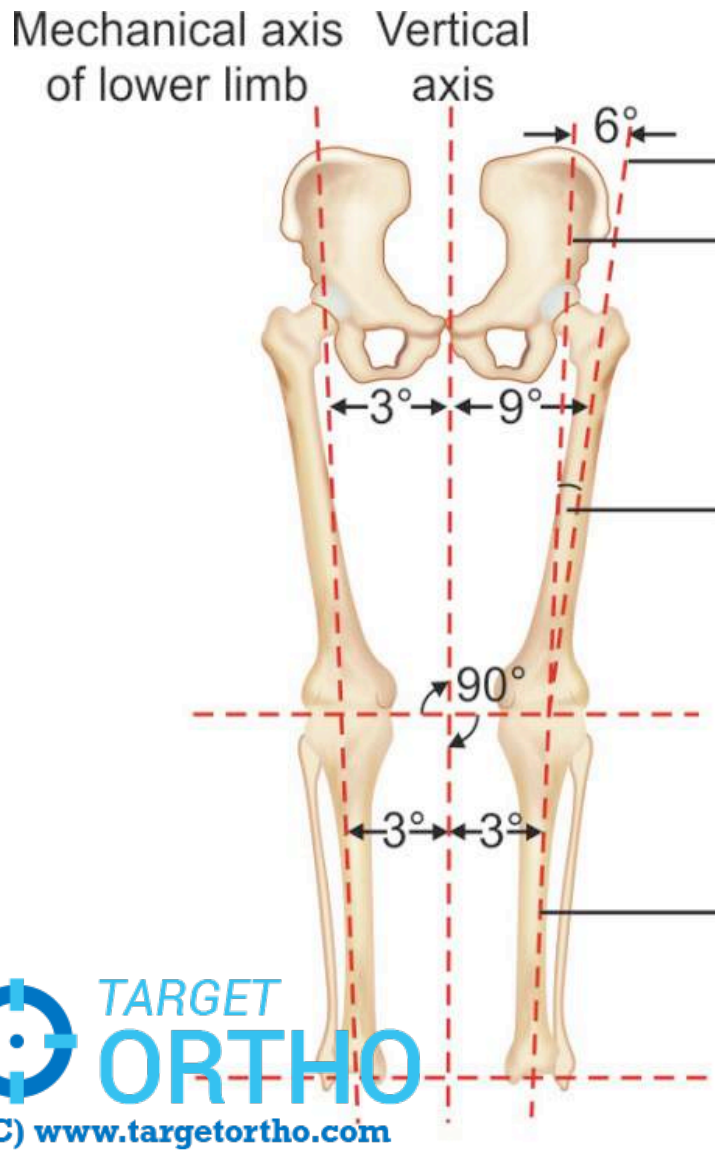
UNICOMPARTMENTAL OA KNEE

SURGICAL OPTIONS



HIGH TIBIAL OSTEOTOMY (HTO)

First introduced by Jackson and Waugh in 1961

Made popular by Conventry after 1965 as a treatment modality for medial compartment OA knee with varus deformity

The BIOMECHANICAL goal of HTO is to unload the involved medial compartment by correcting the mal-alignment!

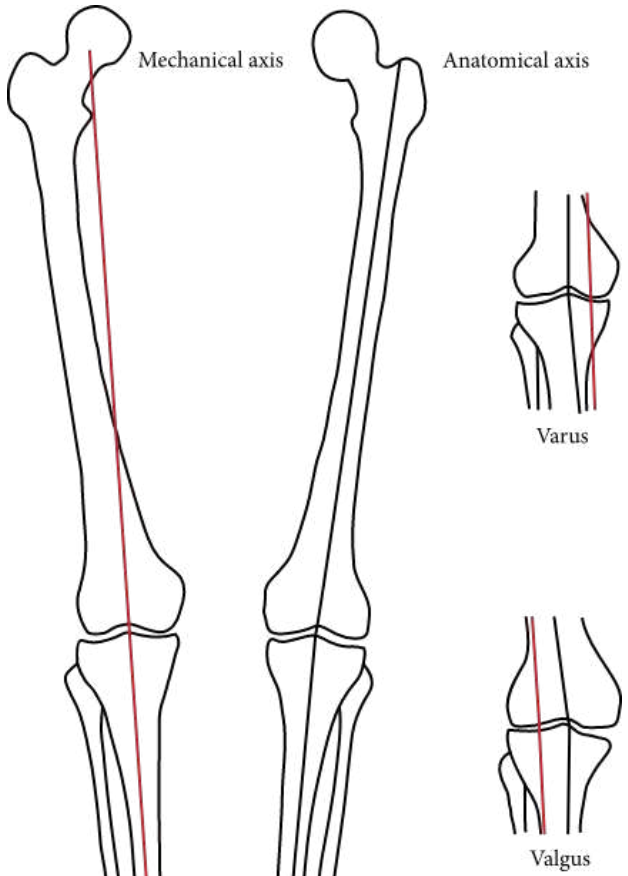
The CLINICAL goals of HTO are twofold:

- to reduce knee pain by transferring weight-bearing loads to the relatively unaffected lateral compartment in varus knees; &

- to delay the need for a knee replacement by slowing or stopping destruction of the medial joint compartment.

INDICATIONS

Weight-bearing line (WBL)
< 50% of tibial width



1) Correction of Varus Malalignment in OA with Primary varus:-
   - i) Reduction in pain
   - ii) Delaying degenerative process
   - iii) Delay in TKR – in needed

2) Correction of Load imbalance in Double and Triple varus:-
   - Varus thrust in chronic PLC deficiency

3) To achieve normal alignment before
   - Cartilage restorative procedure
   - Medial meniscal transplant

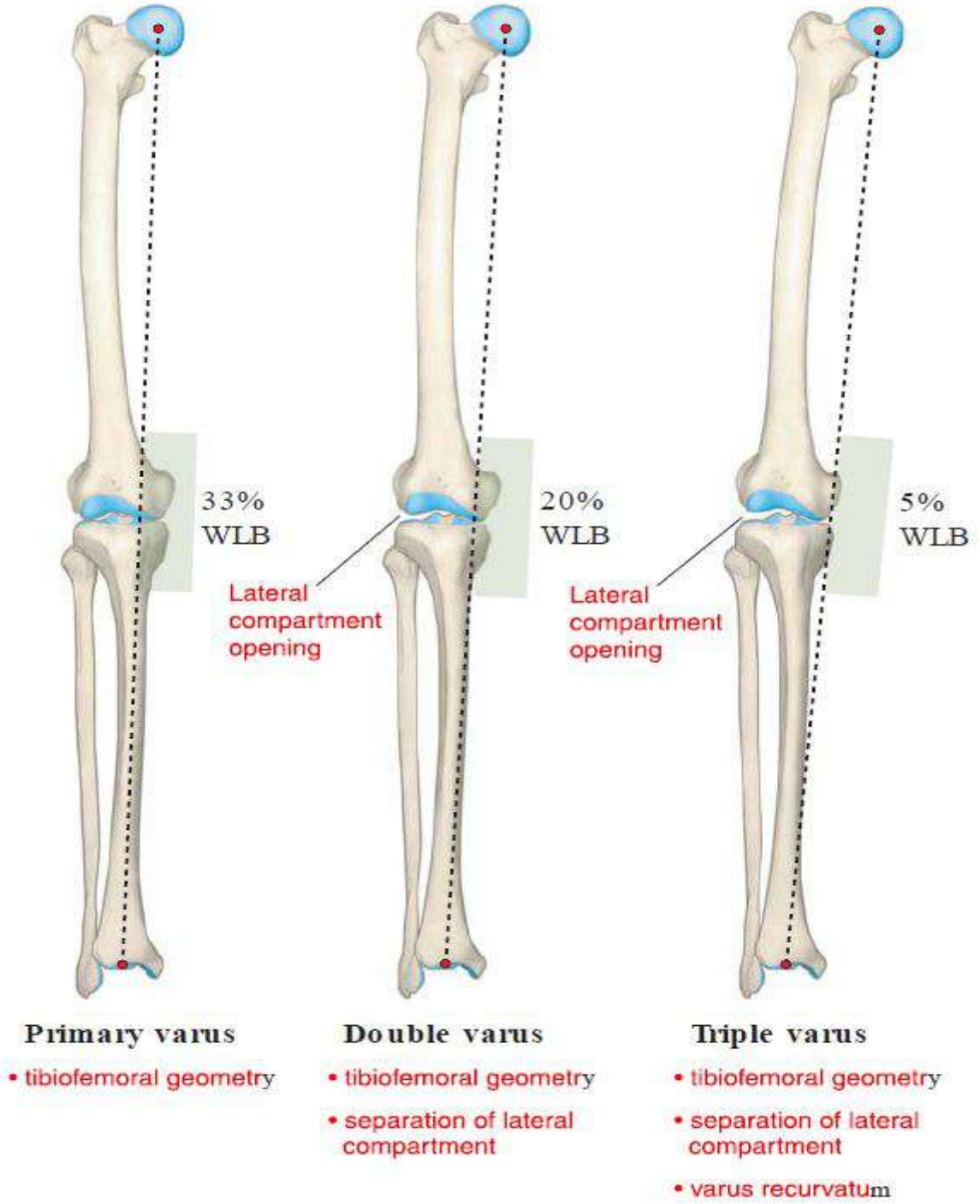
4) Correction of tibial slope (> 15°) to increase AP stability of knee
   - Recurrent ACL tears due to high tibial slope
   - Excessive hyperextension during gait

Primary Varus: Osteocartilagenous narrowing of medial tibio fibular joint space

Double Varus: Osteocartilagenous narrowing + Separation of lateral tibio femoral compartment (> 5mm) due to stretching (but intact) of postero lateral corner structures

Triple Varus (Varus-Recurvatum): Osteocartilagenous narrowing + Absence of Postero-lateral corner structures (lateral opening > 15 mm)

