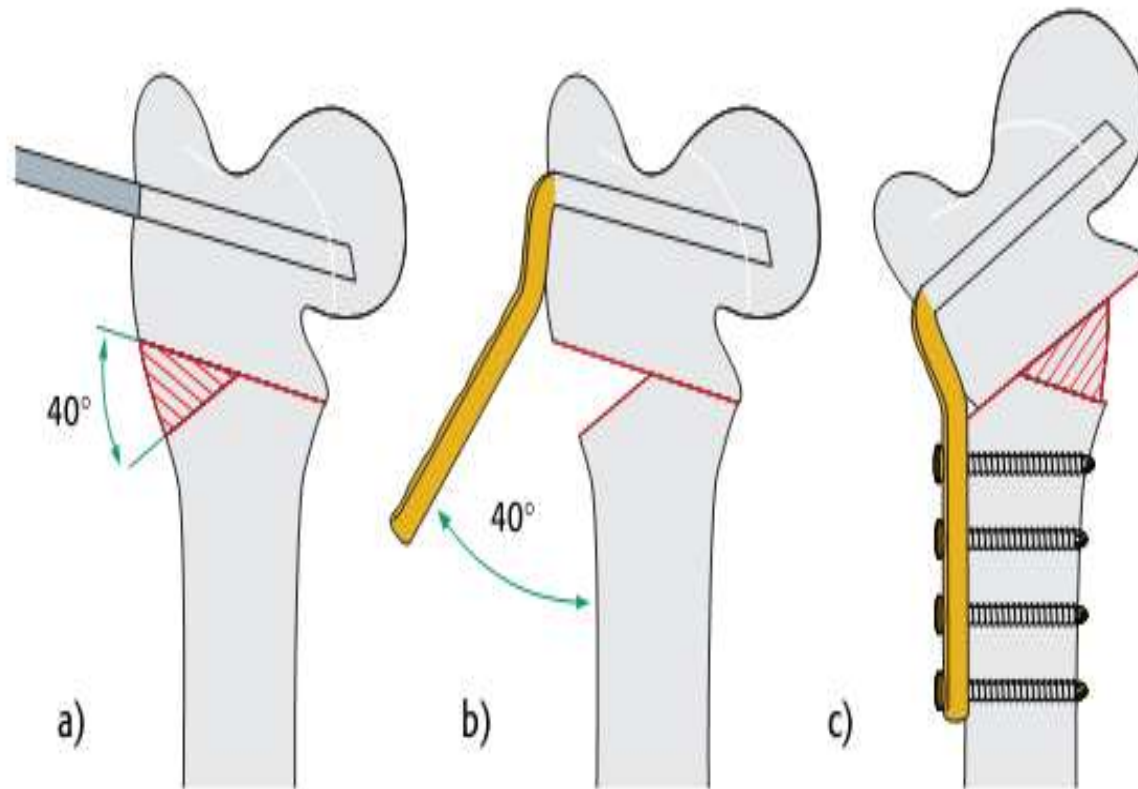
Malunited fractures in the **trochanteric region** can be divided into two types:

- (1) those with internal or external rotation, coxa vara, and shortening of about 2.5 cm

