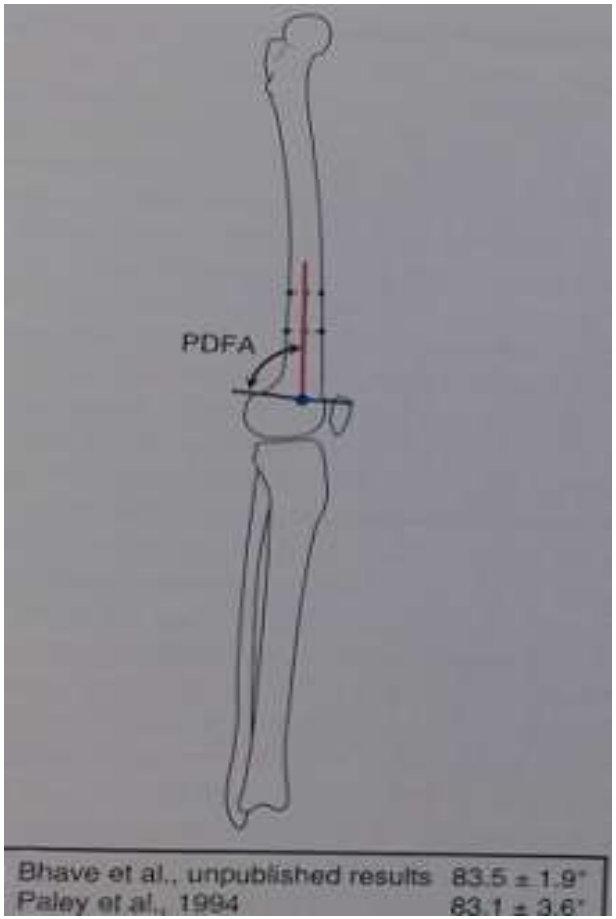
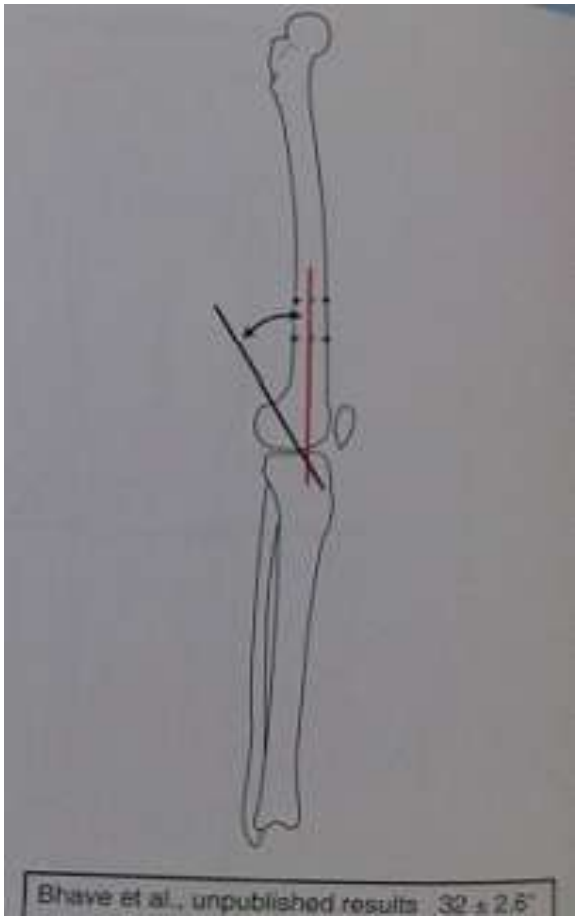
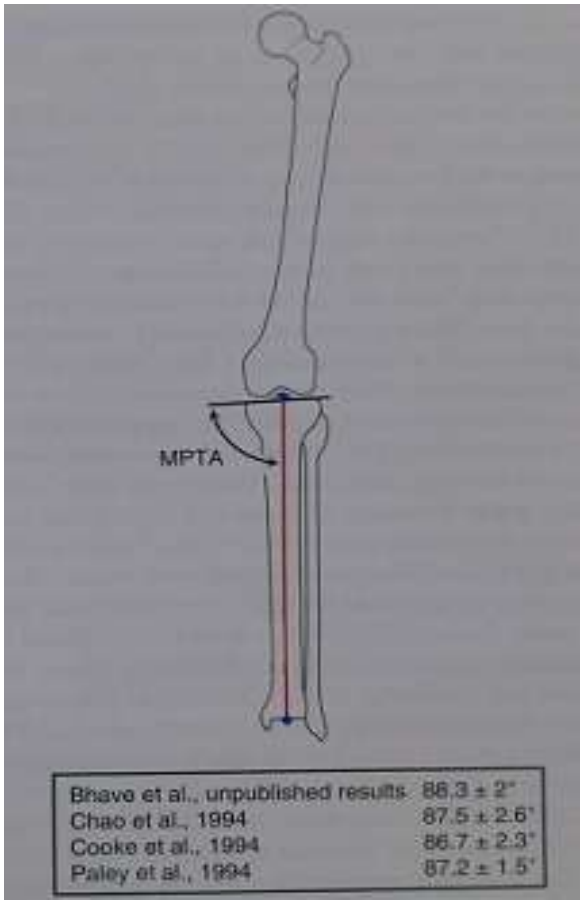
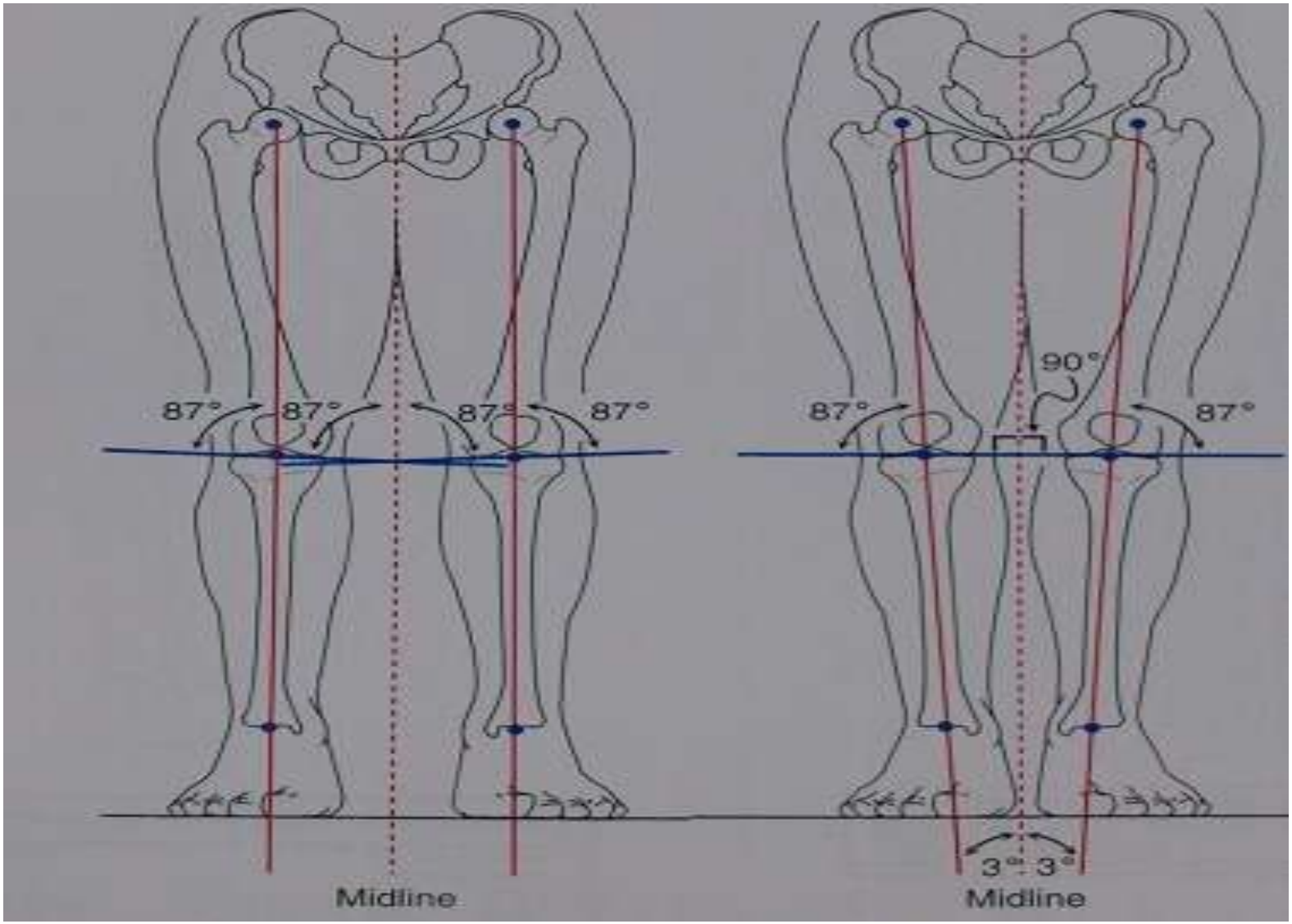
- Knee joint orientation measures approx. 3^{o} to prependicular.