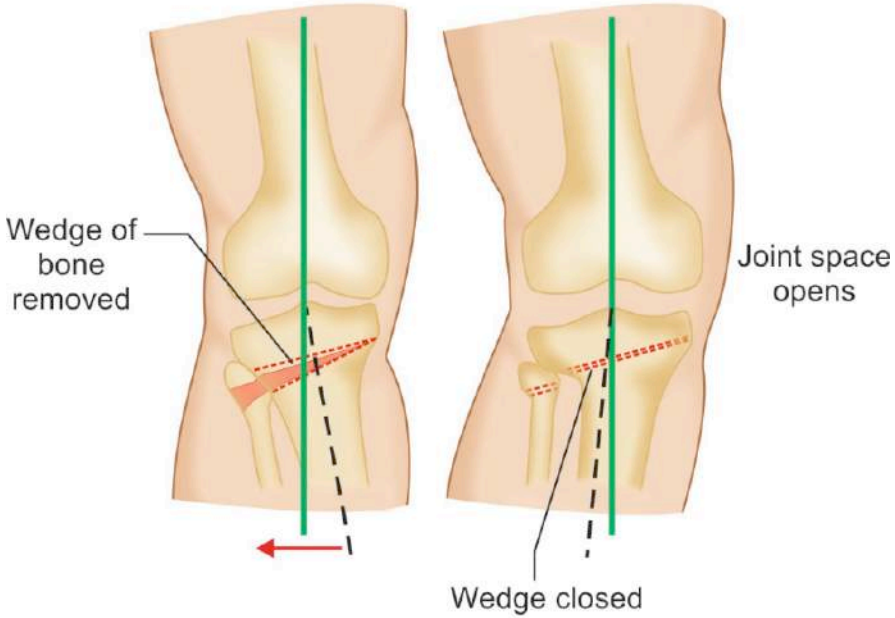
HTO first and then ligamentous reconstruction later (> 9 months)



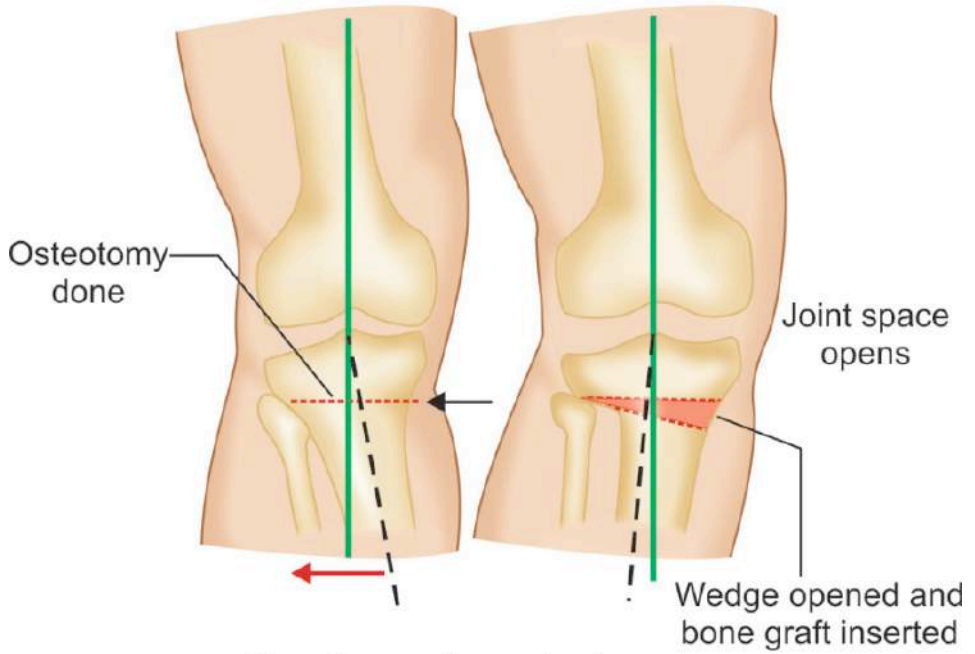
TECHNIQUES

- Lateral Closing Wedge Technique (Conventry)
- Medial Opening Wedge Technique (Hernigou)
- Dual Plane Medial Opening Wedge
- Dome osteotomy (Macquet)
- Medial opening wedge Hemicallotasis (Progressive callus distraction by Turi et al)

- Correction up to 20^{o}
- Changes in Tibial slope
- Changes in Patellar height



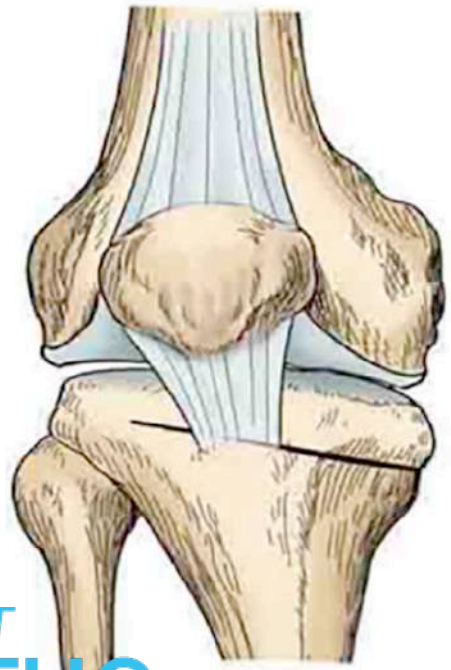
Closing wedge osteotomy

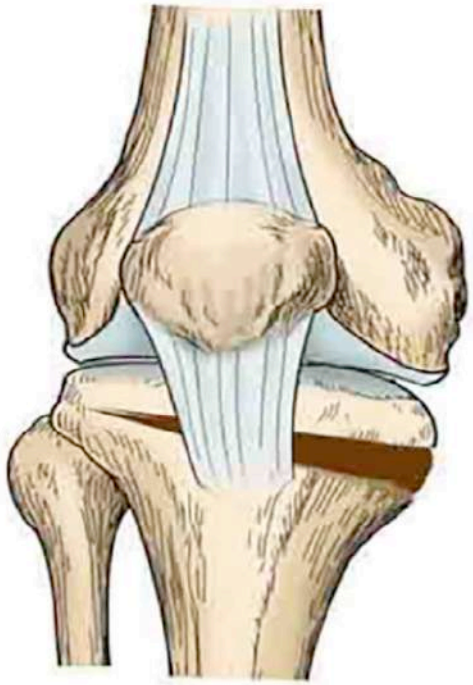


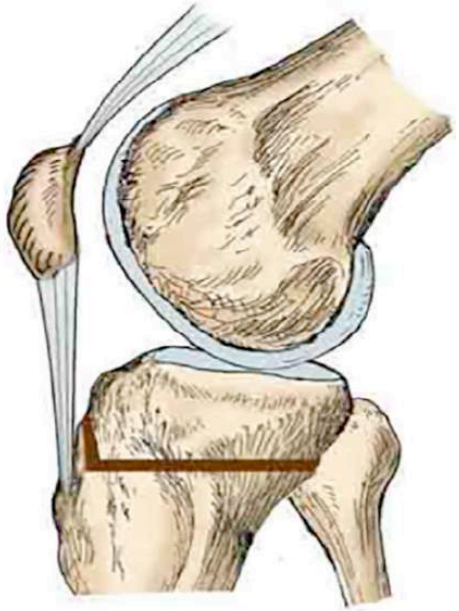
Opening wedge osteotomy

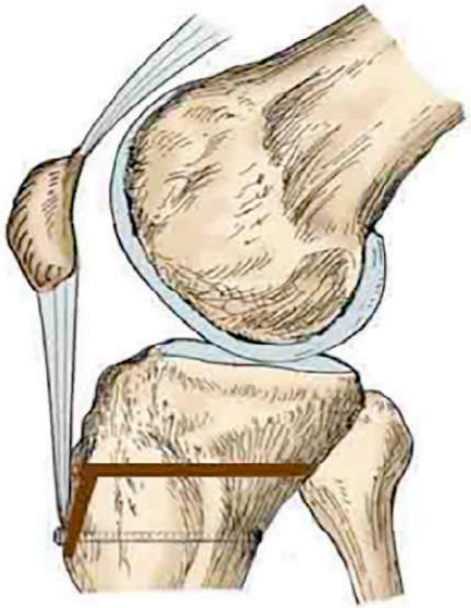
Dual Plane HTO

Can independently control changes in Tibial Slope





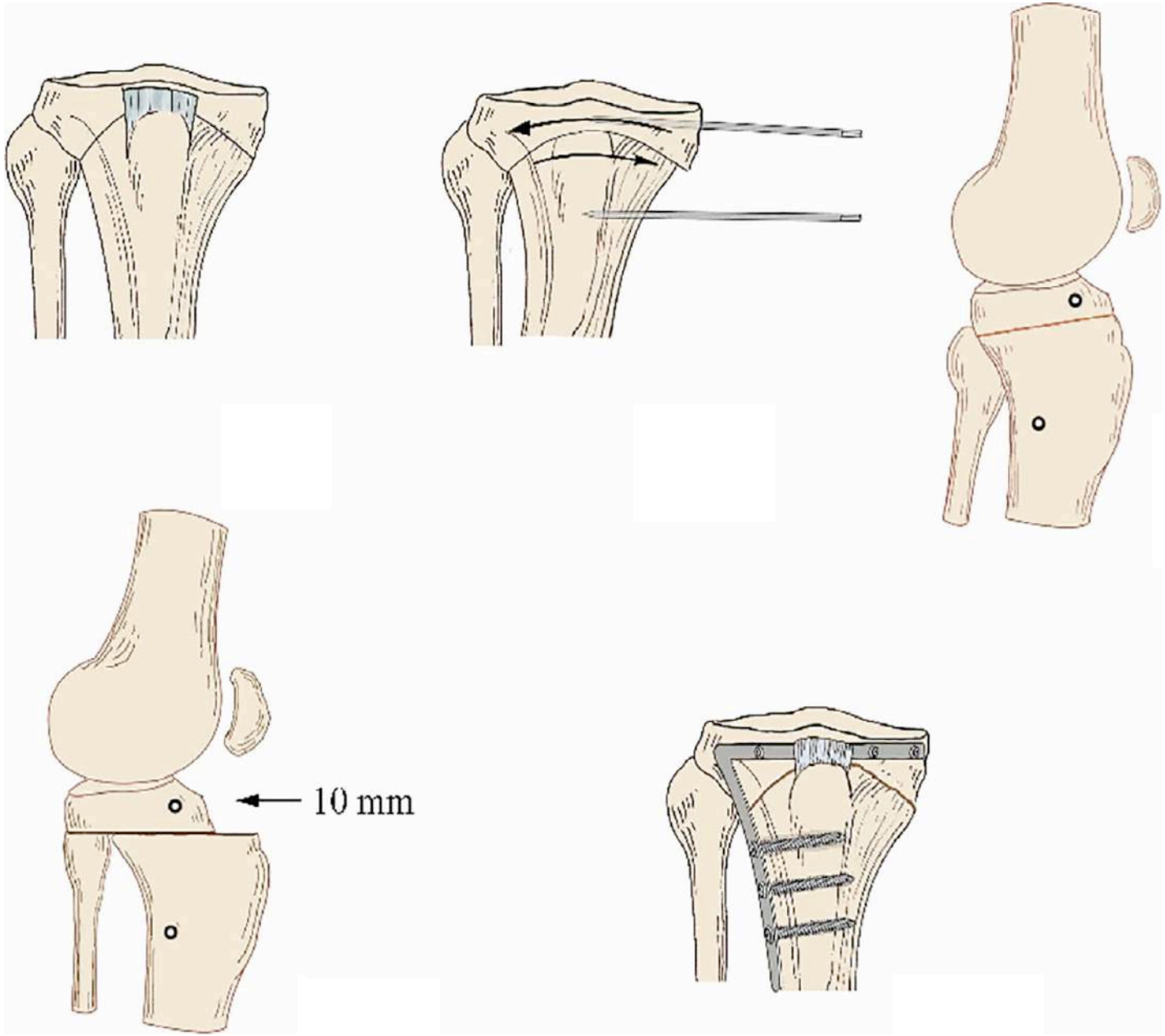




DOME OSTEOTOMY is a procedure using an inverse U-shaped proximal tibial bone cut and a metal plate for fixation. This technique is useful for achieving correction without any changes in the patellar height and allows large degrees of correction (> 20°).