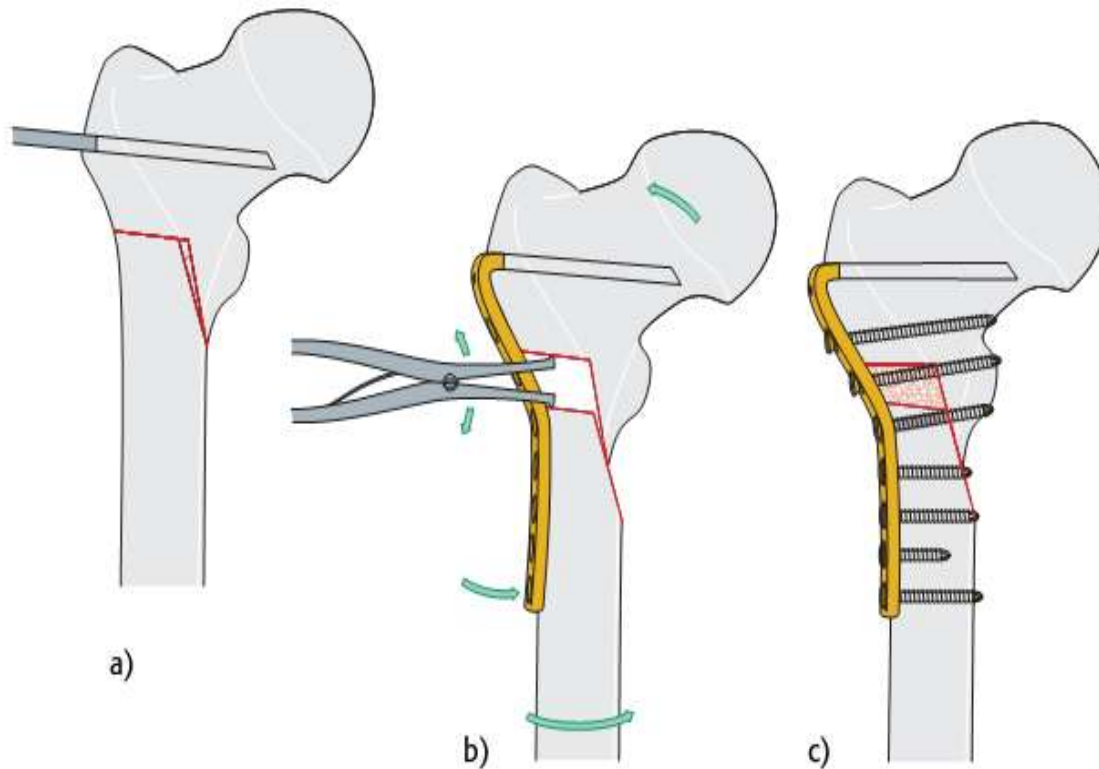
=>Treated with subtrochanteric osteotomy

- (2) those with internal or external rotation, severe coxa vara, and shortening of 5 cm or more

Intertrochanteric valgization osteotomy for varus deformity. Lateral approach, placement of K-wires for the control of anteversion, rotation, and the calculated angle for the seating chisel.



Use of a 120° angled blade plate after repeated reduction using the seating chisel as lever arm until the calculated correction is achieved



- Three-dimensional subtrochanteric lengthening of combined malunion including shortening
- Technically demanding and experience in individual shaping of plates is required



Femoral shaft Malunions

Become significant only if they result in :

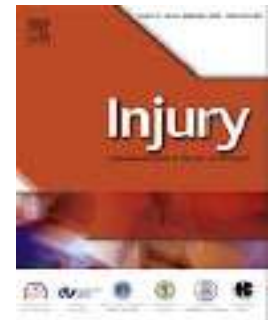
- Shortening of > 2.5 cm,
- Angulated $> 10^\circ$,
- Internally or externally rotated (to the point that the knee cannot be aligned with forward motion during gait)

Malunions of the femur can cause disturbances in gait and posture, which can cause abnormal stresses on the knee and spine (osteoarthritis?)

Long-term follow-up of femoral shaft fracture: Relevance of malunion and malalignment for the development of knee arthritis

J.R.A. Phillips^{a,*}, A.J.H. Trezies^b, T.R.C. Davis^a

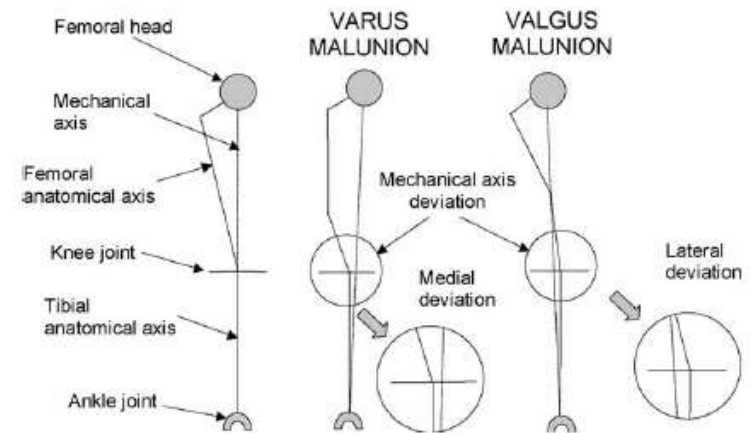
Injury, Int. J. Care Injured 42 (2011) 156–161



