

Bone Cuts & Femoral Rotation in Knee Arthroplasty

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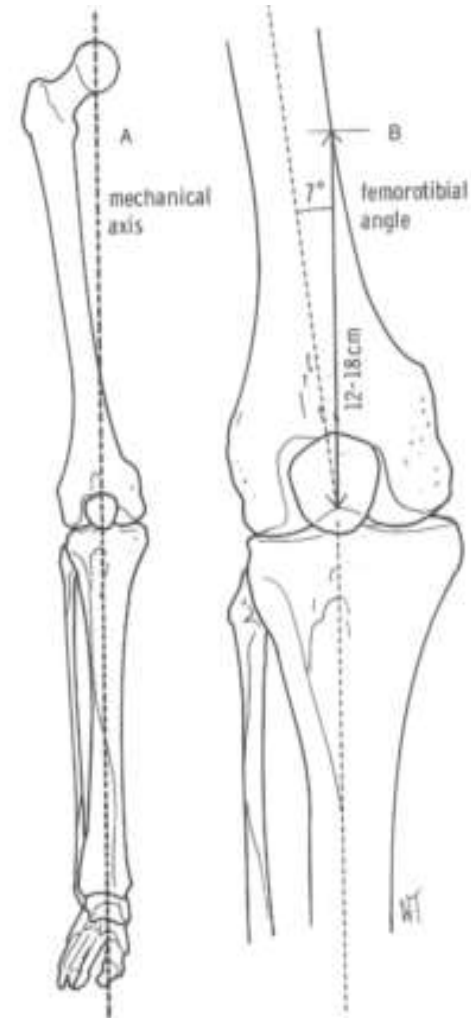
Aims for successful knee replacements

- Perfect alignment of components in axial, coronal and sagittal plane
- Matched femoral and tibial rotation
- Restoration of joint line
- Good soft tissue balance in flexion and extension

» JBJS 90 Br, Sept 2008

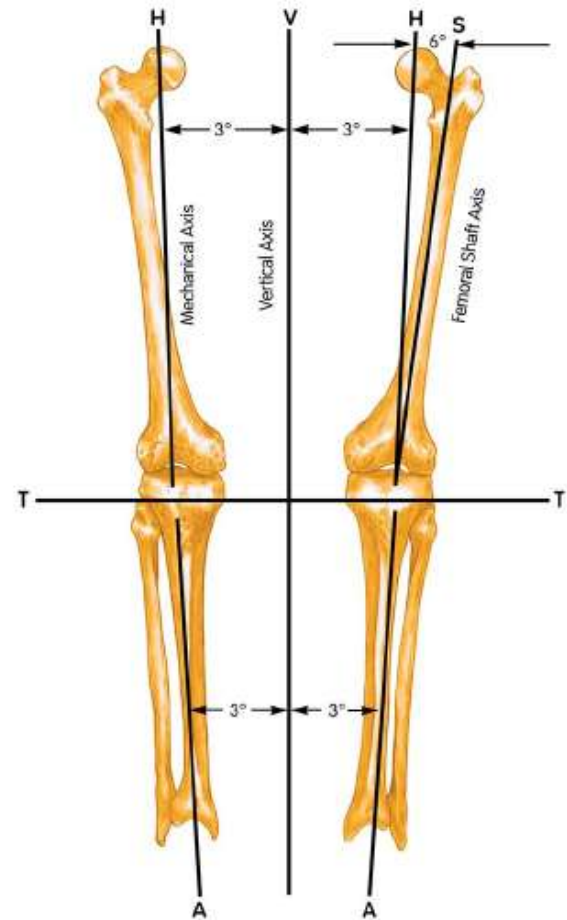
Mechanical axial alignment

- Line passing from the centre of the femoral head, the centre of the knee and the centre of the ankle



Axial alignment

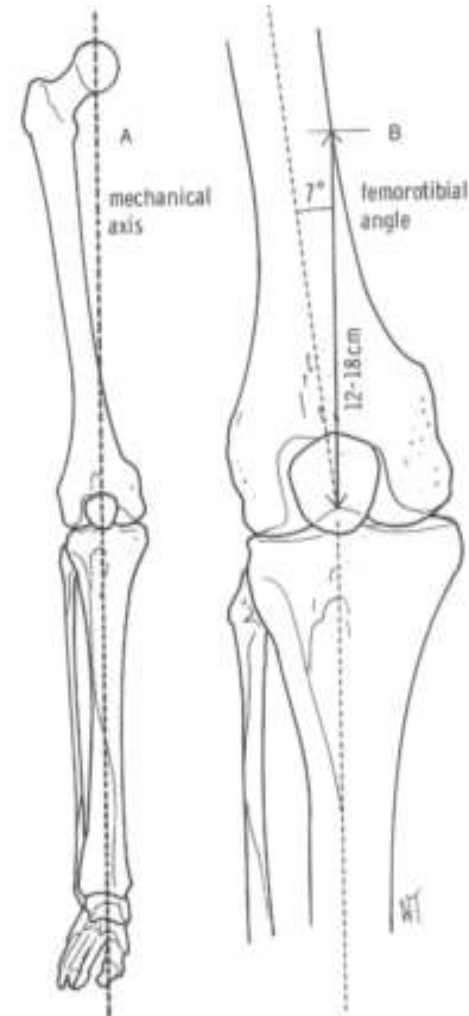
- Mechanical axis is 3° to the vertical axis
- Femoral shaft is 7° – 10° to the vertical axis
- Transverse axis is 3° to the mechanical axis of the tibia shaft



Dynamic alignment

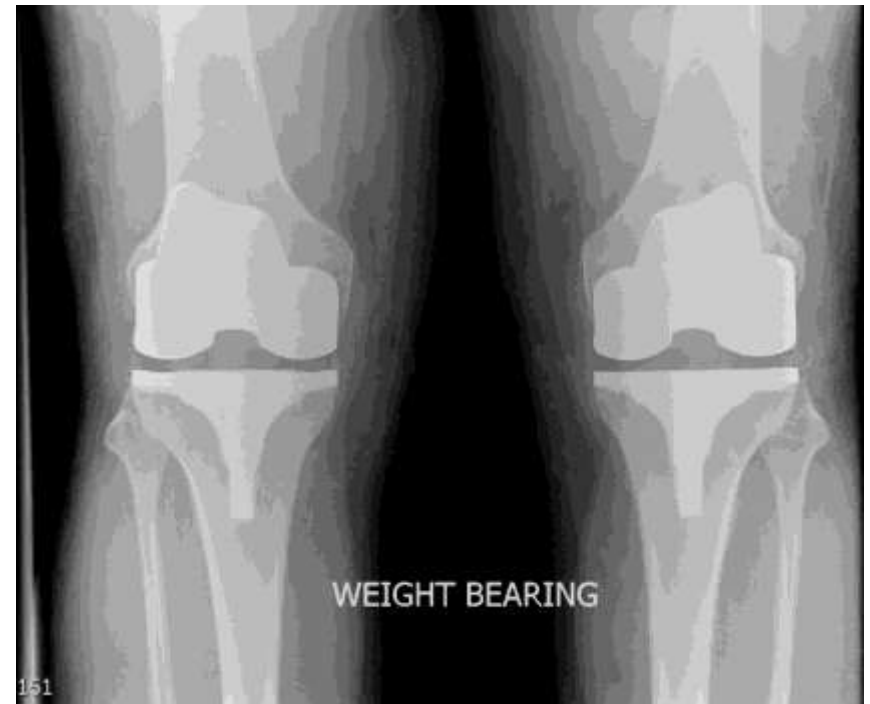
Normal gait leads to
60 – 75 % force on
medial side of joint

3° angle of tibial axis
to transverse axis
leads to a varus thrust
in normal gait



Objectives of knee arthroplasty

- Can we duplicate normal anatomy in knee replacement
- Can we reproduce a 3° varus and a 10° posterior slope