No graft required.

Chevron variant (inverse V shaped cut).



The Progressive callus distraction (Medial opening wedge hemicallotasis by Turi et al) is performed through the medial based osteotomy technique with use of external fixation, an axial (JESS) or ring (Ilizarov) fixator that is capable of distracting osteotomy at controlled rate.

Most progressive callus distraction techniques are used for large degree of correction and require an osteotomy distal to tibial tubercle to minimize changes in the patellar height.

The use of an external fixator allows for correction of various axes, early rehabilitation and weight bearing, and micro-alignment of the lower limbs.

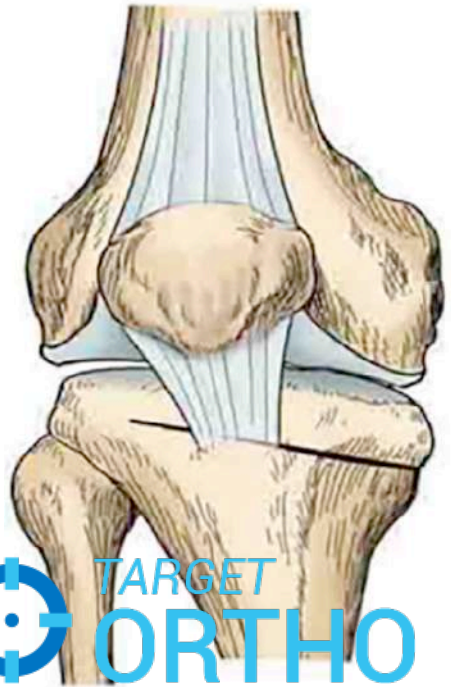
However, external fixation can cause discomfort, pin infections, loss of correction after fixator removal.

In Lateral closing wedge, incidence of common peroneal nerve palsy caused by nerve damage during HTO is 2-16% and fibular shaft osteotomy (at 15 cm distal to the fibular head) has to be added for reduction of such damage.

LCW

MOW

- Disadvantage is Graft
- Non union is a risk
- Hence, close wedge technique is better in nicotine smokers



- Avoids lateral dissection
- Fibular osteotomy not required
- Sparing fibula ensures a future PLC reconstruction if required will be unhindered
- If MCL is also deficient, it can be advanced or repaired simultaneously
- Patella alta and decreased limb length get benefitted

Ideal candidate

- Patient < 60 years age
- Mild to Moderate medial compartment OA knee
  - Thinned not absent cartilage; *Ahlback < 3*
- Reasonably active lifestyle
- Non Obese
  - BMI < 30
  - Body weight < 90 kg i.e. 200 pounds
- *No Contraindications*

Classification	Low-grade OA	High-grade OA
Kellgren–Lawrence	0, 1, 2	3, 4
Ahlback	0, 1, 2	3, 4, 5
Brandt	0, 1, 2	3, 4
OA Research Society International	0, 1	2, 3

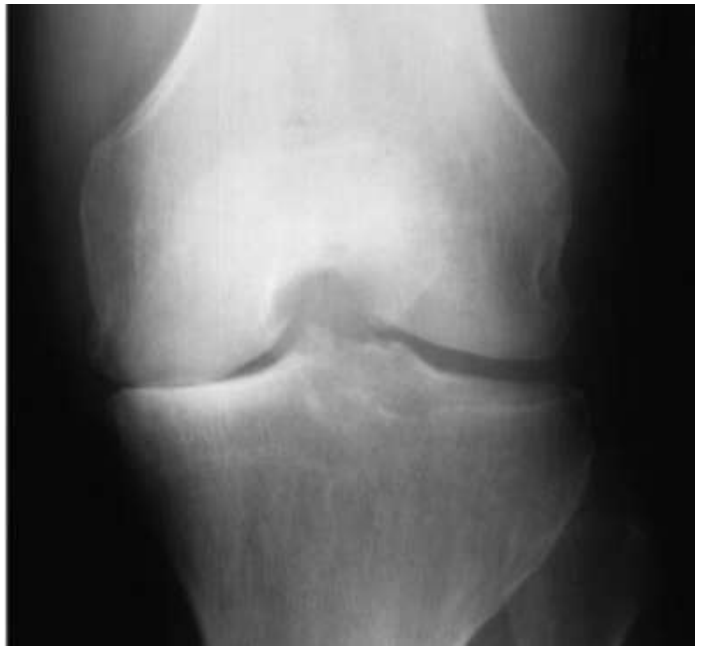
- This classification was proposed by Ahlback et al in 1968.
- grade 1: joint space narrowing (less than 3 mm)
- grade 2: joint space obliteration
- grade 3: minor bone attrition (0-5 mm)
- grade 4: moderate bone attrition (5-10 mm)
- grade 5: severe bone attrition (more than 10 mm)

Contraindications

- Patients > 60 years of age (candidates for replacement)
- No joint space in medial compartment on standing 45° posteroanterior radiographs (Rosenberg view)
- Medial tibiofemoral compartment bone exposure over an area greater than 15 x 15 mm on femur and tibia (MRI)
- Major concavity medial tibial plateau, loss of bone stock → that is producing a "Teeter-Totter" effect.
- >10 mm of lateral tibial subluxation
- Increased slope of affected medal tibial plateau (> 10^{o})
- Marked **symptomatic** and advanced patellofemoral arthrosis

- Knee flexion < 90^{o} or >10° of knee flexion contracture
- ACL tear

- Prior total lateral meniscectomy, or existing lateral tibiofemoral cartilage damage from any cause
- Use of products containing nicotine (healing issues)
- Obesity (body mass index > 30)
- Prior joint infection, diabetes, rheumatoid arthritis, autoimmune diseases, malnutrition states

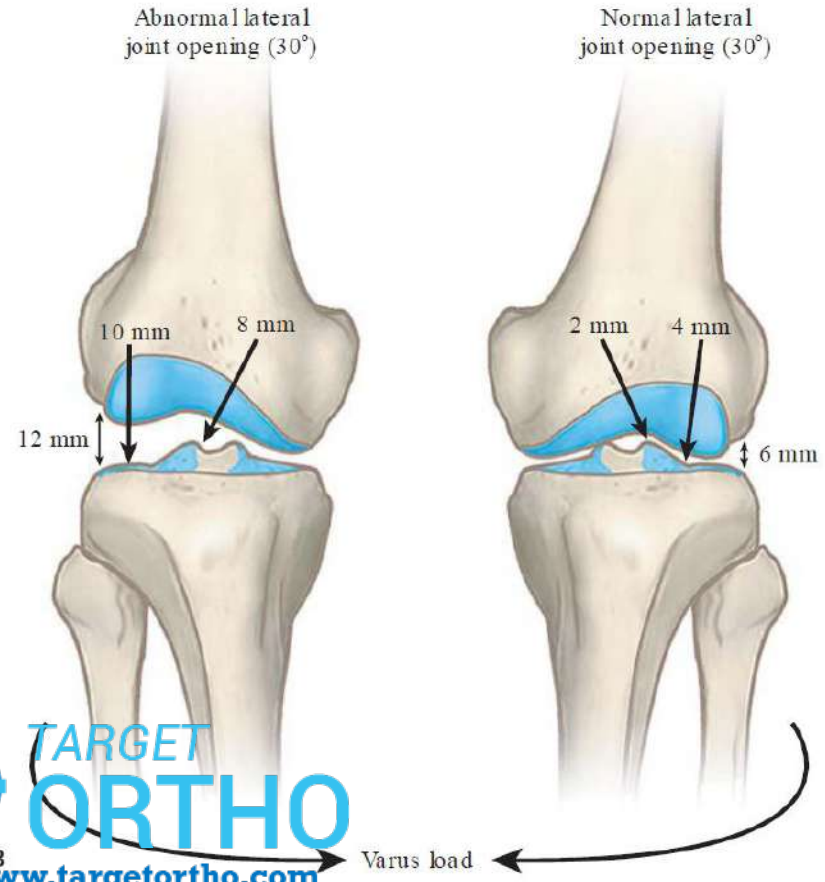


Kettlekamp and colleagues described the teeter effect in 1975 as a contraindication to proximal tibial osteotomy. Excessive bone loss and concavity on the medial tibial plateau prohibits simultaneous weight-bearing on both plateaus after HTO and results in an unstable knee in the coronal plane. A teeter effect occurs because tibiofemoral contact shifts, or teeters, from one plateau to the other depending on the relationship of the centre of gravity to the centre of knee.