- Blumensaat's line angle measures 32 ± 2.6^{o}.









At ease

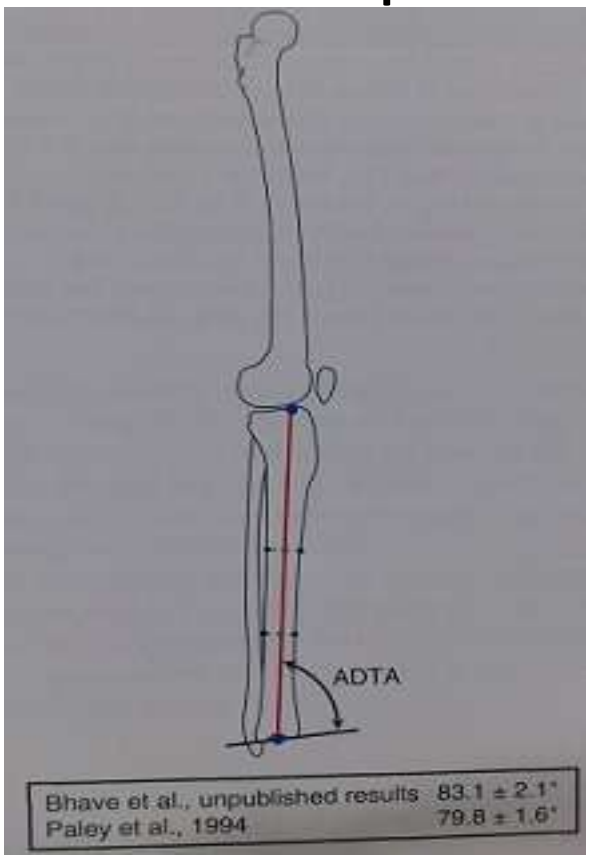
At attention

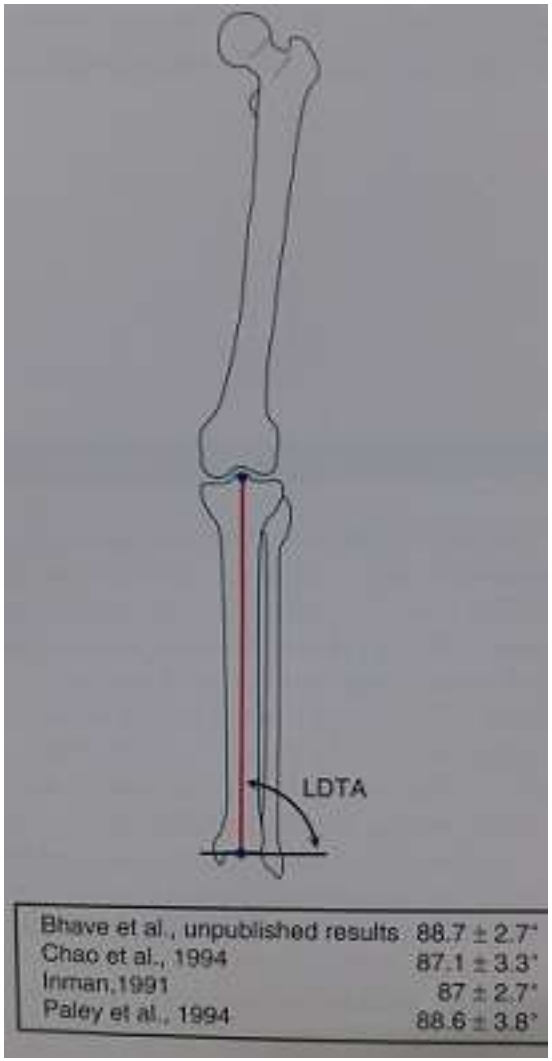
STANDING POSITION

ANKLE JOINT ORIENTATION

- Slight valgus.

- Variable up to 8^{o}.





MALALIGNMENT & MALORIENTATION

- Malalingment refers to the loss of collinearity of hip , knee & ankle.

- MAD arises from 4 anatomic sources :-

✓Femoral frontal plane deformity.

✓Tibial frontal plane deformity.

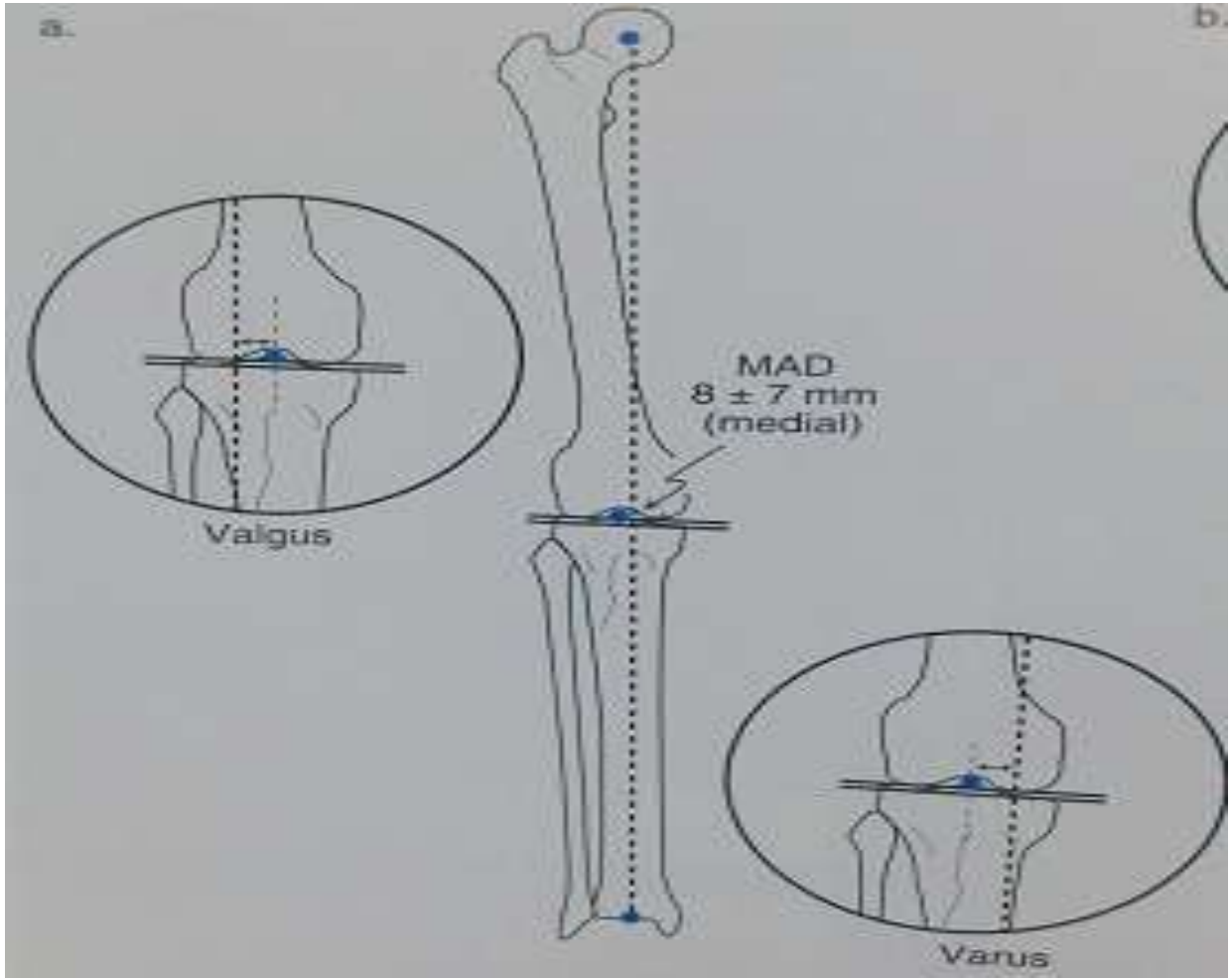
✓Knee joint laxity.