Probably not

At least not time after time

Postoperative alignment of total knee replacement: its effect on survival

Ritter MA. Clin Orth 1994;299:153-6

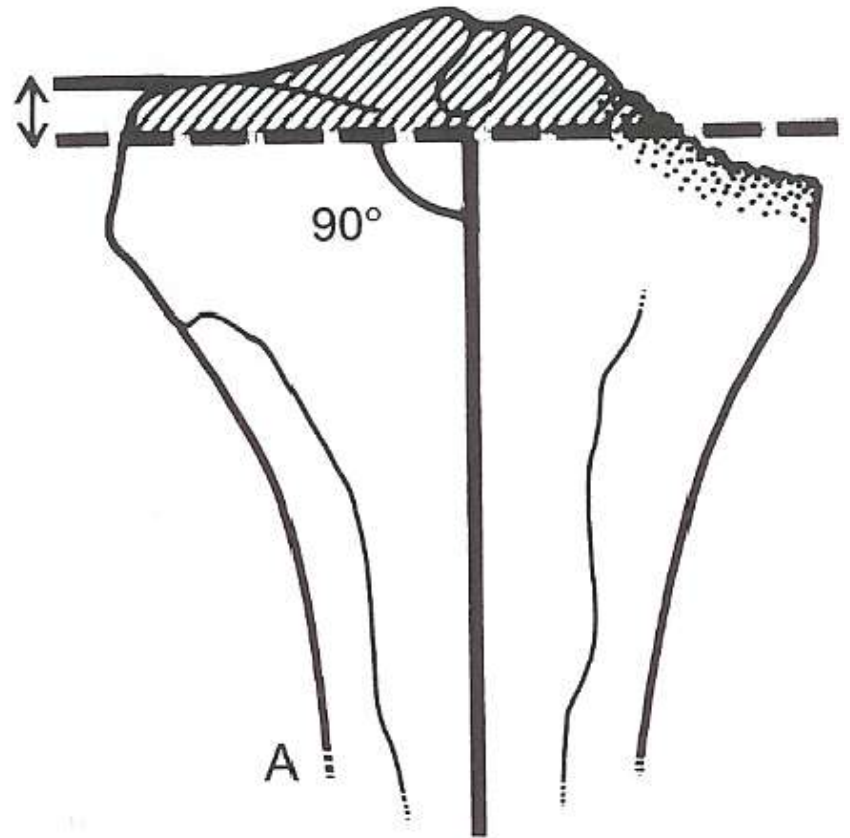
- A mechanical cut between 8 to 4 degrees of valgus leads to good long term function
- Below 4 degrees of varus is associated with an increased risk of failure

Aims of the Bony cuts

- Cut the proximal tibia 90° to the tibial mechanical axis
- Cut the distal femur with appropriate valgus to achieve coronal plane mechanical alignment
- Cut anterior and posterior femur to balance the flexion and extension gaps

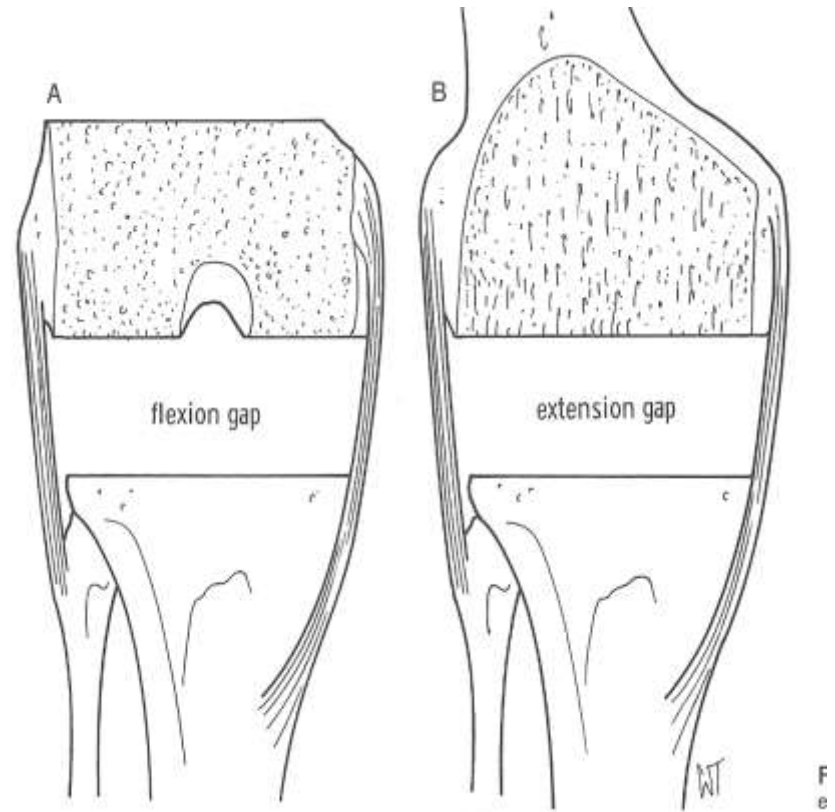
Theories of surgical technique

- Balanced resection or restoration of joint line
 - Aim to restore joint line to prearthritic position
 - Developed for the PCL retaining knee



Theories of surgical technique

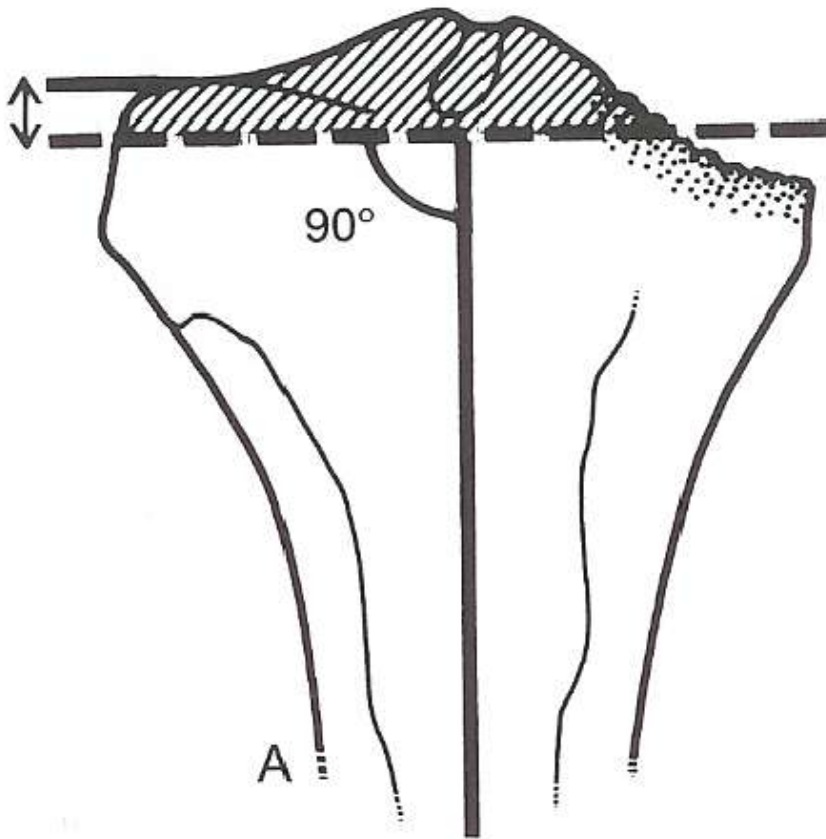
- Gap technique
 - Aim to balance the flexion and extension gaps
 - 3 degrees of ext rot required to balance the flexion gap