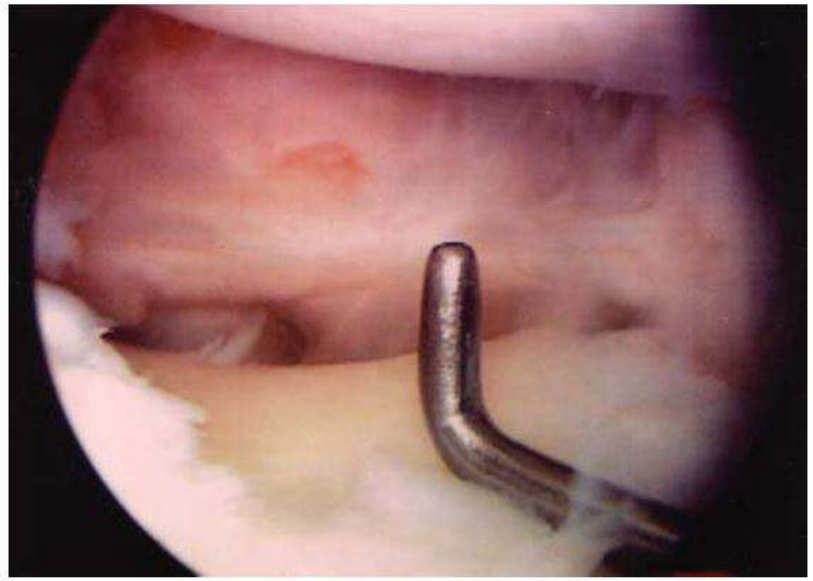
PF arthritis and HTO

The finding of **asymptomatic** articular cartilage changes to the patellofemoral joint is not a contraindication to HTO, because clinicians have noted that the end result in terms of longevity of the HTO depends on the symptomatic medial tibiofemoral compartment

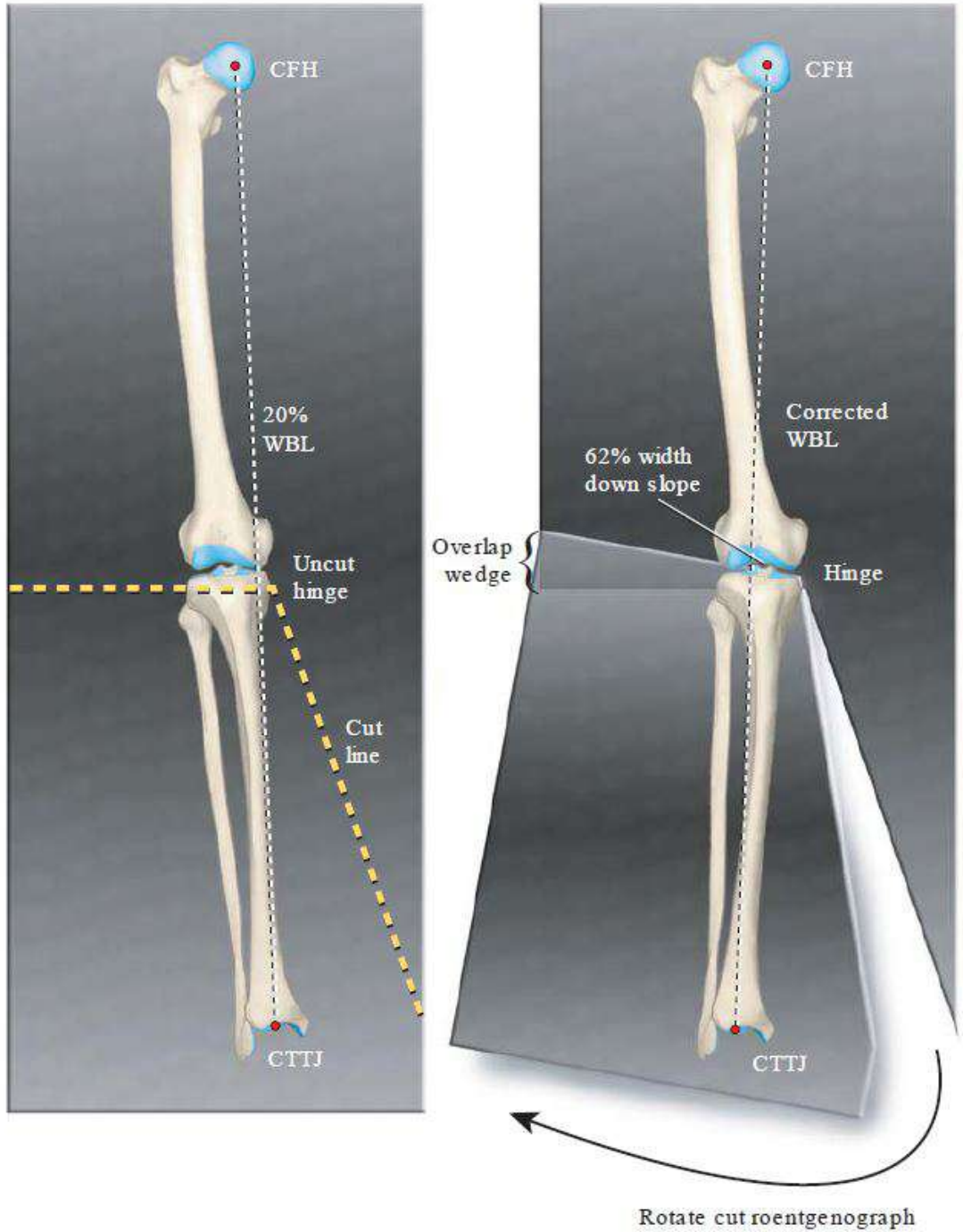
PRE OP PLANNING



- Double-stance, hip-knee-ankle to measure mechanical axis, weight-bearing line, lateral compartment separation
- Lateral, 30° knee flexion (patellar height measurement)
- Posteroanterior, weight-bearing, 45° knee flexion
- Patellofemoral axial
- Stress views, in neutral tibial rotation, under 67 N force
- MRI
- Arthroscopy#



Calculation of correction angle



The proximal osteotomy line is drawn from a point 3.5-4 cm inferior to the medial knee joint line to the tip of the fibular head from which another same length line is drawn obliquely by the α angle.

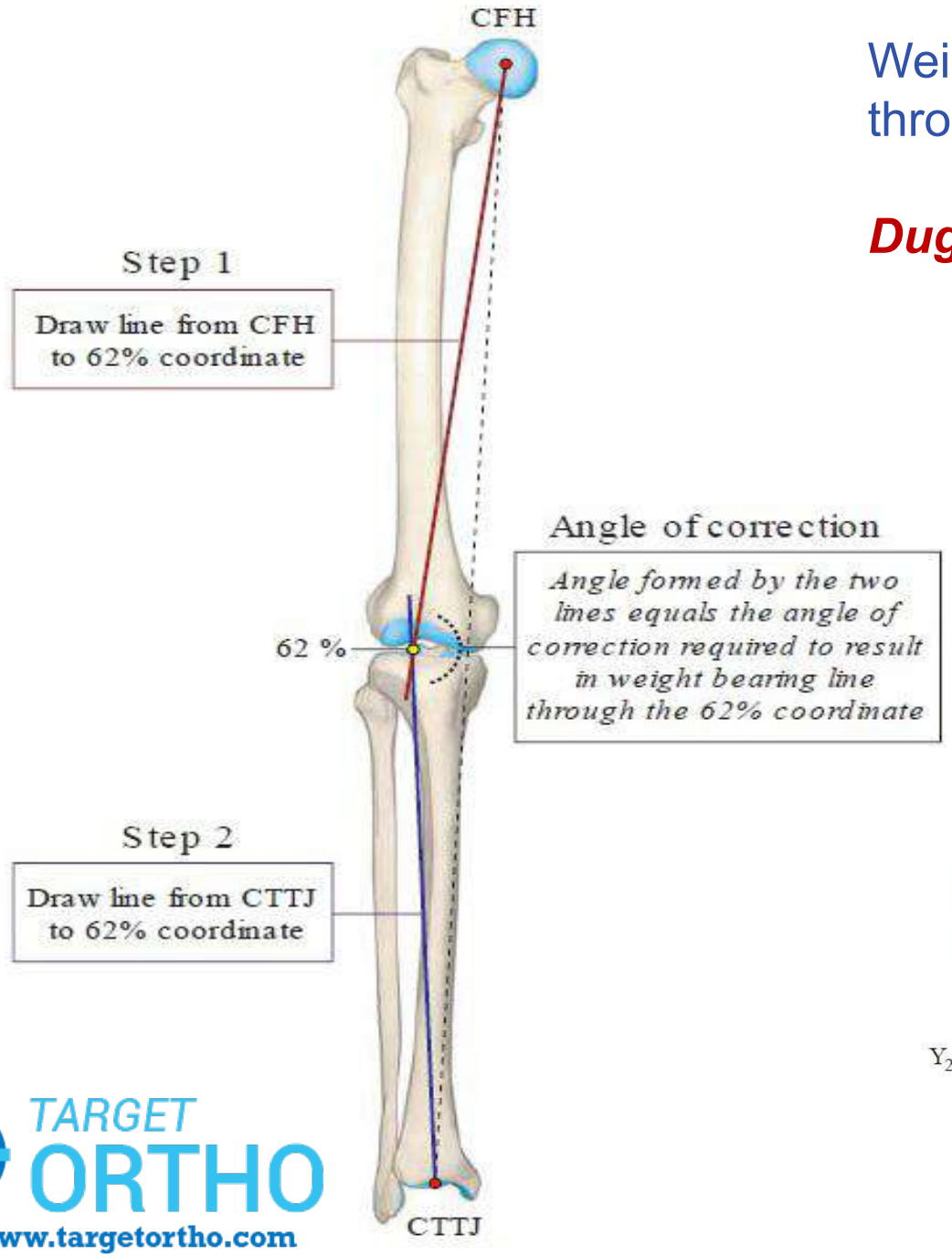
MOW

Osteotomy above tuberosity

Correction < 20°

LCW

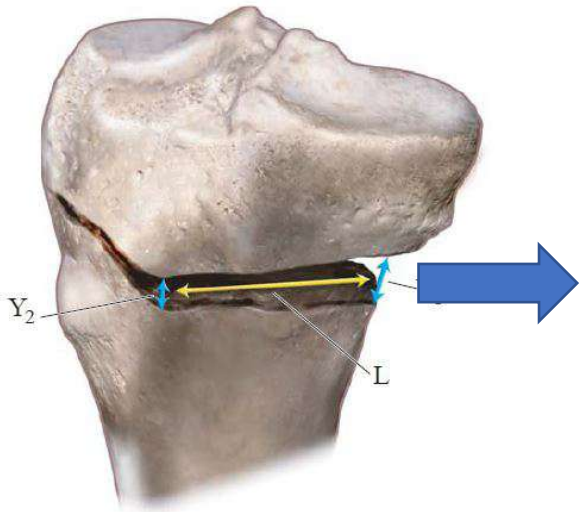
The proximal osteotomy line is located in parallel with the articular surface and 2-2.5 cm inferior to the joint line The distal osteotomy line is determined referring to the α angle and the wedge bone between the osteotomy lines is removed