✓Femoral or tibial condylar deficiency.

MALALINGMENT TEST

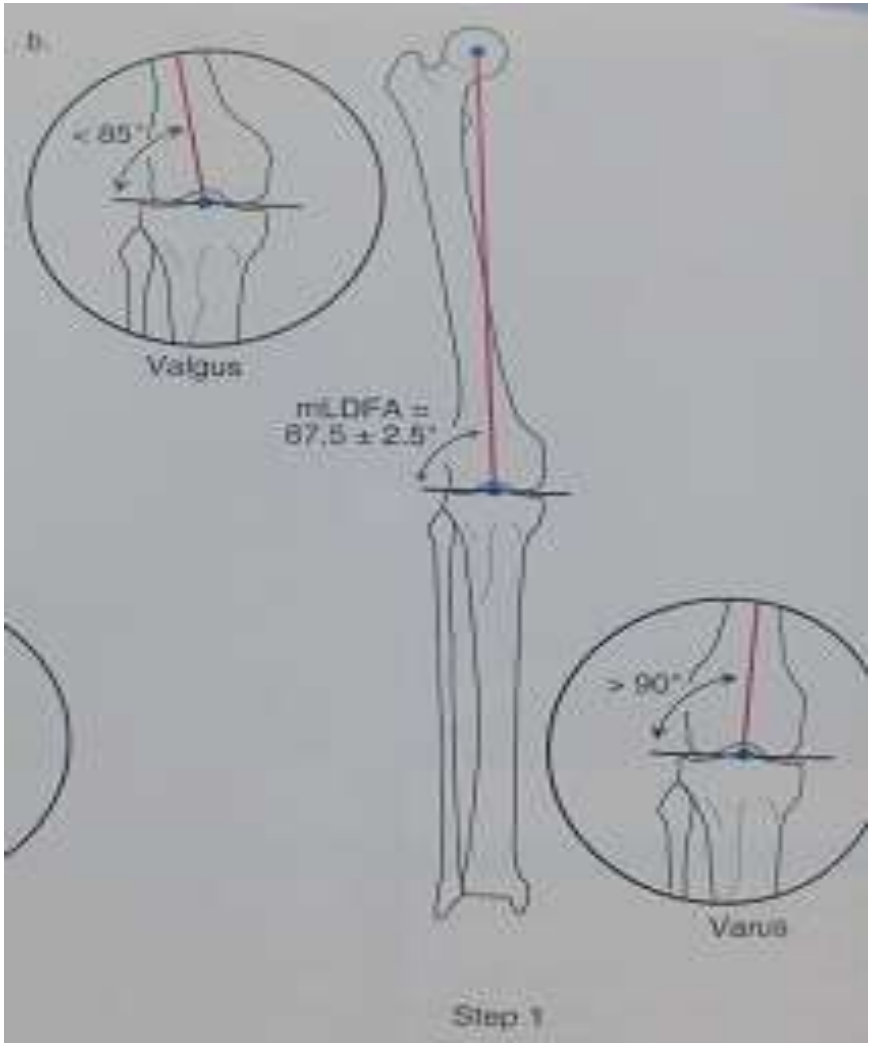
- STEP 0 : Measure MAD

✓Average MAD is 8±7 mm medial.



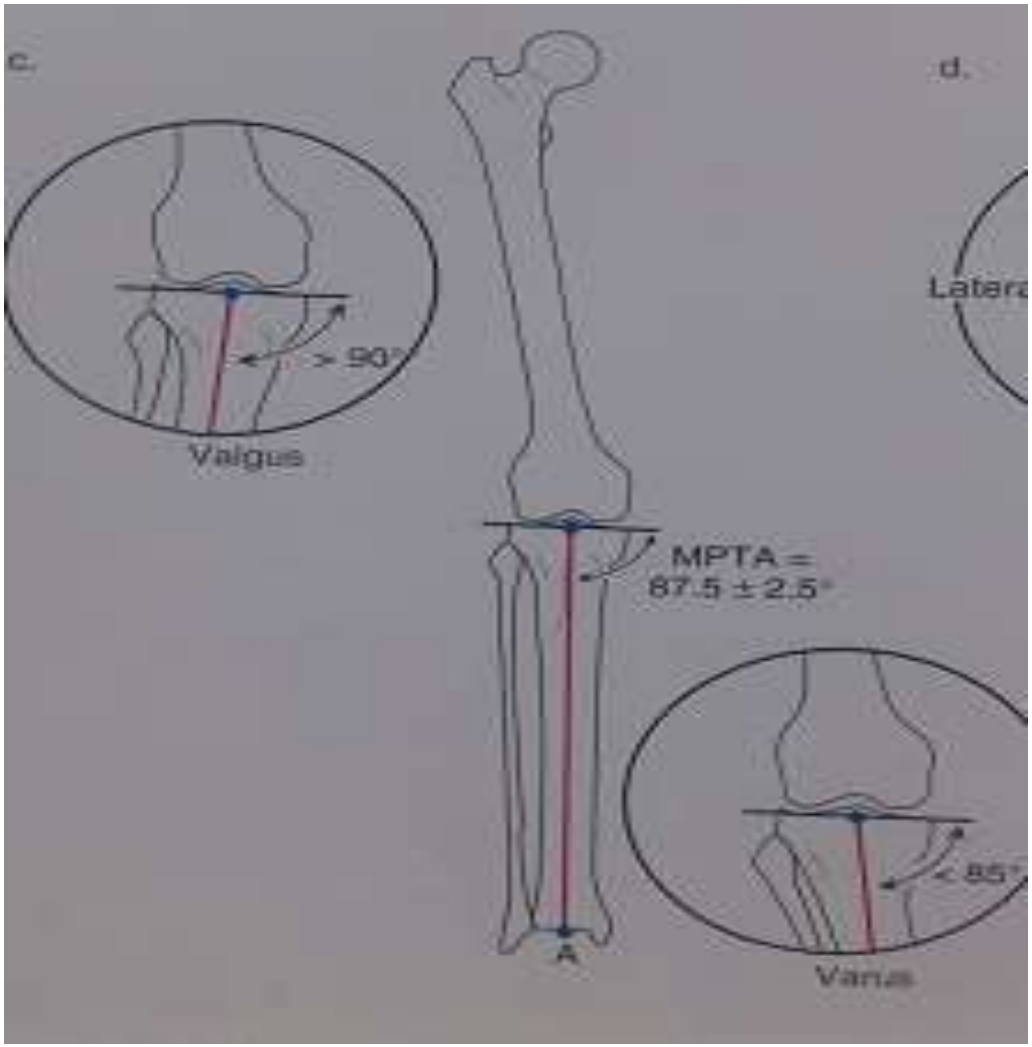
- STEP 1 :- Measure m LDFA.

✓ Normal range is 85^{o}-90^{o}.



- STEP 2:- Measure MPTA.