Bone Resection

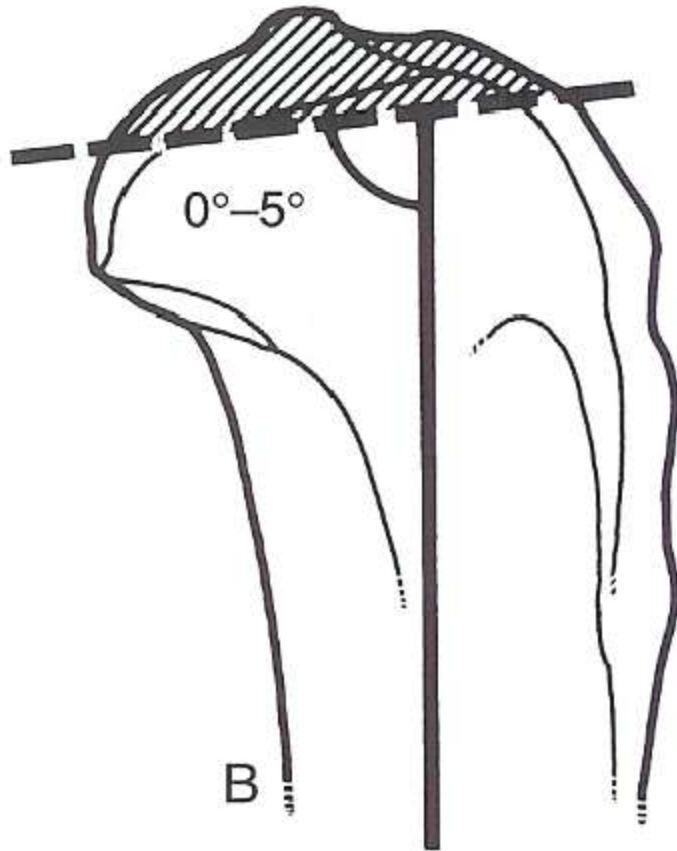
- Tibial cut
- Distal femoral (extension gap)
- Femoral rotational cut (flexion gap)
- Tibial tray rotation

Proximal tibial cut



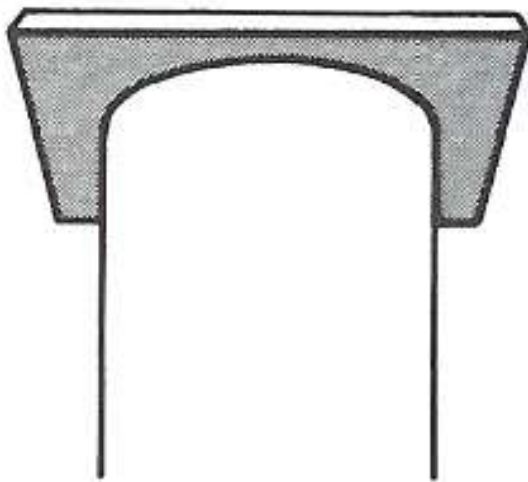
- At 90° to mechanical axis of the tibia
- Reference depth of cut off best side
- Can be done first or second
- Only cut that affects both flexion and extension gap

Posterior slope

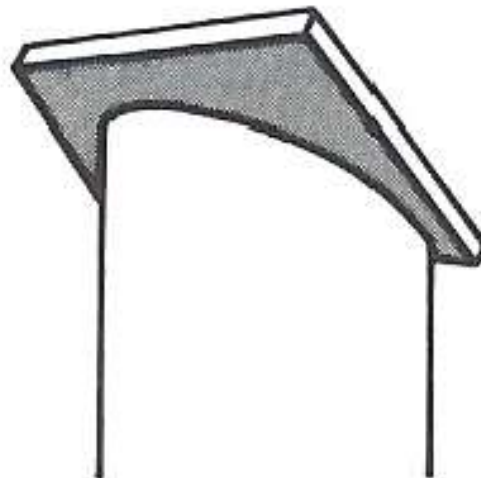


- Aims to mimic normal anatomic slope
- Has profound effect on alignment
- More important in PCL retained designs

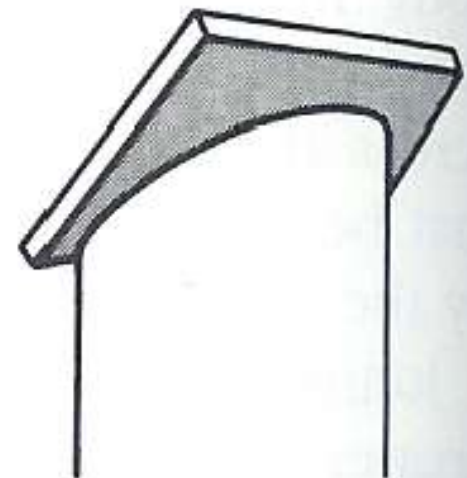
Tibial cut with posterior slope



Neutral guide position
(posterior slope)

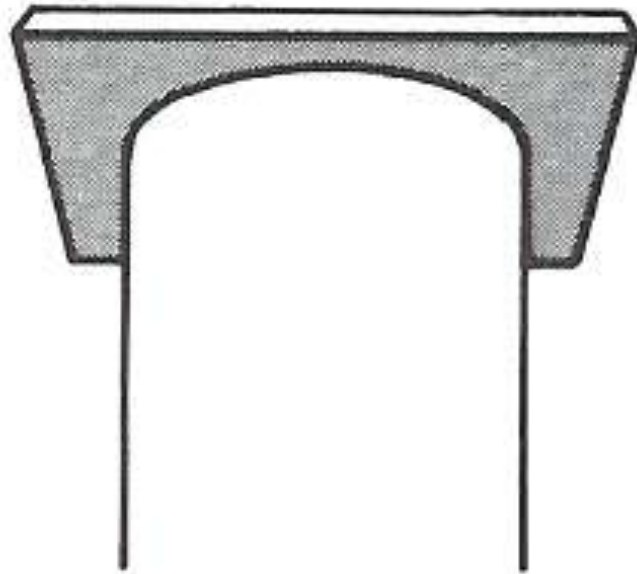


Guide rotated externally
(posteromedial slope)



Guide rotated internally
(posterolateral slope)

Tibial cut with posterior slope

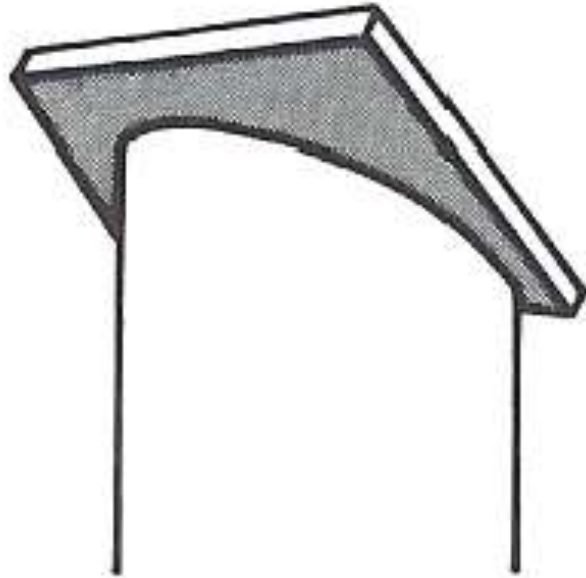


Neutral guide
position
(posterior slope)

Neutral rotation leads to
equal bone resection
on the medial and
lateral sides

Neutral alignment in the
coronal plane and
balanced resection in
the sagittal plane

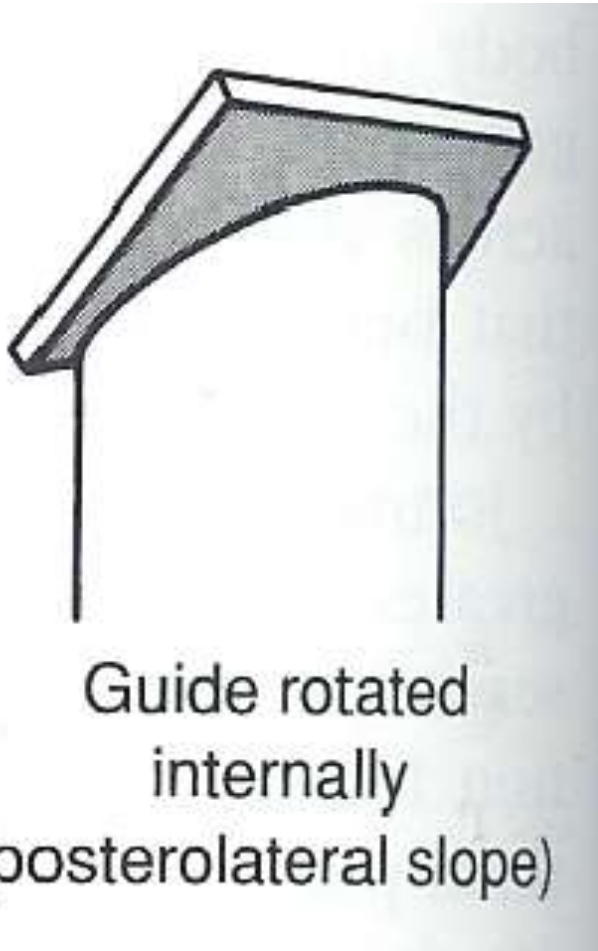
Tibial cut with posterior slope



Guide rotated
externally
(posteromedial slope)