Weight-bearing line (WBL) should pass through the 62.5 % coordinate of tibial width

Dugdale et al

Radiographic assessment of lower limb alignment is based on double-stance, full-length anteroposterior radiographs showing both lower extremities (knee flexed 3° to 5°) from the femoral heads to the ankle joints



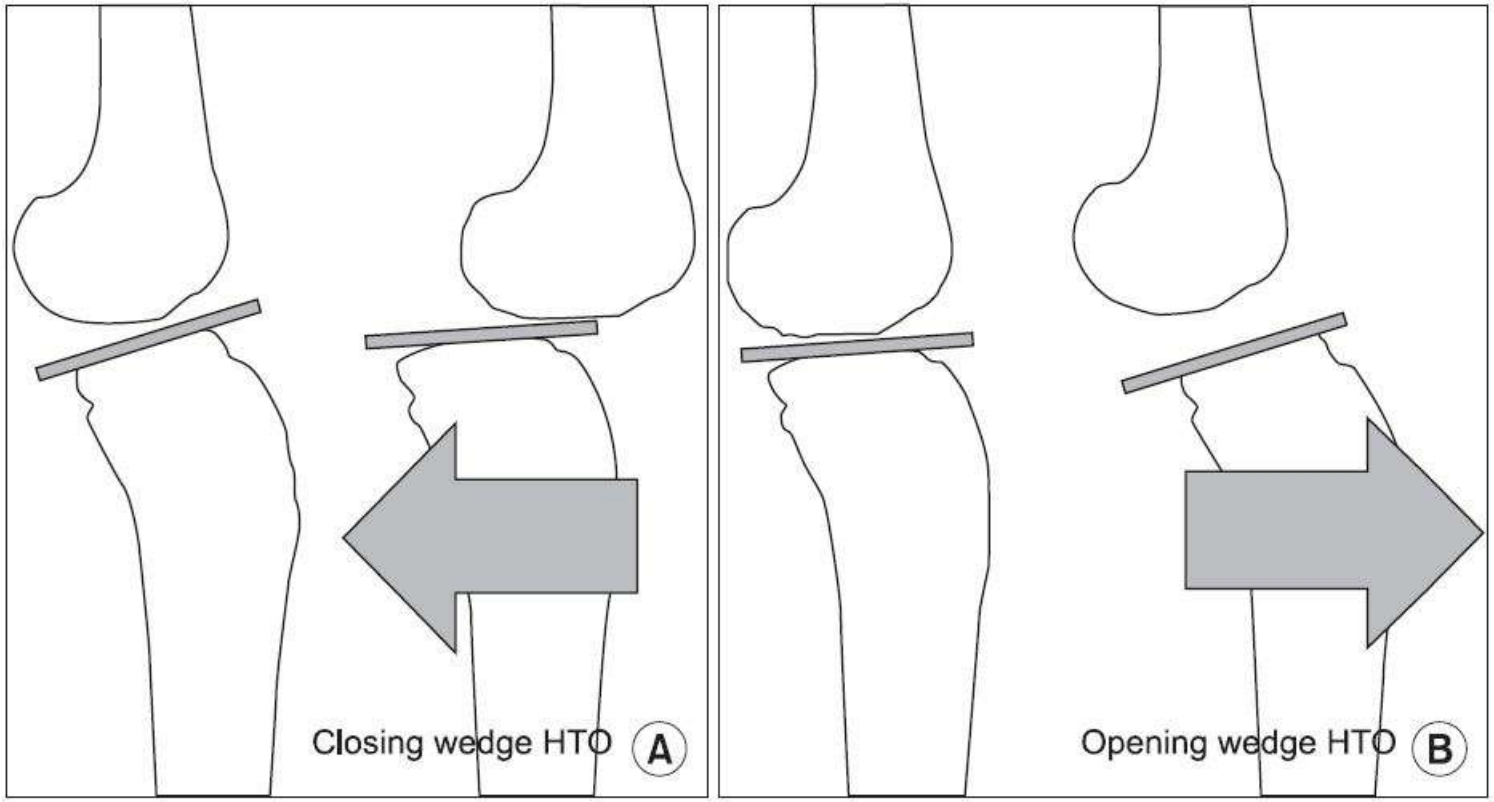
Opening is at
Postero-medial tibial cortex

Bauer, insall and Koshino formula

W (Width at osteotomy base) = diameter x 0.02 x Angle of correction

1º correction for each 1 mm length at base of wedge (provided tibia is 57 mm wide)

Jakob and Jacobi suggested that correction of the mechanical axis depends on the thickness of the cartilage in the medial compartment: if one third of the medial cartilage is lost, the mechanical axis should pass 10-15% lateral from the centre of the tibial plateau; if two thirds of the cartilage is lost, the axis should pass 20-25% lateral; and if all is lost, the axis should pass 30-35% lateral



- Closing wedge high tibial osteotomy (HTO) can cause no change or a decrease in posterior tibial slope, and posterior translation of the tibia can be increased.

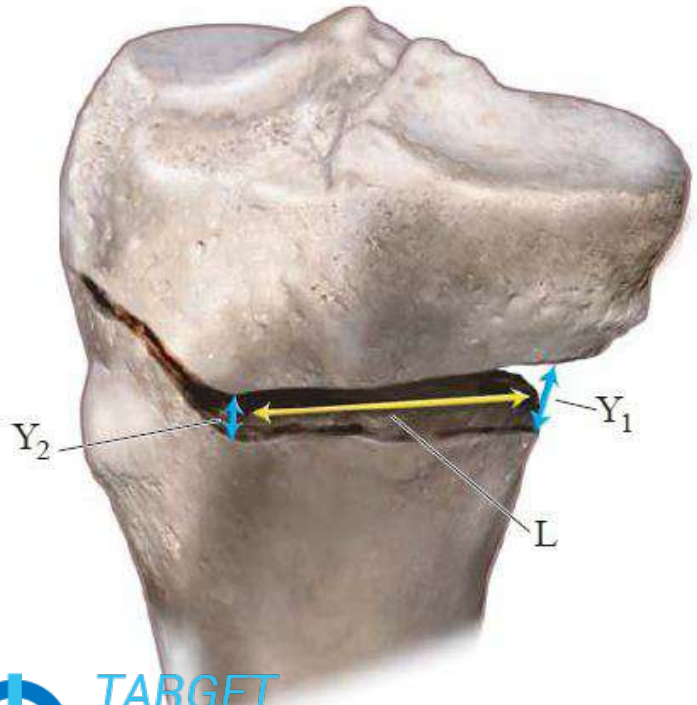
- Opening wedge HTO usually can be caused an increase in posterior tibial slope, and anterior translation of the tibia can be increased

Ideal is to preserve original tibial slope

Never accept slope > 10^{o}

Maintenance of Tibial slope

- Anterior gap at medial opening wedge osteotomy should be one half of the postero medial gap (at plate site 3-4 mm less).
- Every 1 mm of gap change will lead to 2o change in tibial slope.

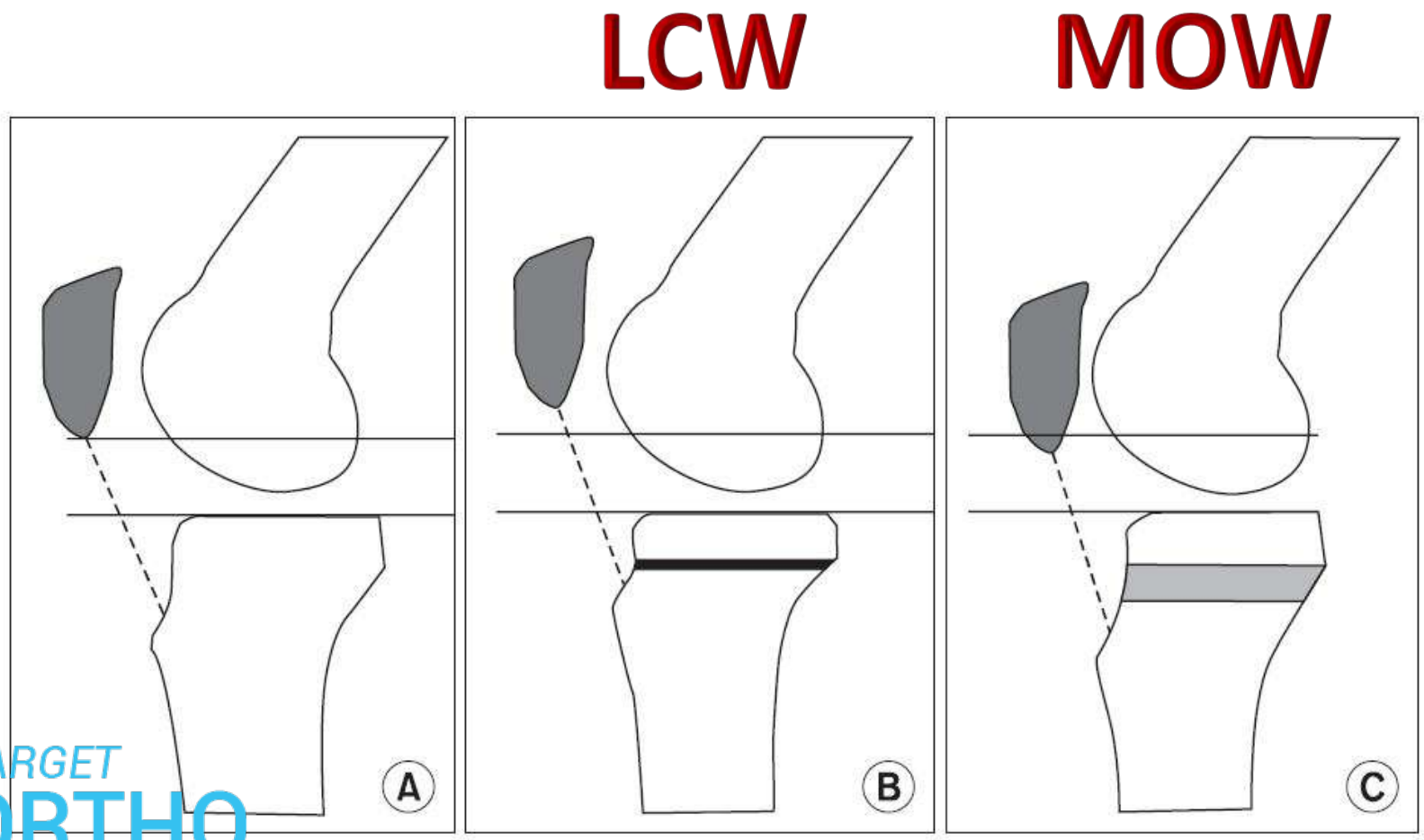


Millimeters of opening at the osteotomy site based on the width of the tibia and the angle of correction