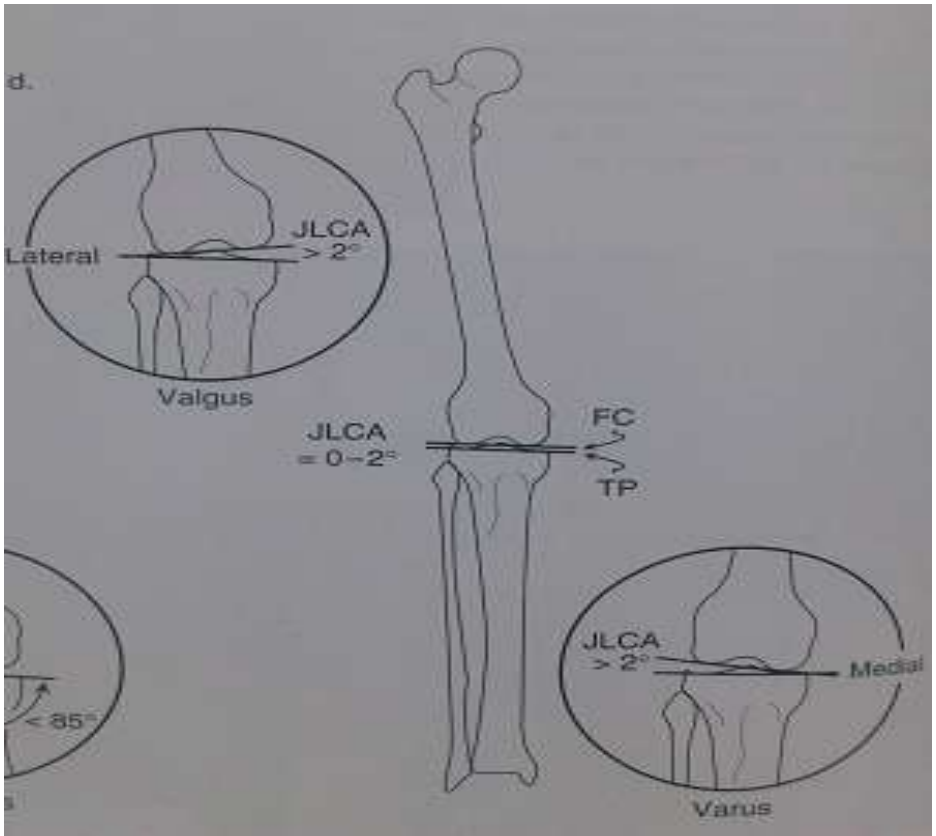
✓ Normal range is 85^{o}-90^{o}.



- STEP 3:- Measure JLCA

✓ Normally joint lines are parallel within 2^{o}.

✓ Angles greater then 2^{o} are considered as a source of MAD.



- RULE OUT JOINT SUBLUXATION

✓ Compare the mid point of femoral & knee joint orientation line.

✓ Normally they should be with in 3mm.

CORA

- Point at which distal & proximal axis line intersect is known as CORA (Center of rotation of angulation).

- Axis of proximal bone segment are proximal mechanical axis (PMA) or proximal anatomical axis (PAA).

- Axis of distal fragment are distal mechanical axis (DMA) or distal anatomical axis (DAA).

MECHANICAL AXIS PLANNING

- Center point of joint is always on PMA or DMA.

- 2 Possible reference line that can be used are :-

✓Joint orientation line
✓Mid diaphyseal line

- At knee there is very little variability in joint orientation angles so preferred reference line is joint orientation line.

- At hip & ankle the variability is more so mid diaphyseal line is preferred.

ANATOMICAL AXIS PLANNING

- Mid diaphyseal line defines anatomic axis.

- In diaphyseal angular deformity proximal & distal mid diaphyseal line can be used to describe CORA.

CORA METHOD

- STEP 0 :- MAT

✓ Draw mechanical axis of both lower limb.

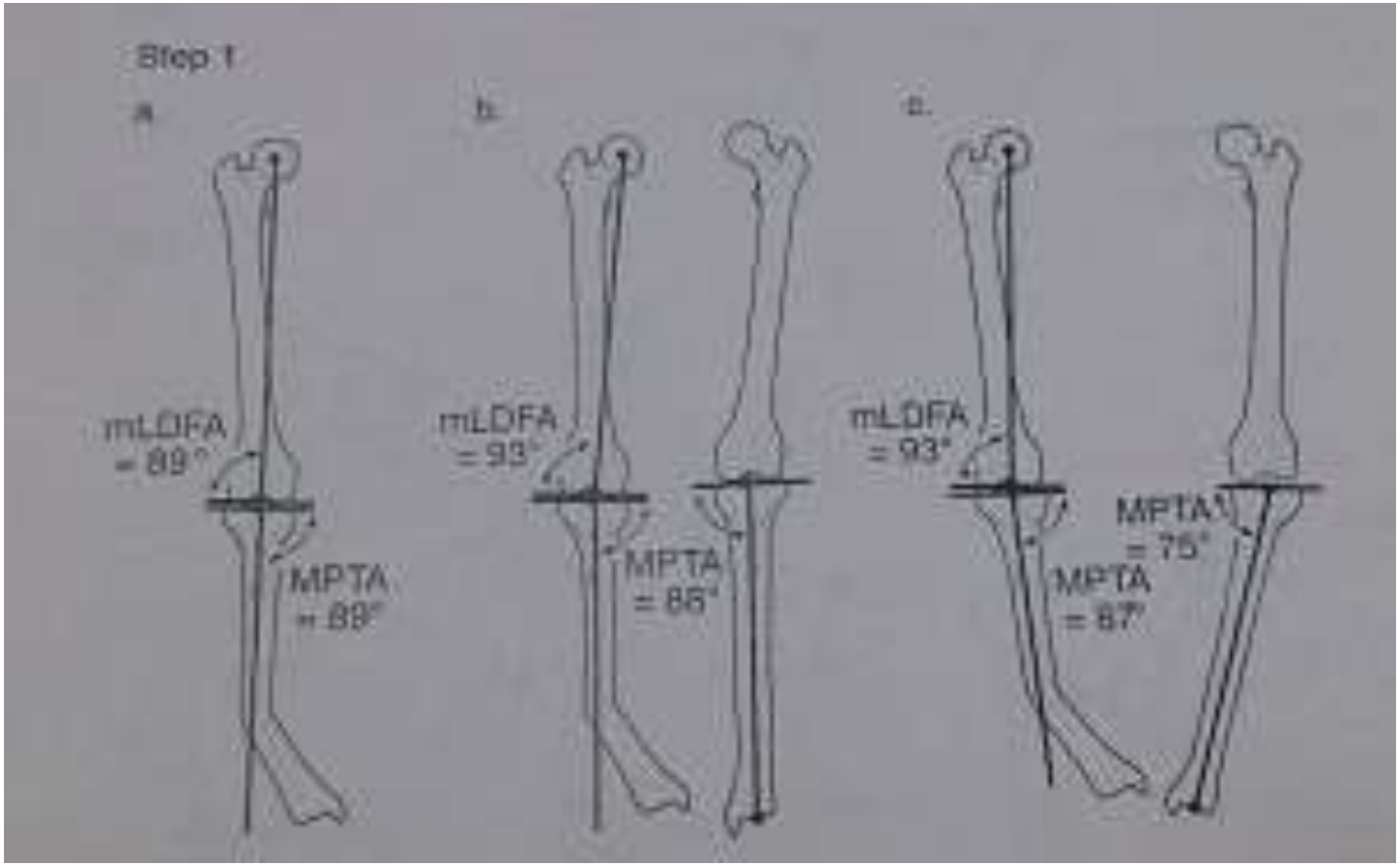
✓ Calculate MAD.

✓ If one side is considered as normal then its angle can be used as template for deformed side.

✓ If the other side also has deformity then the normal angles are considered.