- Cutting block placed in external rotation
- More bone resected off posteromedial aspect
- Varus cut in coronal plane

Tibial cut with posterior slope

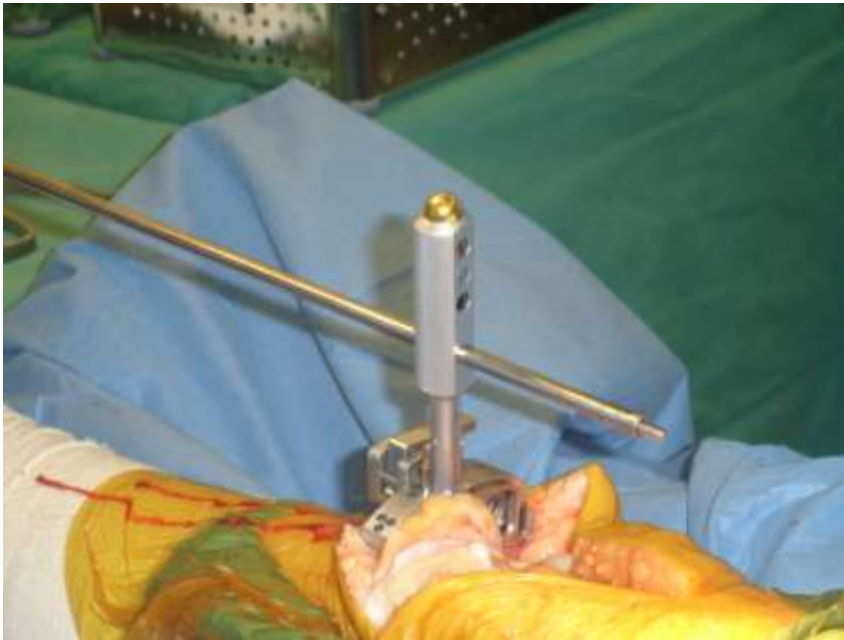


- Cutting block placed in internal rotation
- More bone resected off posterolateral aspect
- Valgus cut in coronal plane

Tips on tibial cut

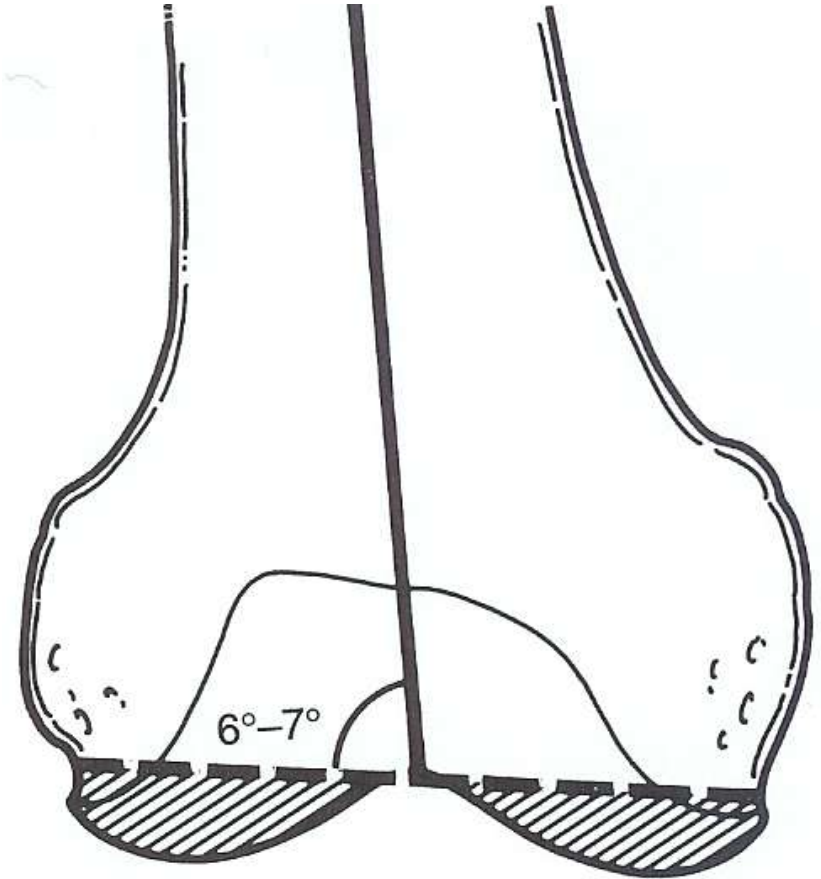
- Extra medullary alignment
 - Partially impact spike between tibial spines
 - Align jig with centre of the ankle i.e. Medial to inter malleolus distance
 - Medial 1/3rd of tibial tubercle
- Intramedullary
 - Pre-operatively select entry point
 - Achieve rod tibial penetration of at least 60% of tibial length
 - Rotate to align with medial 1/3rd of tibial tubercle

Extend the leg and dorsiflex the foot your pins should be pointing upwards



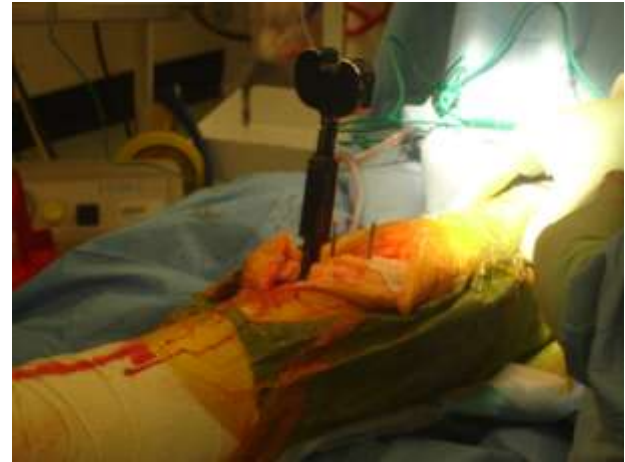
Distal femoral cut

- Intramedullary guided
- 5 to 7 degrees of valgus
- Balanced resection
- Often used to dictate the joint line

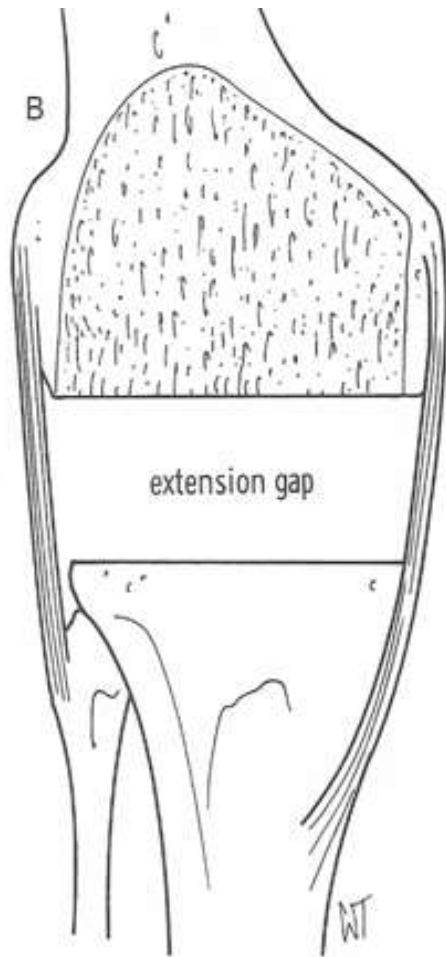


Gap Technique

- Used mainly in PS knees
- Soft tissue releases first
- Either tibial or femoral cut first