	Degree of angular correction								
TW[a]	5	6	7	8	9	10	11	12	13
50	4.37	5.25	6.15	7.00	8.00	8.80	9.70	10.85	11.55
55	4.81	5.78	6.77	7.70	8.80	9.68	10.67	11.94	12.71
60	5.25	6.30	7.38	8.40	9.60	10.56	11.64	13.02	13.86
65	5.69	6.83	8.00	9.10	10.40	11.44	12.61	14.11	15.02
70	6.12	7.35	8.61	9.80	11.20	12.32	13.58	15.19	16.17
75	6.56	7.88	9.23	10.50	12.00	13.20	14.55	16.28	17.33
80	7.00	8.40	9.84	11.20	12.80	14.08	15.52	17.36	18.48
85	7.44	8.93	10.46	11.90	13.60	14.96	16.49	18.45	19.64
90	7.87	9.45	11.07	12.60	14.40	15.84	17.46	19.53	20.79
95	8.31	9.98	11.69	13.30	15.20	16.72	18.43	20.62	21.95
100	8.75	10.50	12.30	14.00	16.00	17.60	19.40	21.70	23.10

CHANGES IN PATELLAR HEIGHT

To be kept in mind !!



SURGICAL TECHNIQUE (OVERVIEW)

A 5-cm vertical incision is made over the centre between the medial aspect of the tibial tuberosity and the posteromedial aspect of the tibia below the joint line.

- Pes tendons to be partially detached exposing MCL
- Sharp incision along the postero medial tibial border of MCL, elevate anteriorly to reattach after osteotomy
- Protech inferior medial geniculate artery beneath MCL.
- Identify and protect patellar tendon attaching on tuberosity

Carry osteotomy 7-10 mm of postero lateral cortex

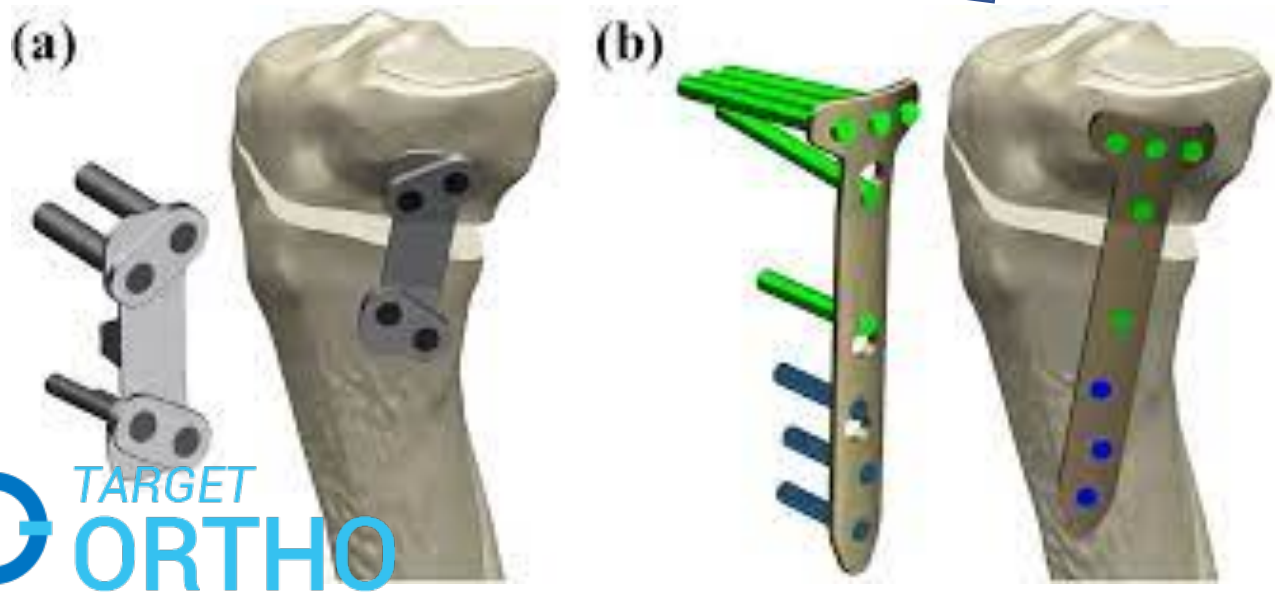
Illiac crest tricortical (triangular shaped) graft
40 mm length, 10 mm width, 30 mm depth

For defects ≥10 mm, corticocancellous autografts or allografts are used whereas for small defects, bone grafting is optional

FIXATION OF OSTEOTOMY

There are various types of metal plates including the Puddu plate, Tomofix, Aesculap (dual) plate.

Among these, TOMOFIX plates have been proved to provide the best fixation.



Post op protocol

- Isometric Day 1
- ROM Day 1
- NWB (Toe touch): 4-6 weeks
- *Alignment to be verified in 4th post op week under partial weight bearing conditions*
- 4-6 wks onwards: Progressive weight bearing
- 3 months: Confirm union and then full Weight bearing

Some authors raise concern that conversion to total knee arthroplasty (TKA) after HTO can cause adhesion or shortening of the patellar tendon or bone loss or overcorrection due to tibial plateau deformity. However, many long-term follow-up studies have failed to demonstrate significant clinical differences between the knees with a primary TKA and a TKA following an HTO

? Future TKR

Total Knee Arthroplasty
After High Tibial Osteotomy

A Comparison Study in Patients Who Had Bilateral Total Knee Replacement*

by John R. Meding, M.D., E. Michael Keating, M.D., Merrell A. Ritter, M.D., and Philip M. Faris, M.D.†

Investigation performed at The Center for Hip and Knee Surgery, St. Francis Hospital-Mooresville, Mooresville, Indiana

Abstract

Background: The outcome of total knee replacement after high tibial osteotomy remains uncertain. We hypothesized that the results of total knee replacement with or without a previous high tibial osteotomy are similar.

Methods: The results of a consecutive series of thirty-nine bilateral total knee arthroplasties performed with cement at an average of 8.7 years after unilateral high tibial osteotomy were reviewed. There were twenty-seven men and twelve women. Preoperatively, the knee scores according to the system of the Knee Society were similar for all of the knees; however, valgus alignment and patella infera were more common in the knees with a previous high tibial osteotomy. Bilateral total knee replacement was staged in seven patients and was simultaneous in thirty-two patients. The results of the total knee arthroplasties were retrospectively reviewed with respect to the knee and function scores according to the system of the Knee Society, the radiographic findings, and the complications.

Results: Intraoperatively, no notable differences were identified in the number of medial, lateral, or lateral

more knees were free of pain in the group without a previous high tibial osteotomy (thirty-six) than in the group with a previous osteotomy (thirty-three), this difference was not found to be significant with the numbers available ($p = 0.4810$). Knee alignment and stability, femoral and tibial component alignment, and range of motion also were similar in both groups postoperatively. One all-polyethylene tibial component was revised in the high tibial osteotomy group. Two knees in each group required manipulation. There were no deep infections.

Conclusions: While patients with a previous high tibial osteotomy may have important differences preoperatively, including valgus alignment, patella infera, and decreased bone stock in the proximal part of the tibia, the present study suggests that the clinical and radiographic results of primary total knee arthroplasty in knees with and without a previous high tibial osteotomy are not substantially different. In our relatively small group of patients, the previous high tibial osteotomy had no adverse effect on the outcome of the subsequent total knee replacement.

High tibial osteotomy has proven to be successful

PROXIMAL FIBULAR OSTEOTOMY (PFO)

PFO hypothetically works on the principle of redistribution of forces towards the lateral compartment as described by Zhang *et al.*, Yang *et al.,* and Shanmugasundaram *et al*

The first reported suggestion that fibulectomy results in a decrease in the medial compartmental pressure and an increase in the lateral compartmental pressure was by Yazdi et al. in 2014.

HTO ≠ PFO

PFO: the IdEA

Maximum fibular loading occurs when the ankle joint is in full dorsiflexion and the subtalar joint in full eversion.

MCQ

Load transmitted by the fibula has been reported to be between 6-16% of the total load borne by the lower limb.

This loading through the fibula is relatively well preserved with age and the fibula contributes to supporting the lateral column of the proximal tibia throughout life.