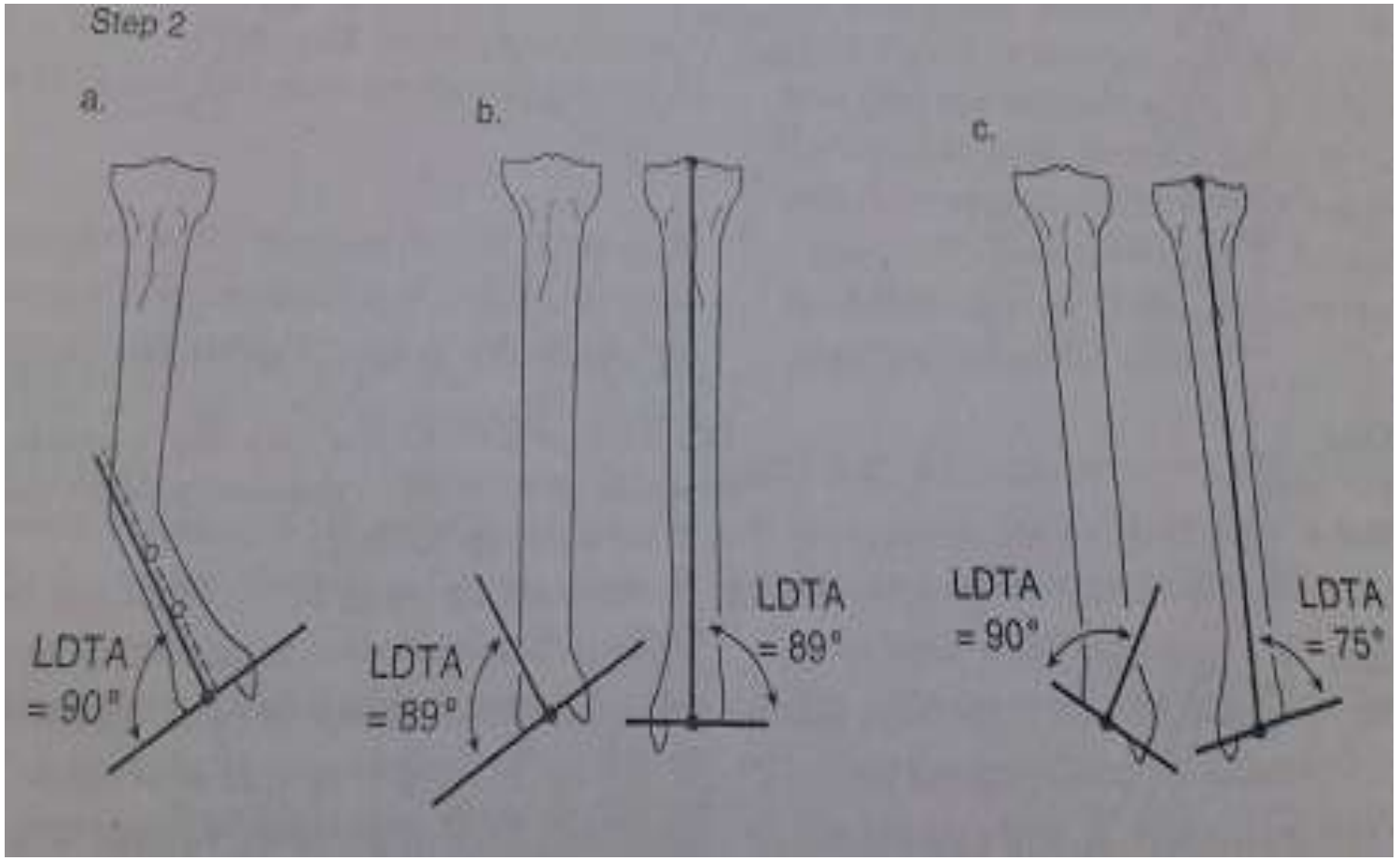
- STEP 1 :-

✓Draw proximal mechanical axis line.



- STEP 2 :-

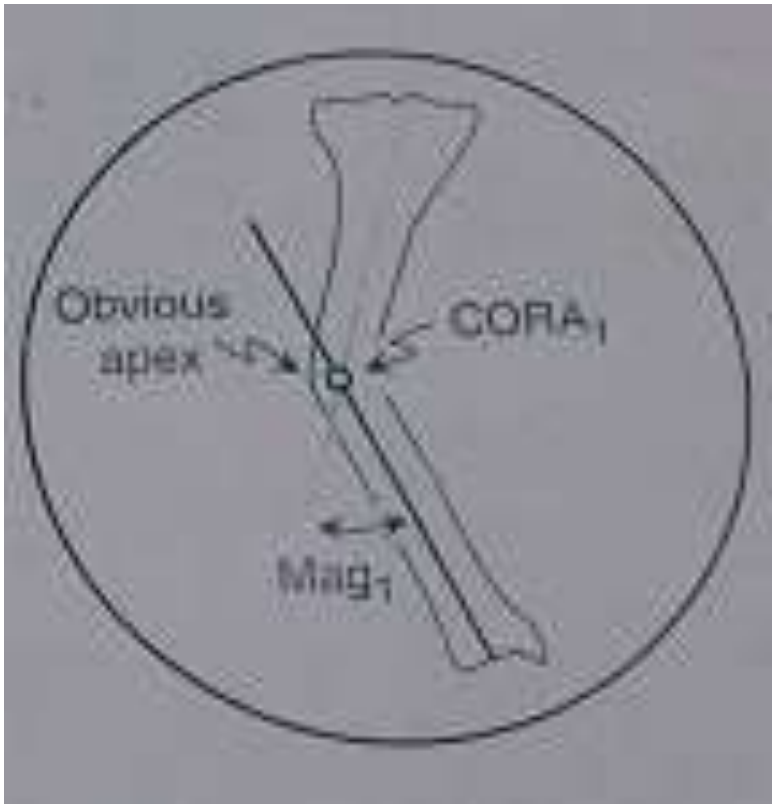
Draw distal mechanical axis.



- STEP 3 : Decide whether its uniapical or multiapical angulation :-

✓ Mark CORA

✓ Measure the magnitude.