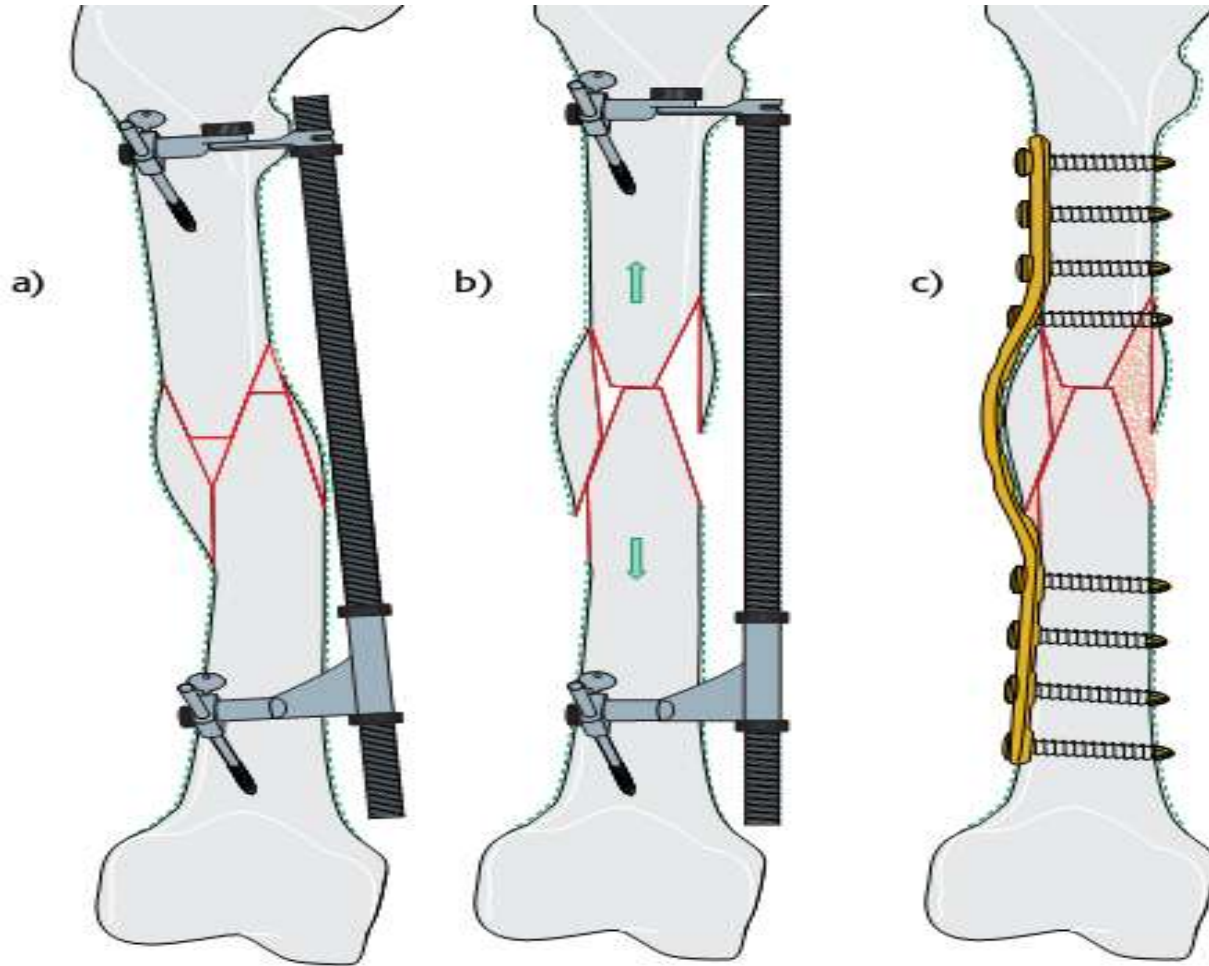
64 pt (37-traction, 10 plate and 17 IMN)
treated between 1970-79

It is concluded that femoral shaft malunion and malalignment does not cause an excess of knee arthritis at **22-year follow-up**.