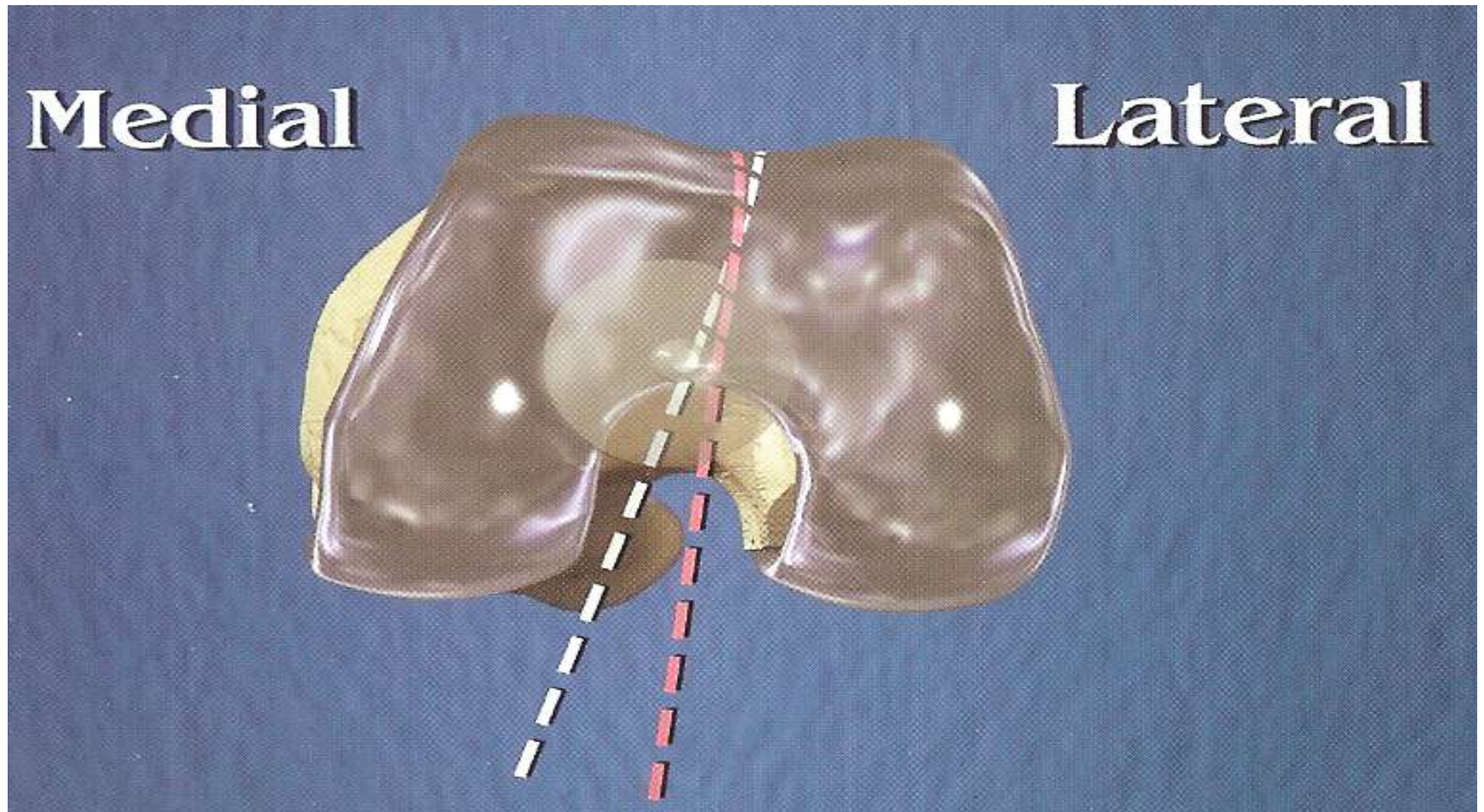


Proximal tibial and distal femoral cuts



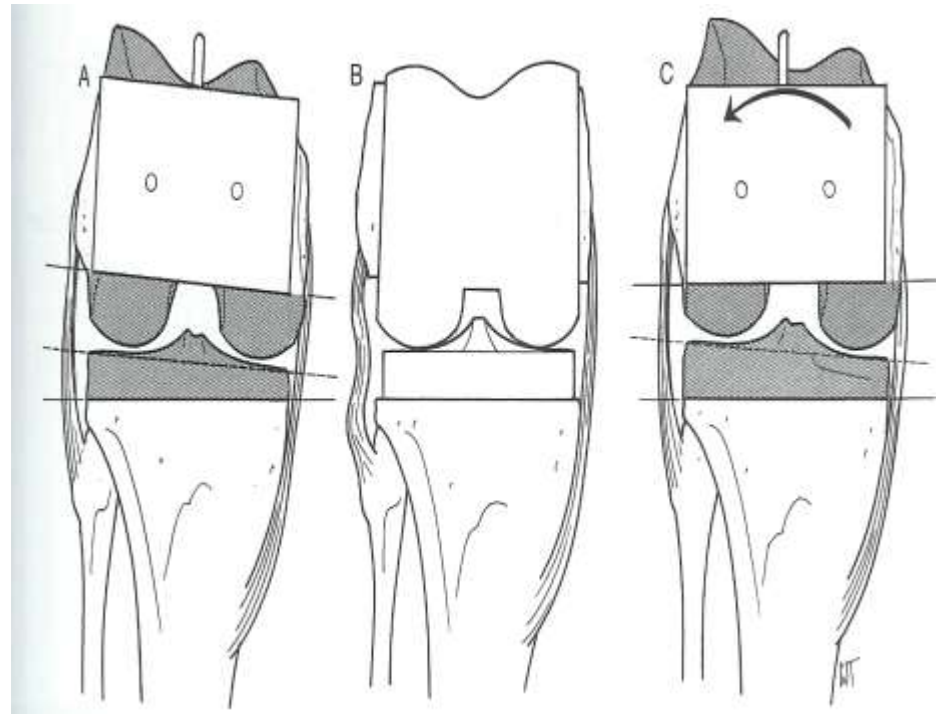
- Two parallel surfaces
- Restored mechanical axis
- Balanced ligaments
- Enough room for prosthesis with the knee FULLY extended
- Joint line restored

Femoral rotation



External rotation of the femur

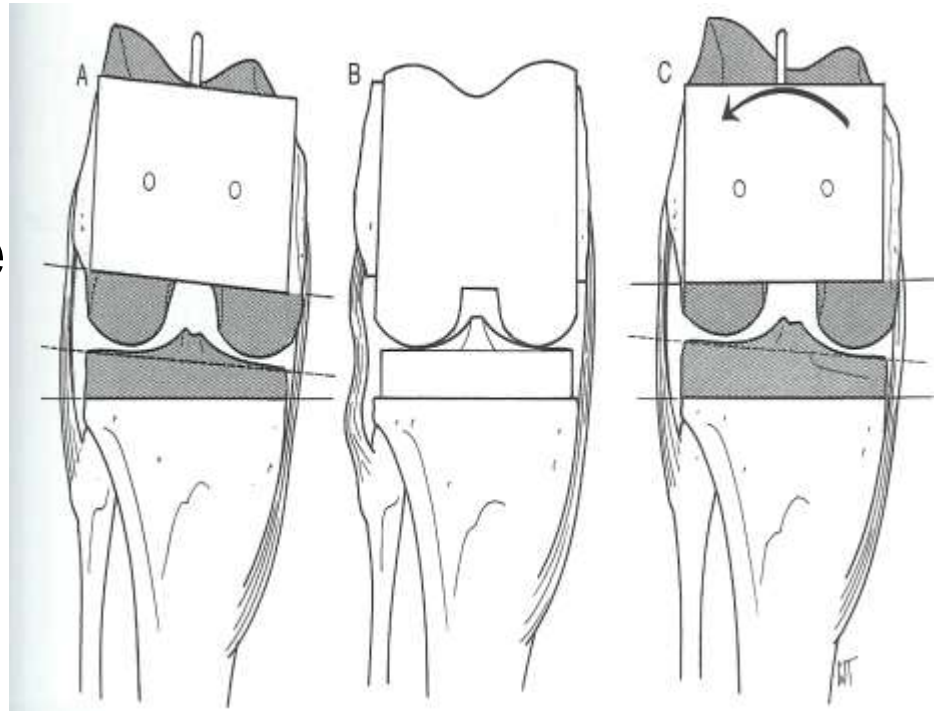
- Normal tibial slope is 3 degrees varus
- Equal lateral and medial posterior cuts leads to a lax lateral ligament
- External rotation of the femoral component balances the flexion gap