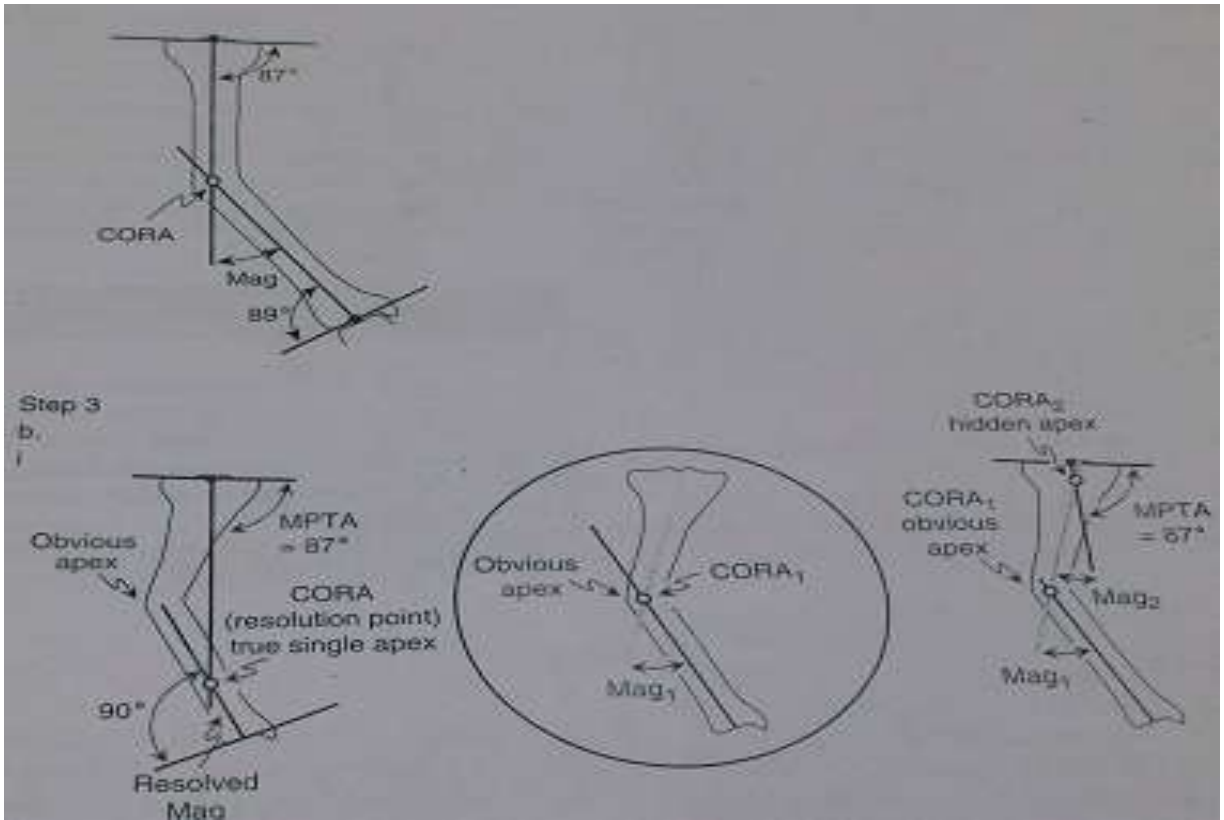


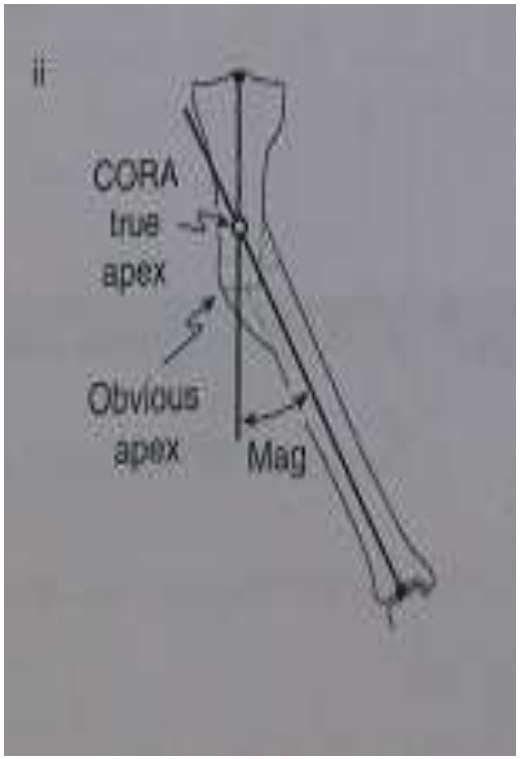
- Intersection point of PMA& DMA is CORA.

- If CORA is not at the obvious apex :-

✓ More then one apex of angulation.

✓ Translation deformity.





Shopping list for deformity cases

- Blount’s
- Fibular deficiency
- Proximal Femoral Focal Deficiency

Blount's Disease

- Progressive pathologic genu varum centered at the tibia
- Infantile :

  -children around 3 years of age - note genu varum is normal up to two years

  -more common

  -typically affects both lower extremities

Adolescent:

  -children > 10 years of age

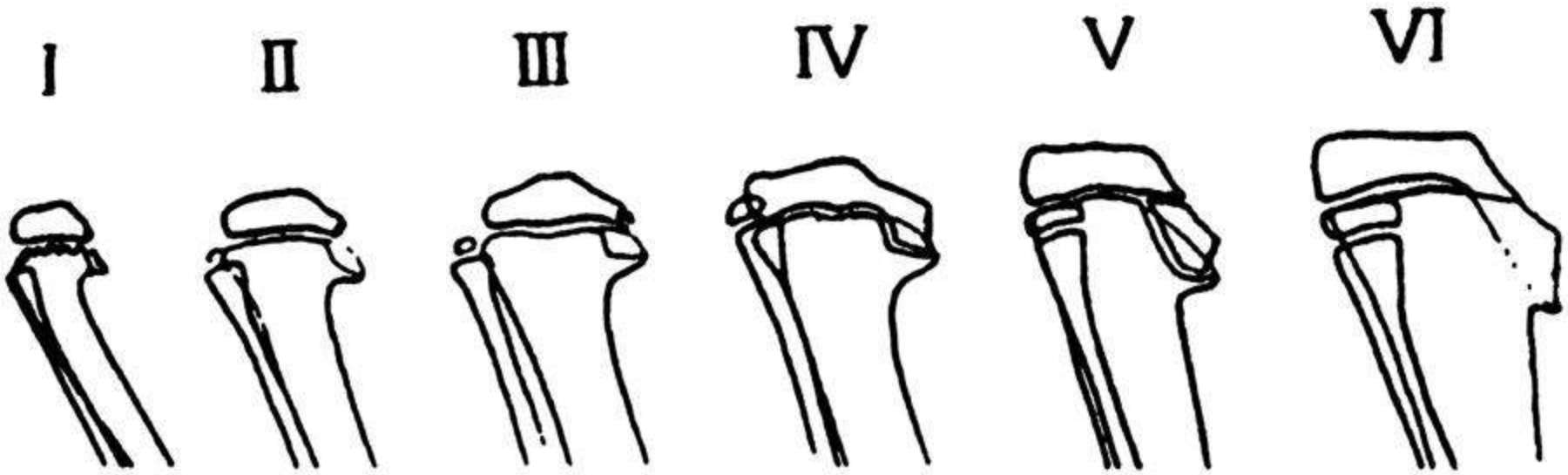
  -less common

  -less severe

  -more likely to be unilateral

Blount's Disease

- Mechanical overload in genetically susceptible individuals
- Excessive medial pressure produces an osteochondrosis (abnormal enchondral ossification) of the medial proximal tibial physis and epiphysis
- Osteochondrosis can progress to a physeal bar
- Langenskiold Classification



Blount's Disease

Drennan's angle

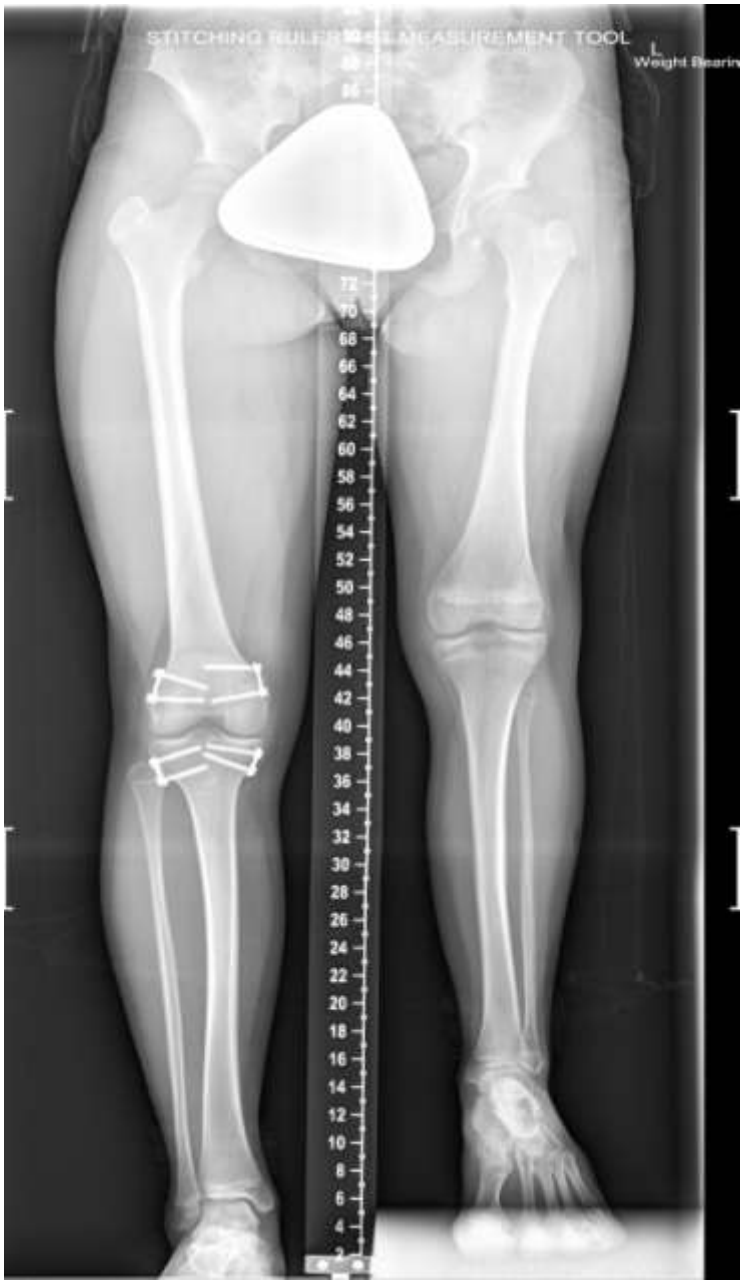
- 16° is considered abnormal and has a 95% chance of progression
- <10° has a 95% chance of natural resolution of the bowing