However, a significant number of this cohort has developed mild symptoms of ipsilateral knee pain or stiffness at a median age of 42 years;



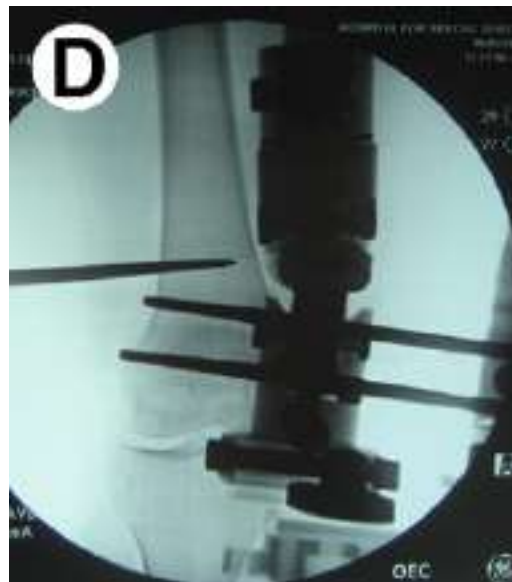
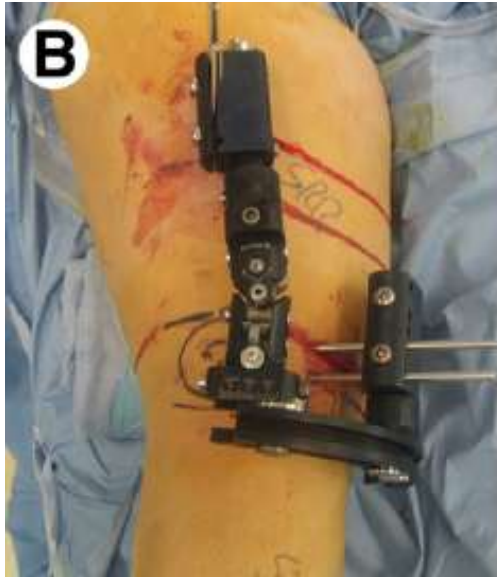
Operative techniques



Fixator-Assisted Plating of Limb Deformities

S. Robert Rozbruch, MD

Oper Tech Orthop 21:174-179 © 2011



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The Clamshell Osteotomy: A New Technique to Correct Complex Diaphyseal Malunions

J Bone Joint Surg Am. 2009;91:314-24

By George V. Russell, MD, Matt L. Graves, MD, Michael T. Archdeacon, MD, MSE, David P. Barei, MD, FRCS(C),
Glenn A. Brien Jr., MD, and Scott E. Porter, MD



Distal Femur Malunion

Indications for surgery:

- Malunions in valgus & varus
- ante, or recurvation deformities
- rotation deformities