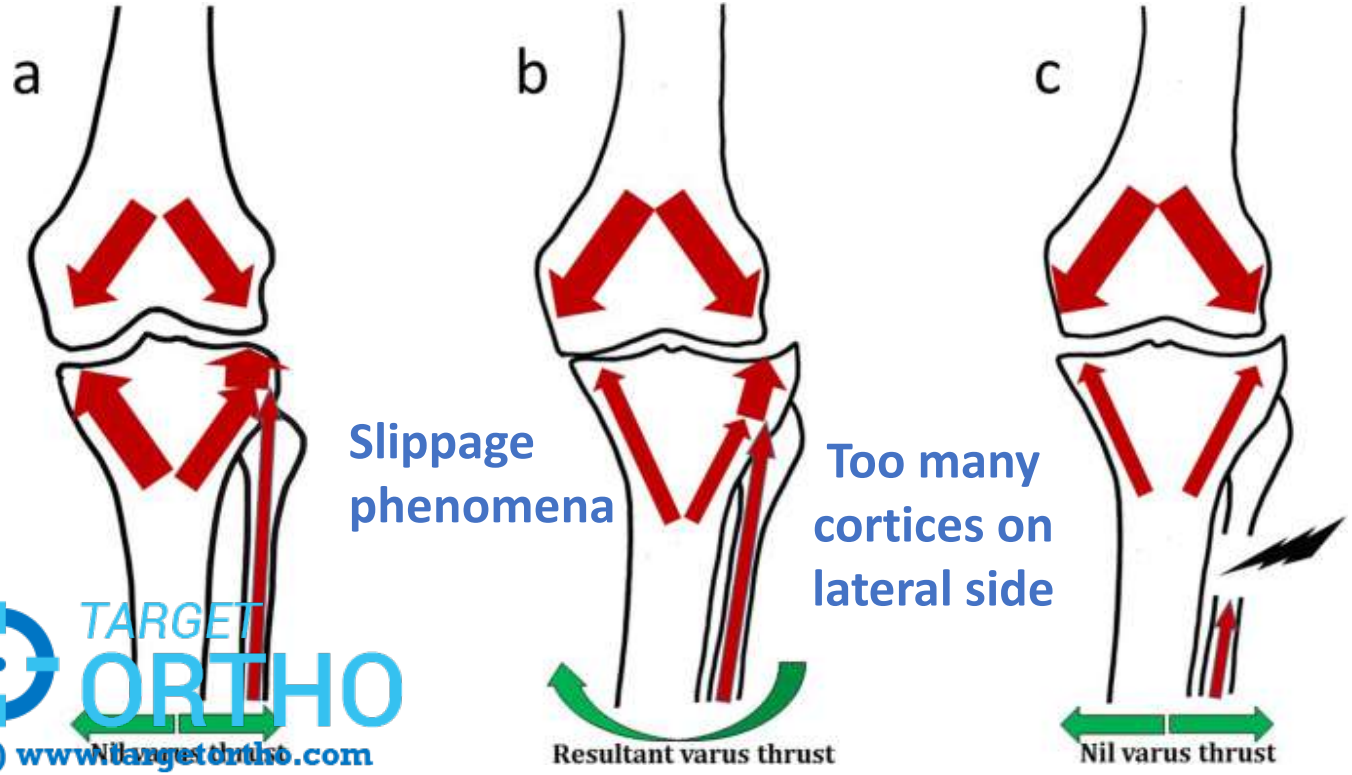
Vs

In the proximal tibia, which is predominantly a cancellous bone, the trabeculae rather than the peripheral cortex share most of the load. Hence, age-related trabecular resorption in the proximal tibia leads to the risk of collapse. The fibula, being a predominantly cortical bone, is not affected by this.

Settling the "Non Uniform Settlement"

With osteoporosis, the support of the fibula by the lateral tibial plateau does not allow the lateral side to "settle" creating a varus deformity. This has been called non-uniform settlement.

The rationale behind PFO is that when this support of the fibula is removed, the lateral side "settles" down, loading the proximal tibia evenly and leading to the correction of the deformity in a varus knee, thereby relieving symptoms and reducing the deformity.



It was found in clinical studies of PFO that varus deformity improved following PFO

Settlement value was defined as the distance of the lowest point of the medial condyle of the tibia in an anteroposterior view of the knee, from a perpendicular drawn through the highest point in the lateral tibial condyle to the tibial mechanical axis.

The Fibular Osteotomy

It is presently NOT clear whether resecting the proximal fibula confers any benefits over resecting the fibula from the distal half for patients undergoing isolated fibular osteotomy for medial OA of the knee.

APPROACH

Huang et al. advocates removing a 1-cm segment of fibula 7–8 cm from the head of the fibula by accessing it through the inter-muscular space between the extensor digitorum longus and peroneus longus/peroneus brevis, under local anaesthesia.

Currently most surgeons approach between the peroneus and the soleus and go for removal of a 2-cm segment; 6–10 cms below the fibular head.

Surgical Tip — Keep your incision posterior to the coronal plane to avoid the peroneal nerve and its branches which are in anterior to the coronal plane.

HTO tends to relieve pain by diverting the weight-bearing axis to the lateral compartment and effectively relieves pain. However, this needs surgical expertise and is costly. Infection, non-union, common peroneal nerve injury are some of its disadvantages.

Another problem with HTO is while converting these patients to TKRs one needs to remove the plate and then go for TKR.

Technically, converting HTO to TKR is more difficult because of the distortion of the proximal tibial metaphysis and due to ligamentous imbalance.

UNICONDYLAR KNEE ARTHROPLASTY (UKA)

Generally, UKA refers to medial or lateral unicondylar knee replacement!

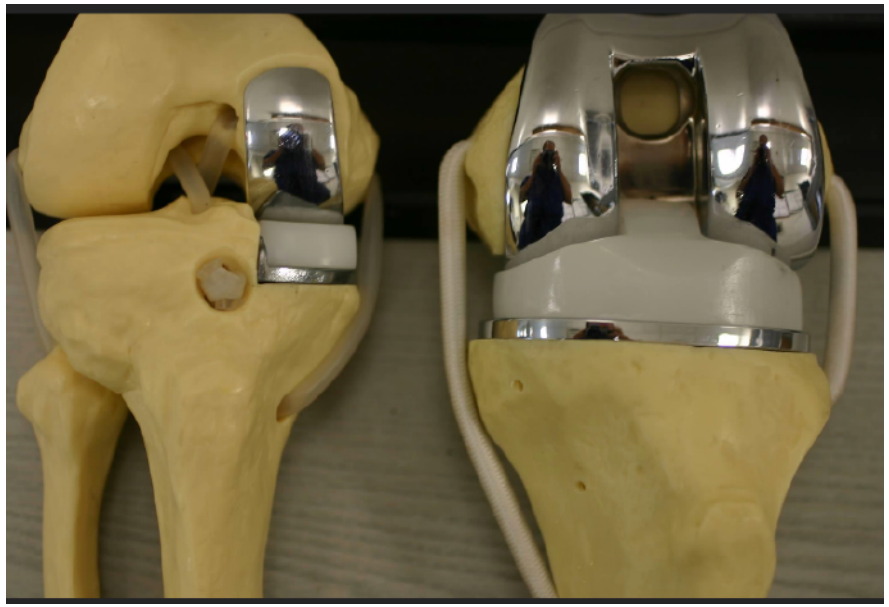
UKA Vs HTO/ PFO

HTO: Younger, more active and **heavier patients** and those with OA knee with varus > 10°. *Alignment axis adjustment is not possible in UKA.*

Most authors agree that HTO is more appropriate than unicompartmental knee arthroplasty for overweight patients.

UKA Vs TKR

UK provides more normal knee mechanics, and hence greater ROM and better proprioception can be expected



If the joint has subluxation of 3 mm or more or there is a *so called kissing lesion wherein the femoral notch and the tibial spine overlap* due to instability of the femorotibial joint, *it should not be considered as an indication for UKA*

Patient Selection

Kozin Scott JBJS 1989

- <15° cumulative angular deformity
- One compartment minimal erosions
- One compartment no changes
- NOT physically active / heavy labour
- ROM > 90° ; Flexion contracture < 5°
- Older than 60 years
- Weight less than 82 kg
- Minimal rest pain
- Non inflammatory
- ACL Intact

Varus < 5º

MCL intact
(no fixed contracted)

The principles of ligament balancing followed in TKA cannot be applied to UKA.

The medial collateral ligament should be released till the retractor can just be inserted. If the medial collateral ligament needs to be released to a greater extent, it can cause joint instability and progressive arthritis of the unreplaced, i.e., lateral part of the knee joint.

Hence, TKA should be considered instead of UKA if the medial collateral ligament needs to be released to a greater extent because of the varus deformity.

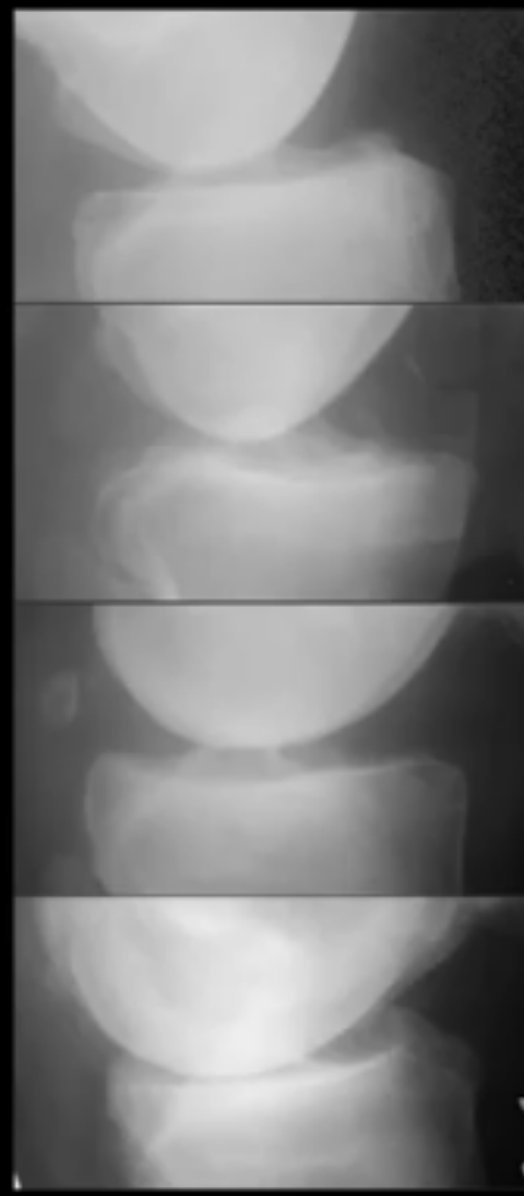
- **Functionally intact ACL**

- XRays
  True lateral with both condyles overlapping
  Flexion angle - any

- Tibial erosion extent

- 95% predictive ACL intact

- Better than MRI



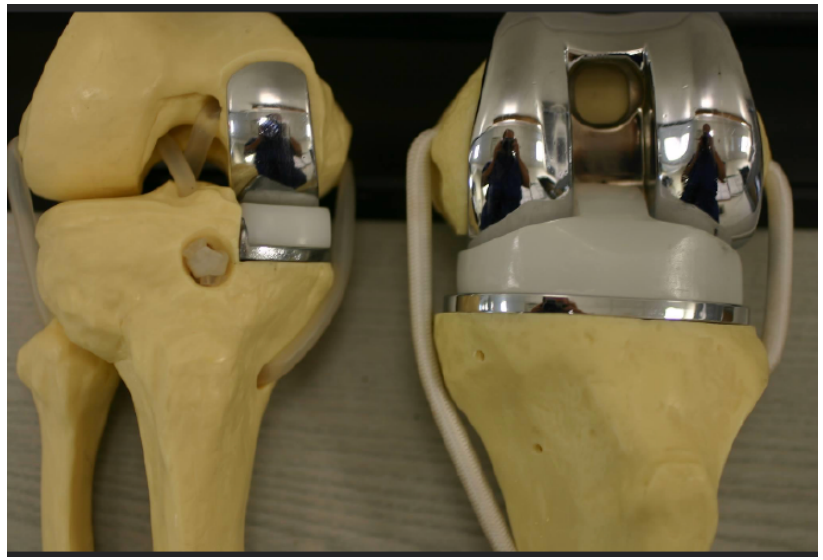
The Evolution

Historically, the first modern UK was designed by McKeever in the 1950s; it was a type of hemiarthroplasty of the tibial surface with metals and the main cause of failure was loss of the femoral cartilage.