- Treatment – bracing / valgising osteotomy / hemiepiphysiodesis +/- medial plateau elevation

Fibular deficiency

- Remember – three types of bowing in children:
- Anterolateral – neurofibromatosis
- Posteromedial – physiological
- Anteromedial – fibular deficiency

- FD = Fibular hemimeila = shortening or complete deficiency of the fibula = tibial bowing/ ankle instability (ball and socket ankle) / absent lateral rays /unstable knee/ pFFD / equinovalgus foot/ tarsal coalition


STITCHING RULER
MEASUREMENT TOOL
L
Weight Bearin

Fibular deficiency

- Determined by stability and level of foot and ankle function, as well as the degree of limb shortening
- Not determined by the length of the fibula

- Operative:
- **contralateral epiphysiodesis** – indicated for mild projected LLD (<5cm) stable, plantigrade foot
- **limb lengthening procedure** – indications = plantigrade, functional foot with a stable ankle and predicted LLD < 30%

What needs correcting?

- The goals are - relieve symptoms if present and to protect adjacent joints from development of arthritis secondary to the deformity.

- The following deformities should be considered for treatment, even in asymptomatic patients:

  distal femoral mechanical valgus greater than 5 degrees, proximal tibial mechanical varus greater than 5 degrees, and mechanical axis deviation greater than 15 degrees.

- Other asymptomatic deformities should be considered for correction prophylactically if radiographic evidence of degenerative joint disease is seen or if clinical signs are detected (eg, positive Trendelenburg sign in a dysplastic hip, lateral thrust in a varus knee).

What needs correcting?

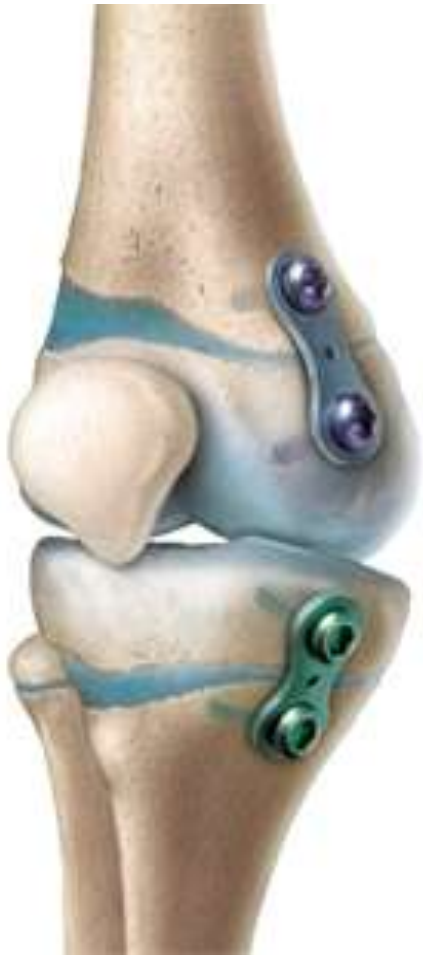
- Other deformities that should be considered for treatment include:

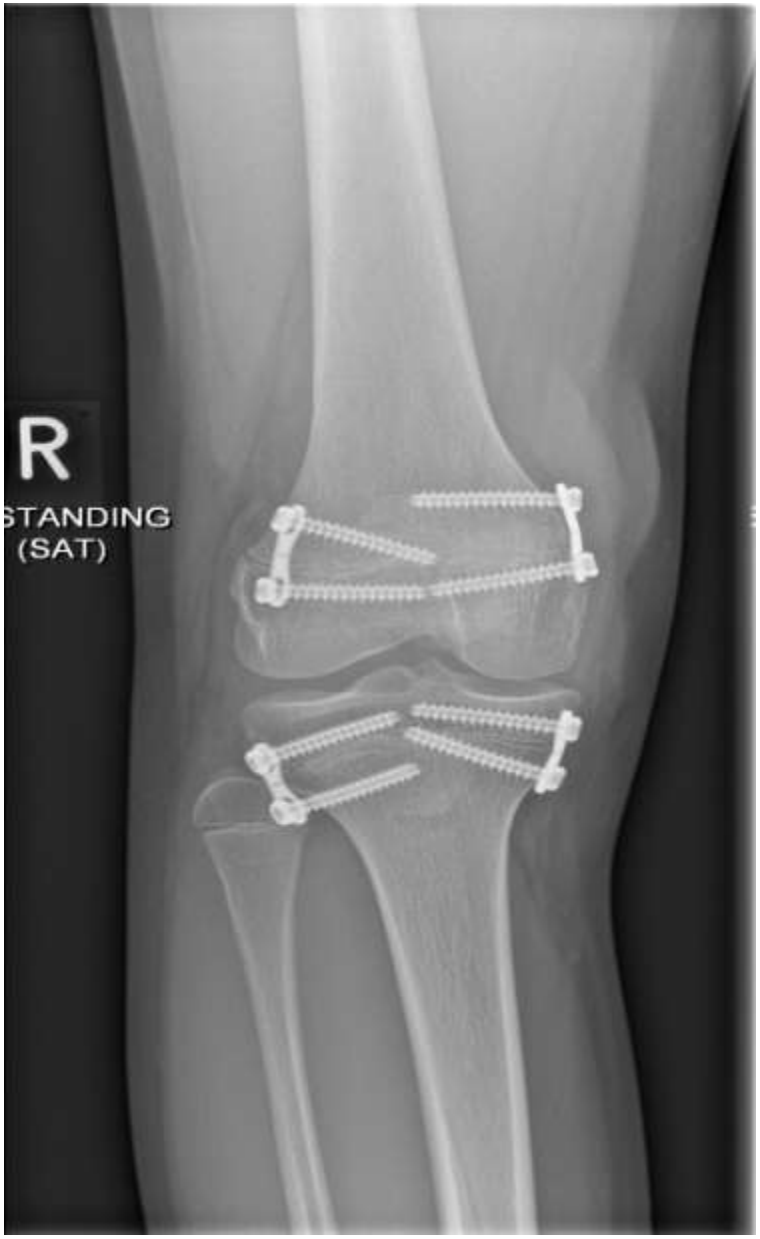
  Procurvatum deformity of the distal tibia greater than 15 degrees

  Recurvarum deformity of the distal tibia greater than 10 degrees

  Varus or valgus deformity of the distal tibia greater than 10 degrees.

Guided growth – Hueter Volkmann Principle




R
STANDING
(SAT)

Distraction Osteogenesis

- ideal conditions include stable fixation, a low energy osteotomy followed by 5–7-day latency, and a distraction rate of 1mm/day

- During distraction, regenerate bone arises between the entire cross-section of each distracted bone surface with a central radiolucent fibrous interzone comprising of type I collagen.

- New bone trabeculae form directly from this central collagen zone extending to both bone surfaces.

- It is orientated parallel to the distraction force and surrounded byblood vessels. Following distraction, these microcolumns consolidate and rapidly remodel to form a structure similar in composition to that of the host bone, a process called consolidation.

Stability

- Bony stability is essential for osteogenesis and is dependent on the stability of the external frame.
- Frame stability is greatly impacted by the ring properties; rings of large diameter are less stable than smaller rings
- Reducing ring diameter by 2 cm increases axial frame stiffness by 70%
- A general guideline is to leave 2 cm space between ring and skin circumferentially to allow for possible limb swelling.

Stability

- Distance between the rings will also affect stability; rings that are far apart and connected with long rods will be less stable.