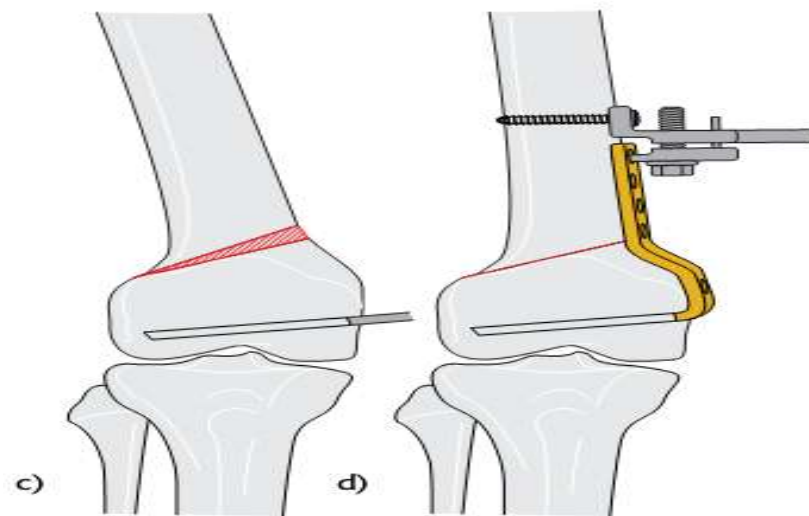
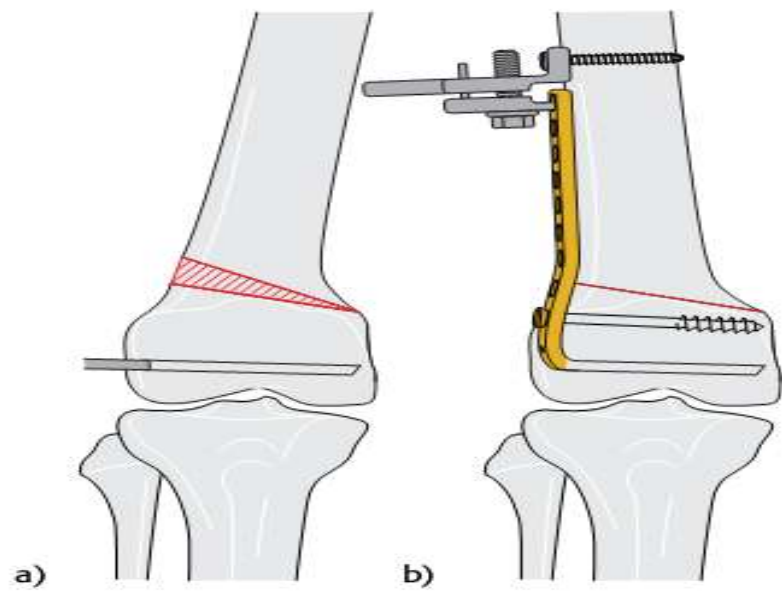
Treatment: Axial correction by open or close wedge supracondylar osteotomy

Implants of choice:

- The **hip plate 90°** with a displacement potential of 10–20 mm for medial application in valgus deformities
- **condylar plate** fits exactly to the lateral side of the distal femur for varus, antecurvation/recurvation and rotational malunions

Pearl: The contra-lateral cortex should remain intact so as to create some intrinsic stability





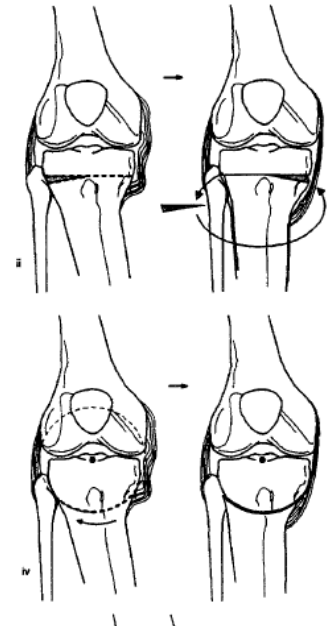
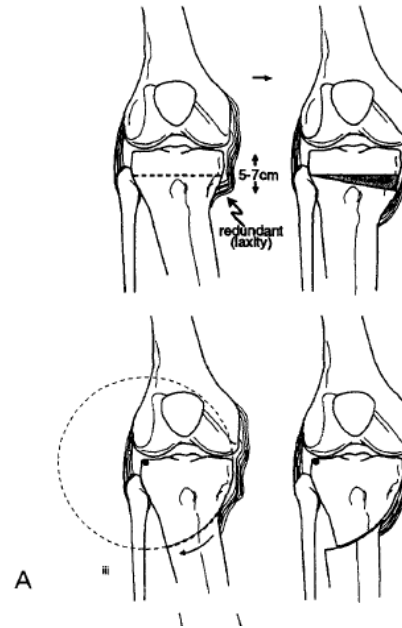
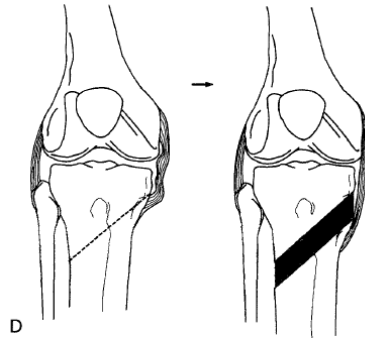
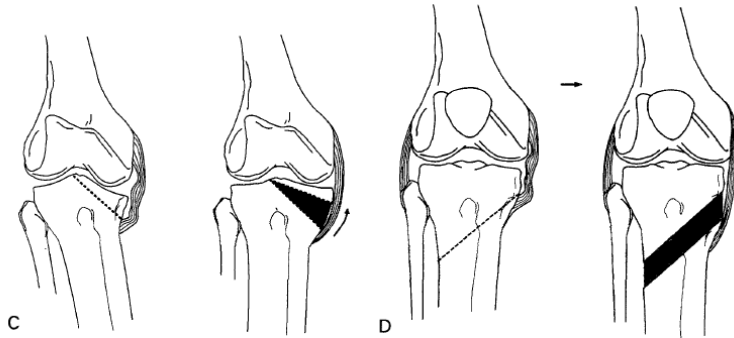
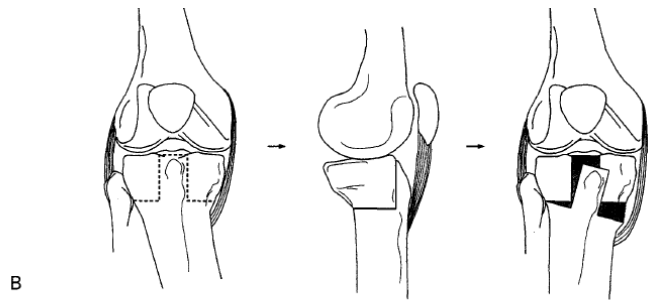
Proximal Tibia Malunions