External rotation of the femur

Improve range of motion

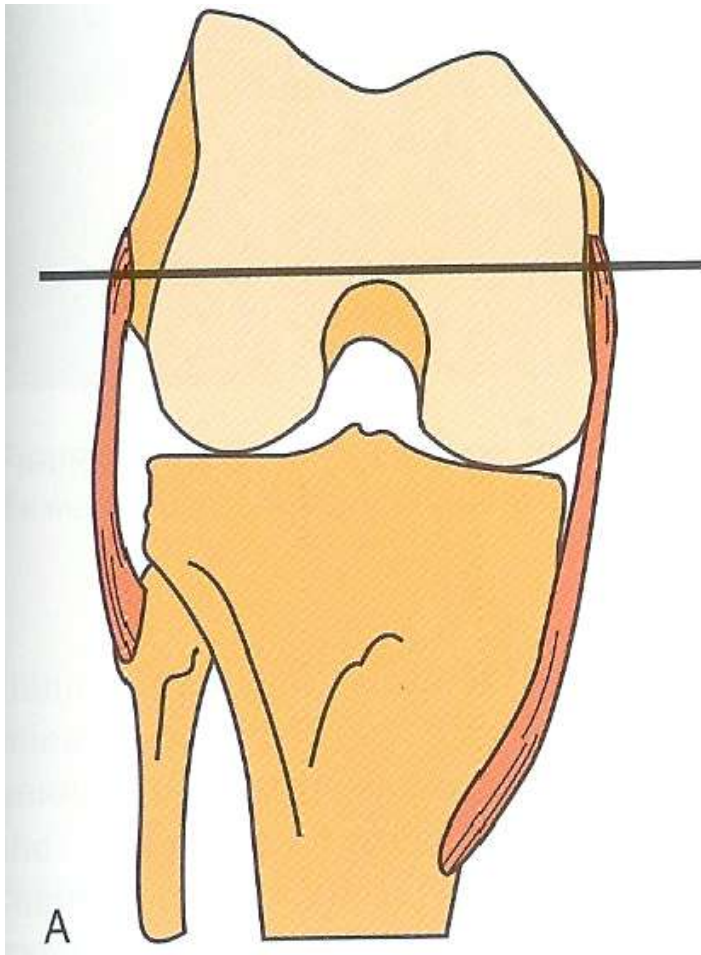
Decrease the incidence of Zone 1 tibial radiolucencies



Rotational alignment of the Femur

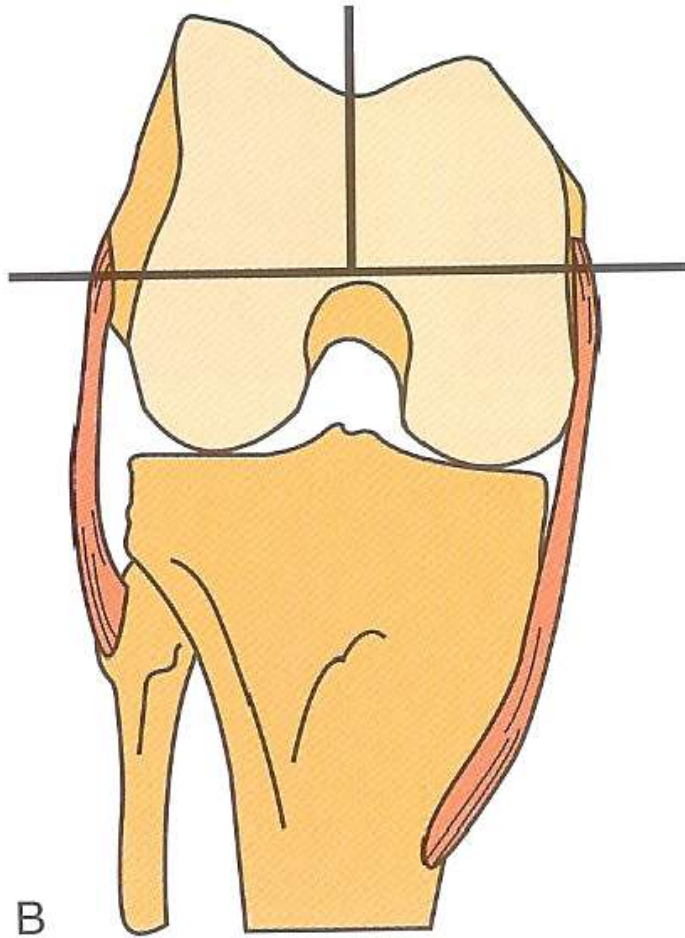
- Epicondylar axis
- Posterior femoral condyles
- Anteroposterior femoral axis
(Whiteside's line)
- Tibial shaft axis
- Ligament tension
- Use of an asymetrically sized femoral component

Epicondylar axis



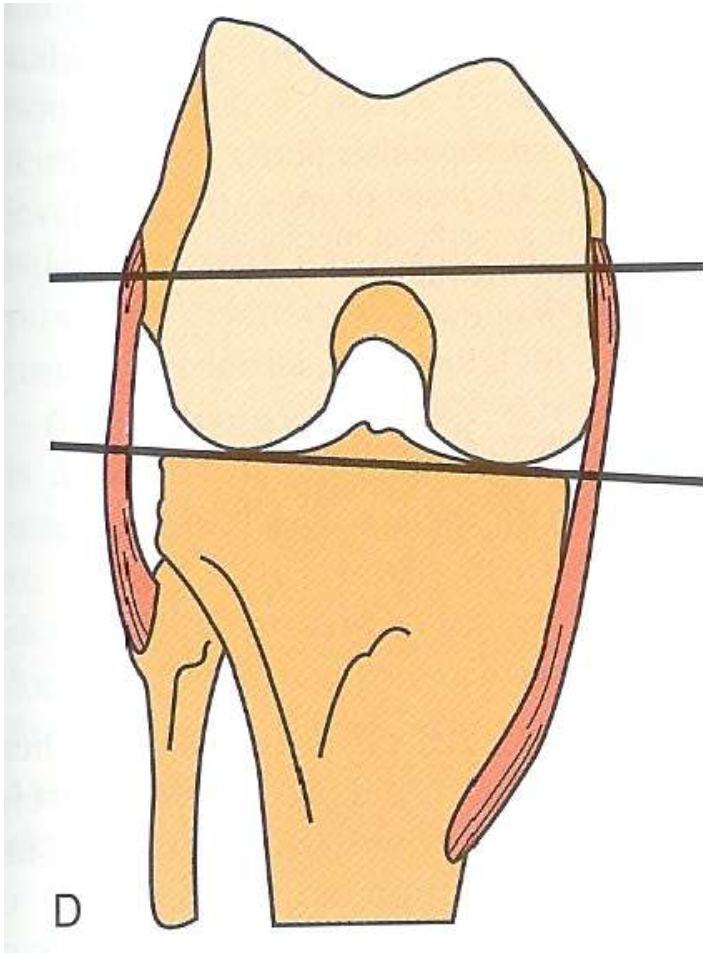
- Line between the lateral epicondyle and the sulcus of the medial epicondyle
- Axis rotation of the knee
- Medial epicondyle is quite large and sulcus not easy to palpate