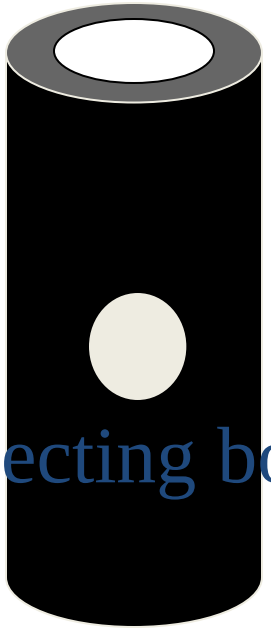
- In order to minimise the unsupported length between rings, additional connecting rods or an intermediate free ring secured in the mid-portion of the long rods should be used.

- The stability of the ring is further increased by using two rings instead of one for each bone segment

- Frame stability increases with increasing wire diameter and tension, the use of more wires per ring, placing wires on opposite sides of the ring and inserting wires in different planes.

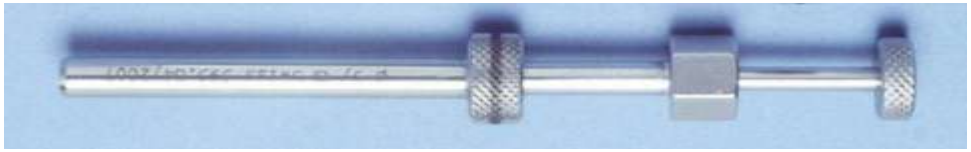
Pins

- Principle: The pin is the critical link between the bone and the frame
  - **Pin diameter**
    - Bending stiffness proportional to $\mathbf{r^4}$
    - 5mm pin 144% stiffer than 4mm pin
  - Pin insertion technique respecting bone and soft tissue



< 1/3 dia

Pin Insertion Technique



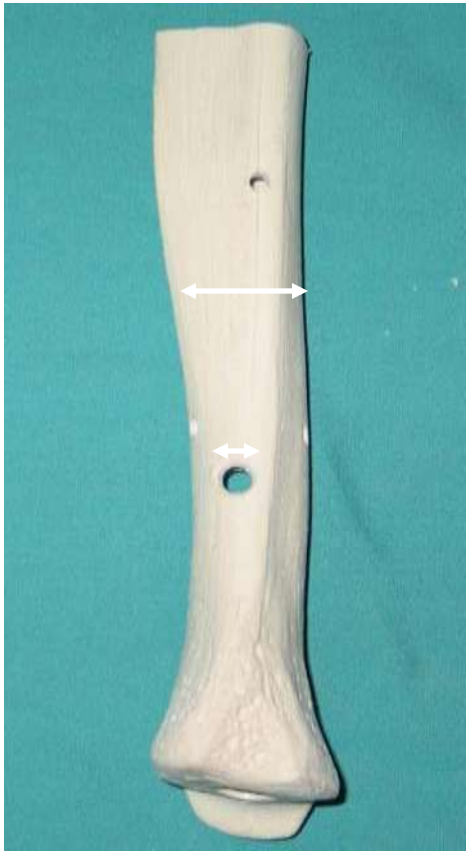
1. Incise skin
2. Spread soft tissues to bone
3. Use sharp drill with sleeve
4. Irrigate while drilling
5. Place appropriate pin using sleeve

Avoid soft tissue damage and bone thermal necrosis

Pin Diameter Guidelines

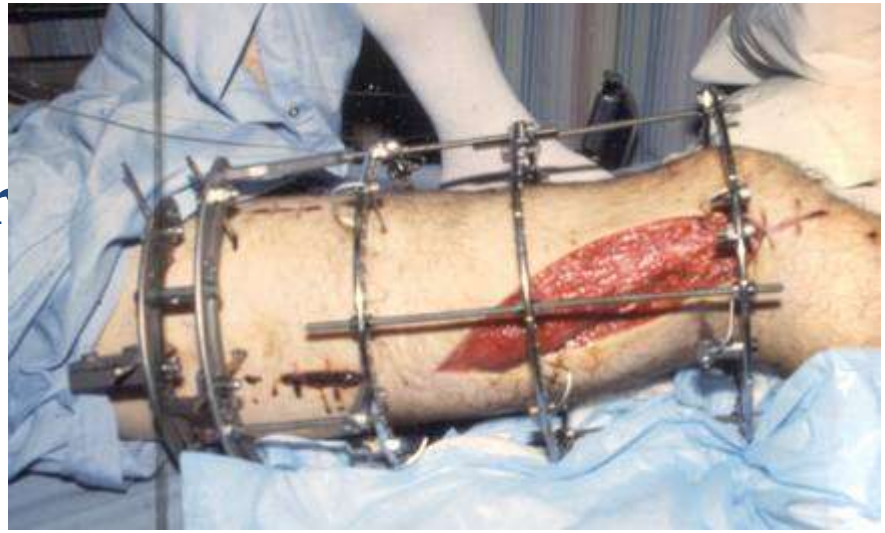
- Femur – 5 or 6 mm
- Tibia – 5 or 6 mm
- Humerus – 5 mm
- Forearm – 4 mm
- Hand, Foot – 3 mm

< 1/3 dia



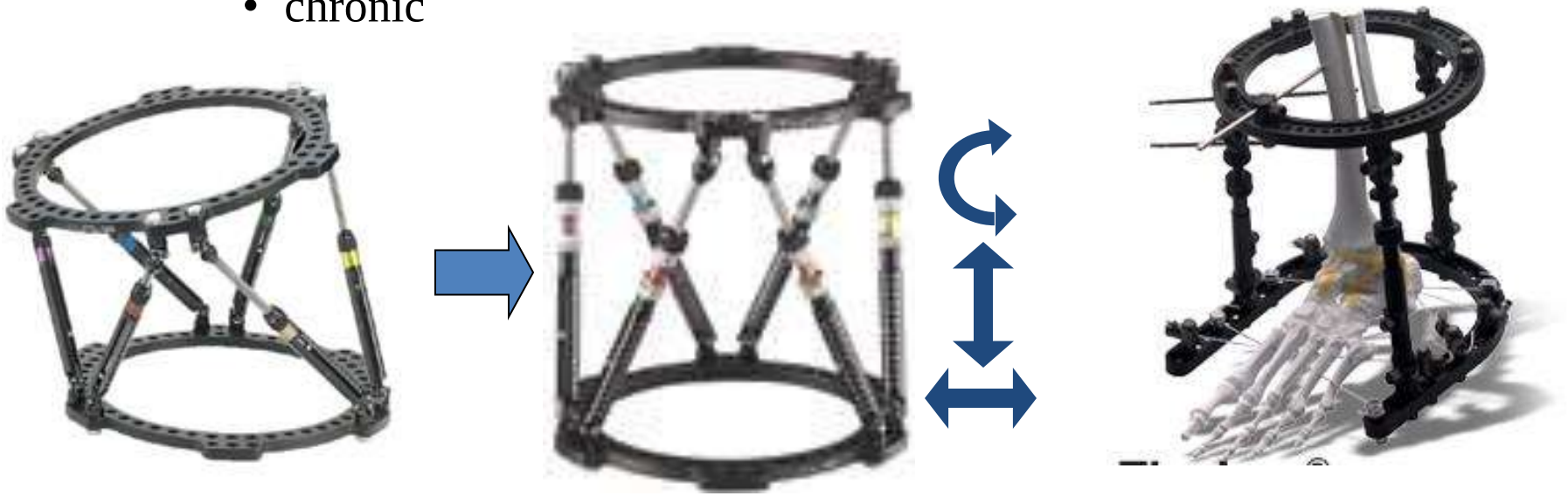
Ring Fixators

- Principles:
  - Multiple tensioned thin wires (130Nm) or half pins
  - **Place wires / pins as close to 90° to each other**
- Can maintain purchase in metaphyseal bone
- Allows dynamic axial loading
- May allow joint motion



Multiplanar Adjustable Ring Fixators

- Application with wire or half pins
- Adjustable with 6 degrees of freedom
  - Deformity correction
    - acute
    - chronic



TSF Software / correction

- https://www.spatialframe.com/myCases.action