Indications for surgery:

- Deformities of the proximal tibia in all three planes
- Intra-articular malunions after monocondylar fractures
- Residual joint impaction in combination with ligamentous instability.

Part 4: Corrective Osteotomies for Lower Limb Deformities

D. Paley

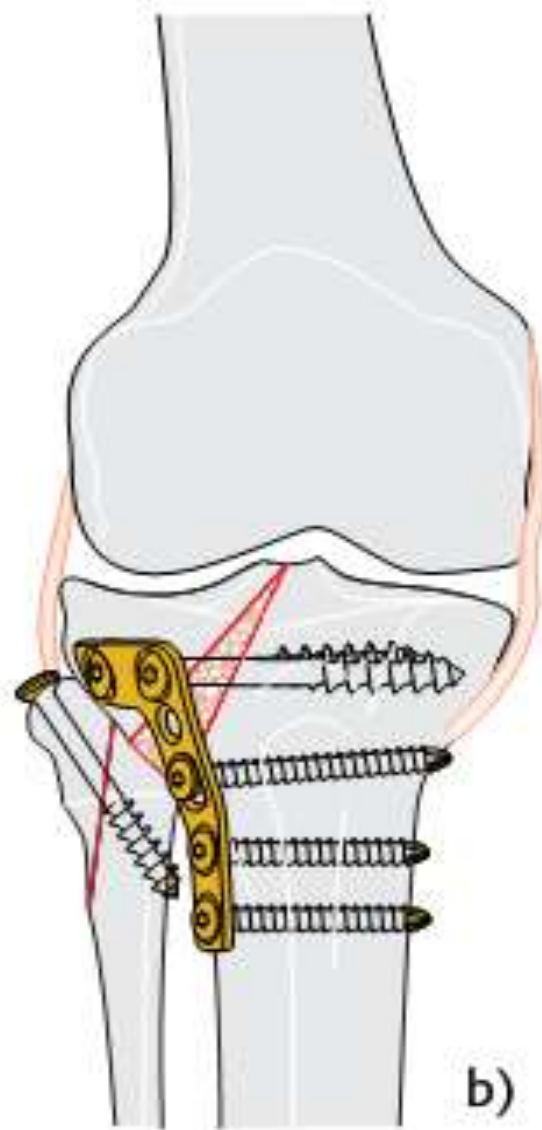
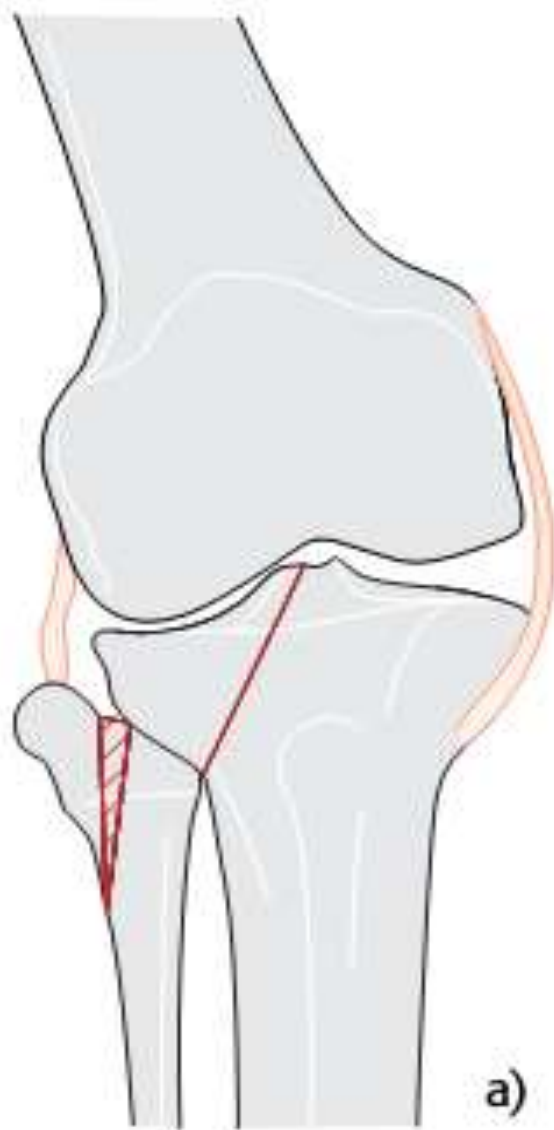