Anteroposterior femoral axis



- Whiteside's Line
- Perpendicular to a externally rotated epicondylar axis

Posterior femoral condyle

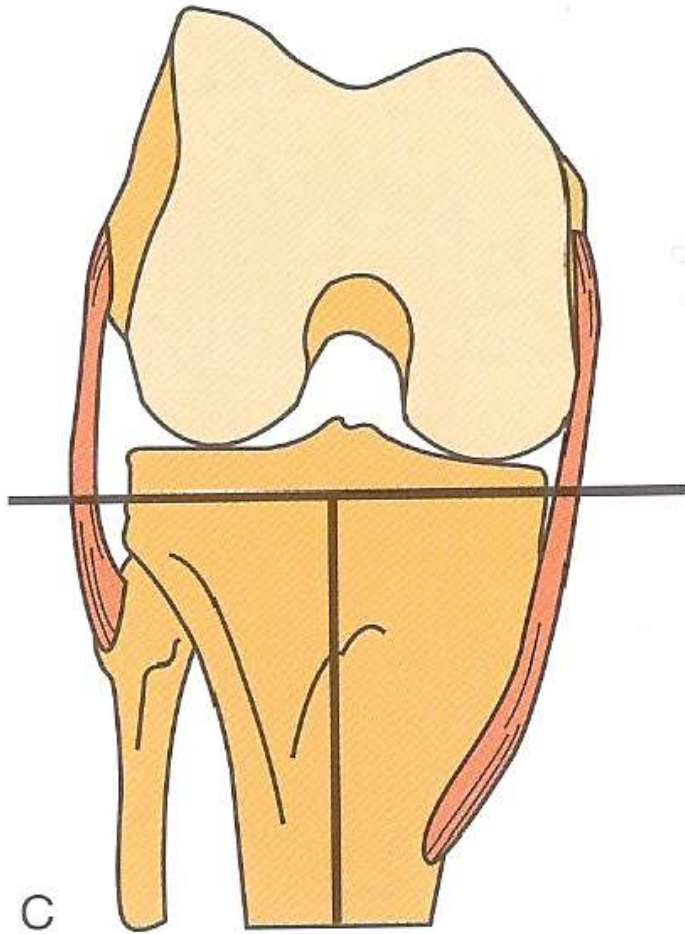


- Can be affected by defects in the condyles
- Poor predictor of epicondylar axis

Beware of dysplastic lateral femoral condyles

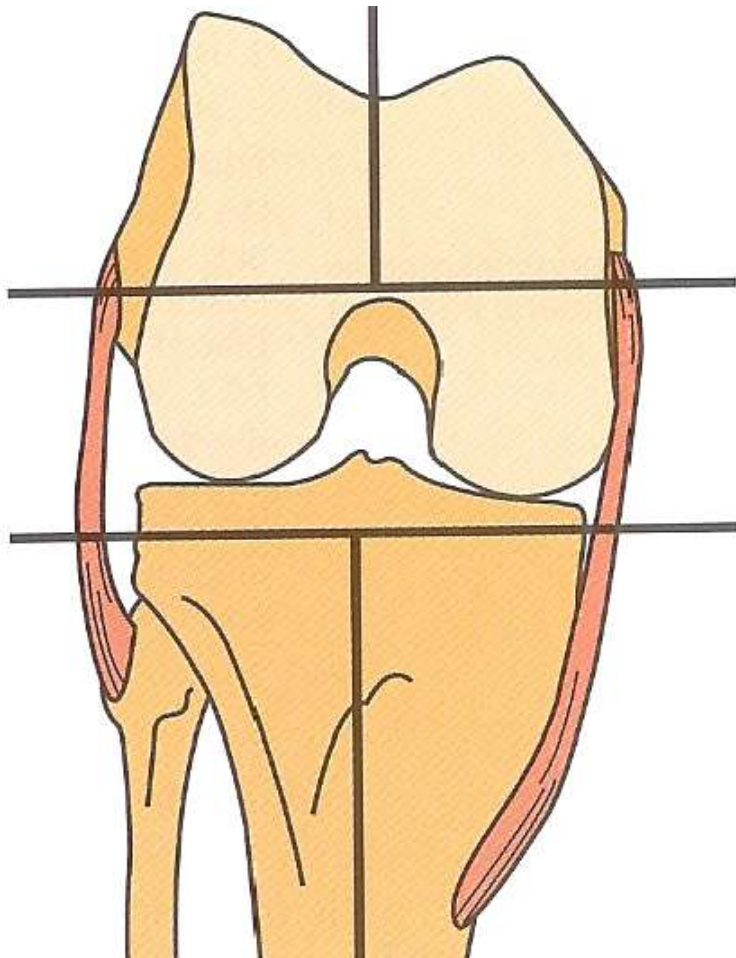


Tibial shaft axis



- Dependent on accurate tibial cut
- Does not take anatomical 3 degrees of varus into account

LCS knee – Tibial cut determines femoral rotation



Femoral rotation – WHY ?

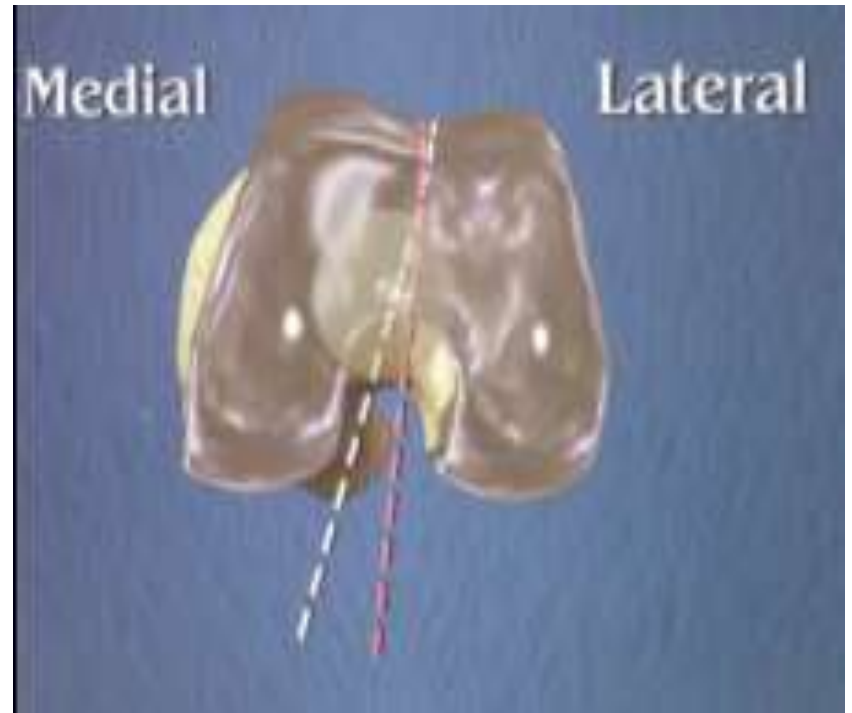
- External
 - Improve patella tracking
 - Balance patellofemoral contact areas
 - Avoid anterior notching anteromedial
 - Correct rotational alignment of the tibia in extension
- Internal
 - Shifts knee into valgus alignment in flexion
 - Increases Q angle
 - Deleterious to patella tracking
 - Imbalanced flexion/extension gaps

Disadvantages of external rotation

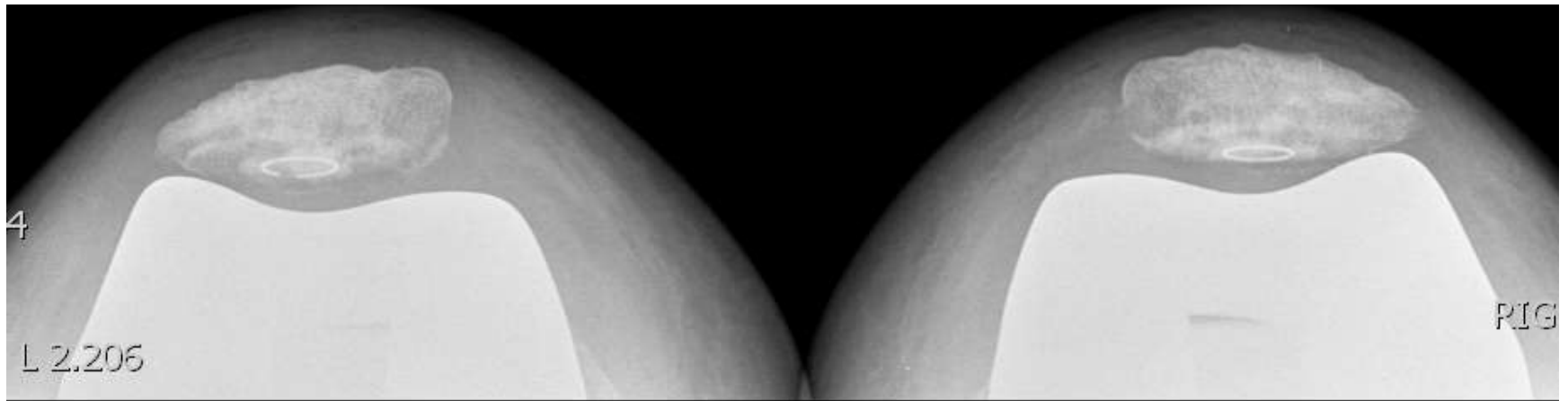
- Rotational incongruity between femoral and tibial articular surfaces
- Medialisation of patella tracking during flexion
- Reduced tibial bone coverage
- Notching of the anterolateral femoral cortex