Preoperative planning is difficult but very important:

- Rö studies (AP/Lateral & oblique views, full length, weight bearing)
- CT-scan reconstruction in intra-articular deformities.

The standard device is a 95° blade plate with screws



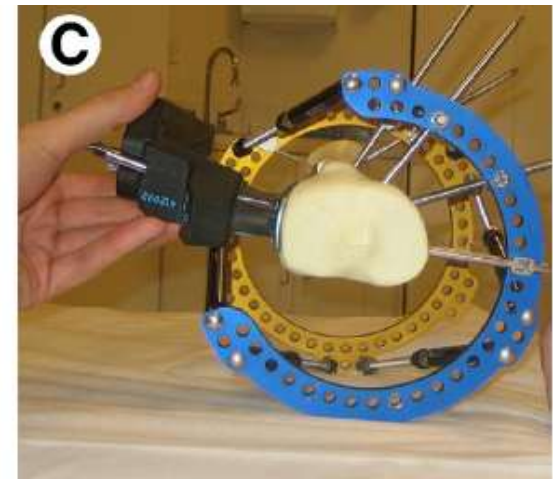
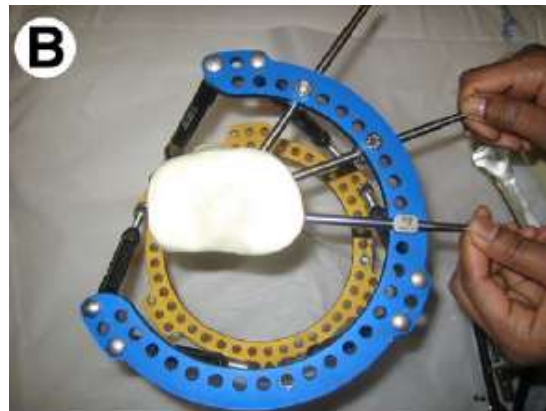




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Malunion Of the Tibial Shaft

Varus deformities were more poorly tolerated than were valgus deformities

Surgery is indicated for :

- valgus deformity of $> 12^\circ$
- varus deformity of $> 6^\circ$
- external rotation deformity of $> 15^\circ$
- internal rotation deformity of $> 10^\circ$
- > 2.5 cm of shortening



Several choices of treatment:

Simple opening wedge, closing wedge, or dome-shaped osteotomies

Oblique osteotomies can be used to correct multiplanar deformities



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