Patella maltracking- medialisation

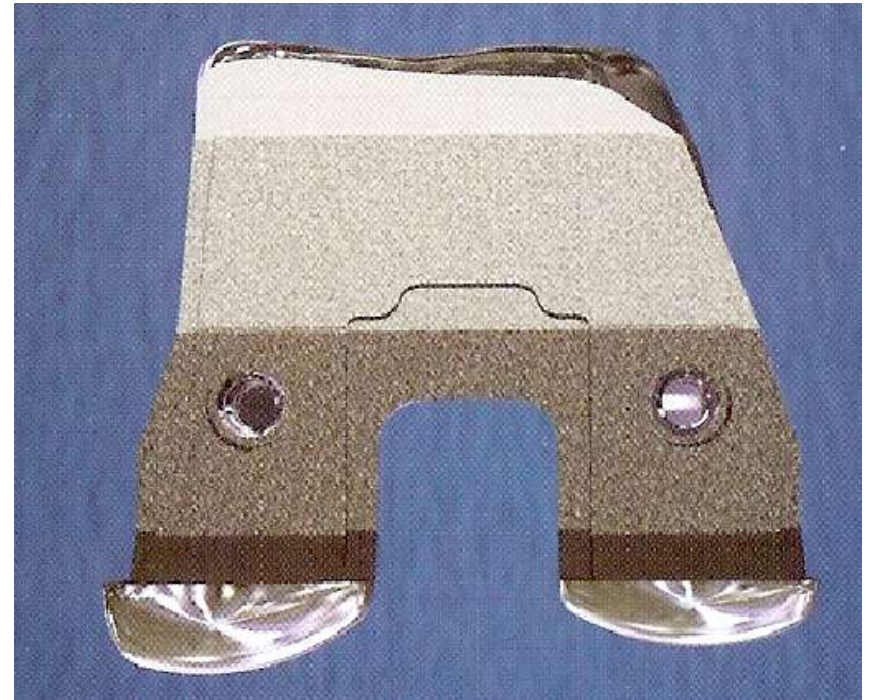
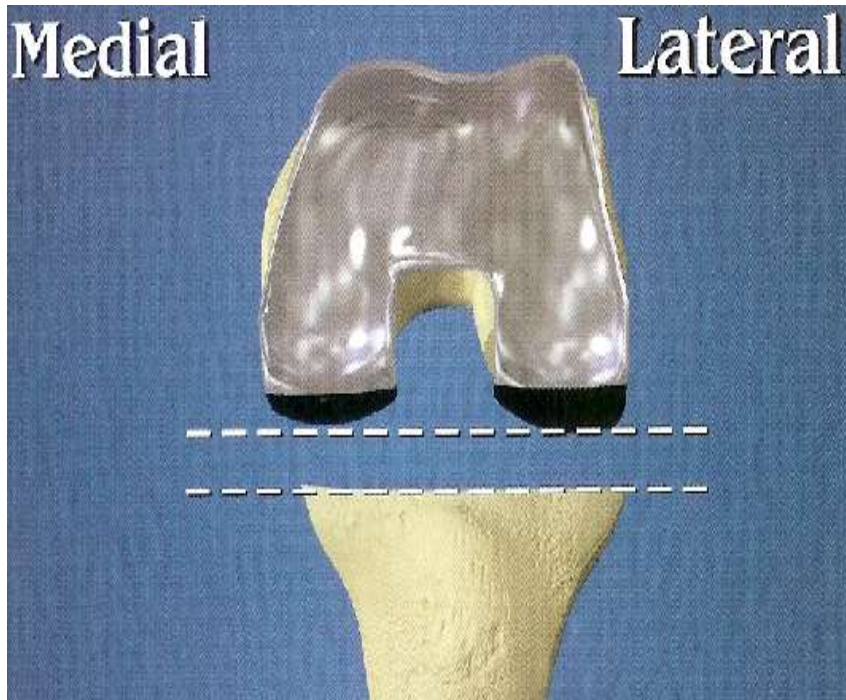
- Contributing factors
 - Wear
 - Loosening
 - Fracture
 - Pain



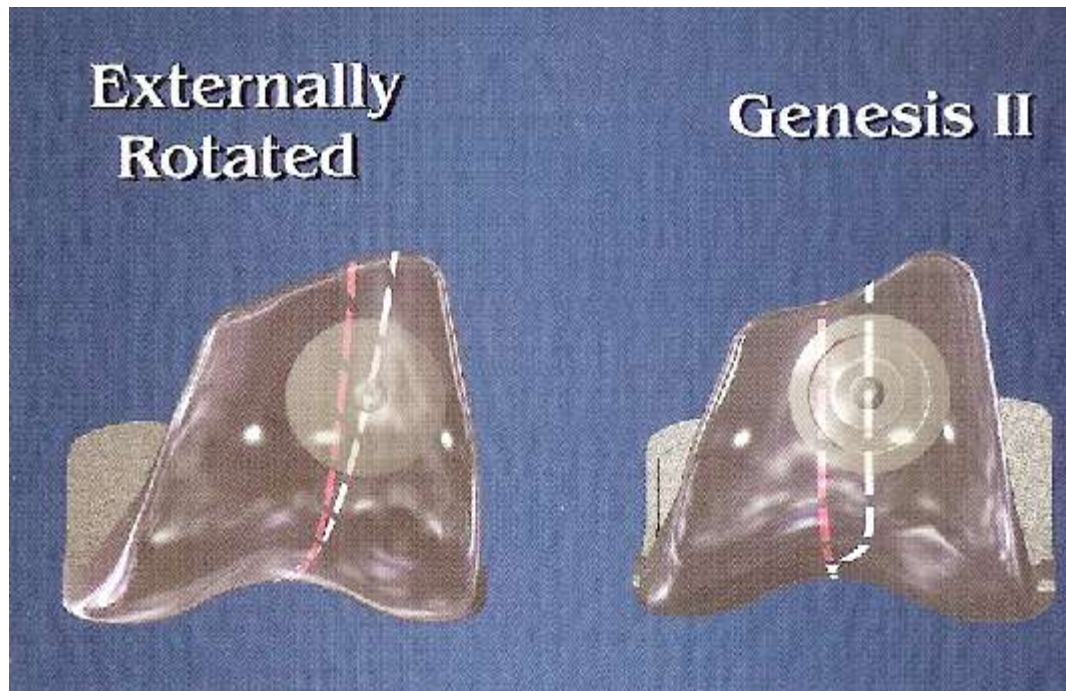
Correct rotation – patella sits centrally in flexion



Alternative – differential size for posterior condyles



Improved patella tracking



Improves femoral/tibial congruency



Advantages



- Less chance of femoral notching on the anterolateral side
- Better implant bone interface as it avoids inadequate bone resection anteromedially

Tibial base plate rotation

- External rotation of tibia to match femur
 - Overhang anteromedially and posterolaterally
 - Tendency to undersize to avoid overhang
 - If compound slope occurs it has a profound effect on alignment

Tibial Base Plate Rotation

- Set using anatomical landmarks
 - Medial third of tibial tubercle
- Rotation set by femur
 - Flex the knee several times and assess where it sits

Tibial femoral congruency

- Both components externally rotated
 - Contact area maximised in extension and reduced in flexion
- Tibia in neutral and femur externally
 - Contact area maximised in flexion and reduced in extension

Femur and Tibia both cut in neutral rotation

- Balanced flexion gap achieved with asymmetric post condyles
- Improved patella tracking
- Maximum contact area throughout range of movement

Summary

- Axial alignment needs to be achieved
- Tibial perpendicular to tibial axis
- Distal femoral cut between 5° & 7° valgus
- Extension gap balanced to comfortably fit the components in full extension
- Flexion gap balanced by
 - External rotation of femoral component
 - Use of component with asymmetric posterior shims
- Tibial rotation set to match femoral rotation