In 1970s, Marmor solved this problem by performing femoral resurfacing simultaneously and this was the first type of cemented UKA on modern lines.

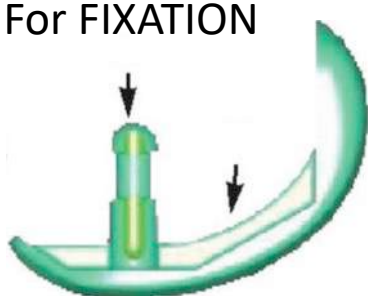
The Oxford type (Zimmer biomet) was developed in the late 1970s. In this type, the mobile congruous design of
PE in the shape of a meniscus was adopted so as to reduce the wear and loosening.

There are other types also such as Miller– Galante and Repicci UKA, Sigma Depuy. Last one is a fixed bearing design.



FEMORAL COMPONENT

Lug and Fin
For FIXATION



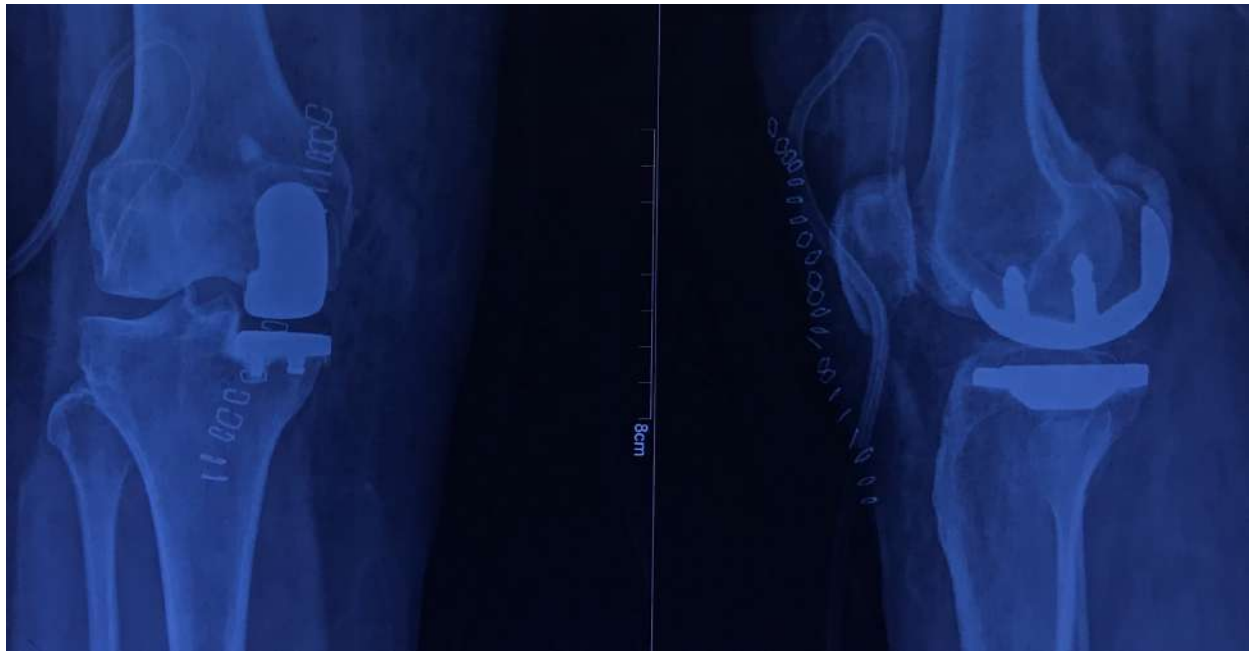
COMPONENT DESIGN

The current design aims to restore anatomy of the posterior condyle so as to cover the posterior condyle fully (small diameter: subsidence) and to taper the anterior femoral edge below the subchondral bone so as to reduce the chances of patellar impingement

Loosening ∞ Conformity

Wear rate 1/ ∞ Conformity

ADEQUATE CONFORMITY



TIBIAL COMPONENT

The shape of the tibial component should be as anatomical as possible.
Even with optimized designs, a maximum of 76 % of the implant edge lay on cortical bone.

Metal backed PE

Fixed Bearing

*The thickness of PE should be **at least 6 mm at the thinnest portion** regardless of the type of PE so as to reduce the wear.*

Mobile-bearing PE was developed so as to decrease the wear and loosening .

The added advantage of mobile-bearing PE in UK is that it allows for “real” resurfacing, which reduces the amount of bone resection as well .

However, the drawbacks of this design are that the operation is more difficult to perform, more resection of the anterior portion of the tibia is required, the PE may not move , and joint instability such as PE dislocation can occur .

TECHNIQUE

Overcorrection to be avoided at every cost in UKA

Basic Principle

The tibia first technique is commonly used in mobile bearing joints <But not a rule>

Incision for medial parapatellar arthrotomy

Medial meniscus removed

Medial spurs removed

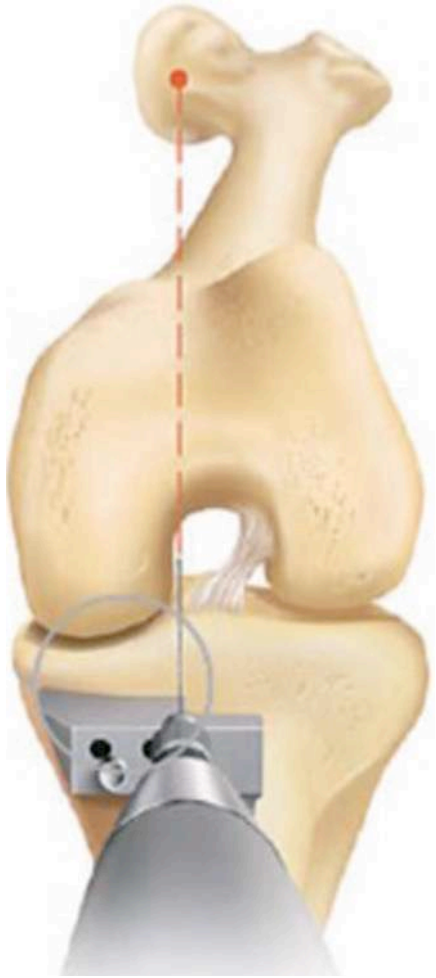
Retractor placed under MCL

Calculating tibial cut

The tibial prosthesis should be at the level as high as the anatomical tibial plateau, and its alignment should be in the neutral position without overcorrection!

Amount of resection calculation:

For example, if bone loss is 2 mm, total loss is 5 mm (cartilage 3 mm + 2 mm). When an 8 mm thick component is planned for use, 3 mm of bone (component 8 mm − total loss 5 mm) is resected.



Vertical osteotomy is done as close to the tibial spine as possible, but up to a point where the cruciate ligaments are not injured

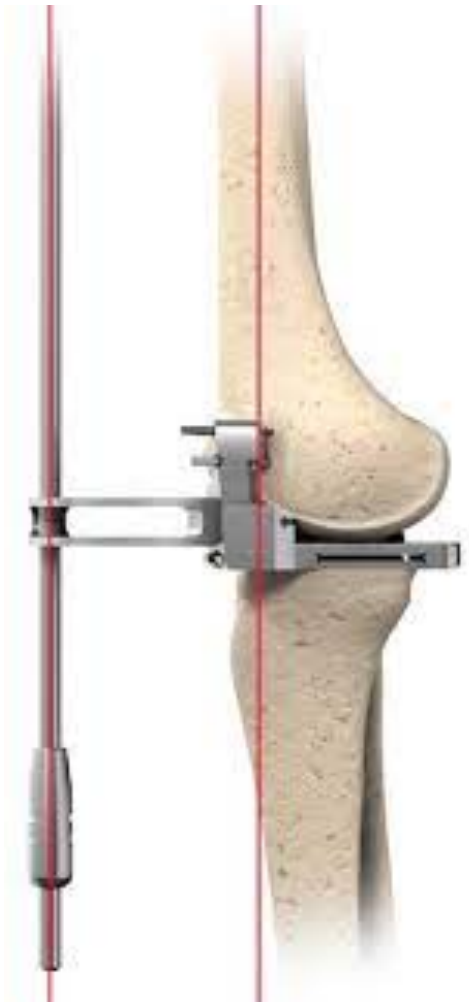
Even though the anatomical posterior slope is known to be 10°, posterior slope greater than 7° is not recommended since it causes ACL strain .

Femoral osteotomy is done using the **Gap technique**

Femoral jig is mounted on spacer block.

Size of block:
The spacer block should slide with little resistance.

Distal cut



Cut

Anterior

Posterior

& Chamfers

Femoral component

Rotation

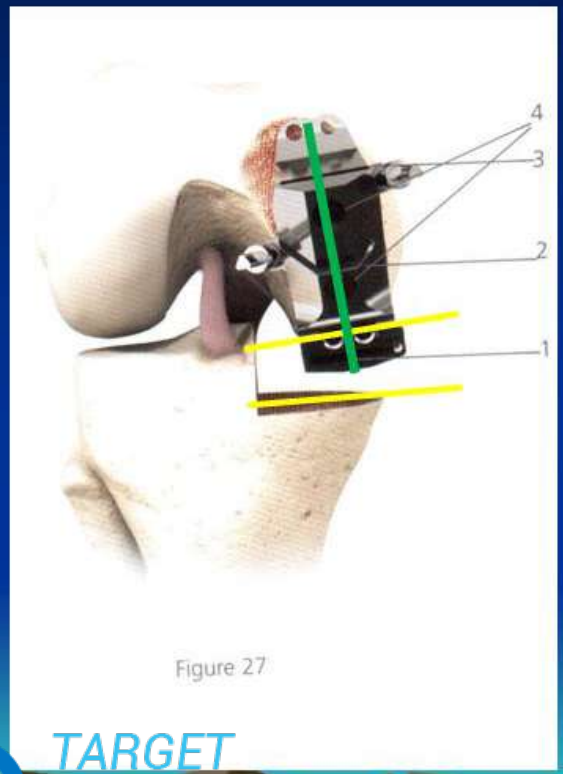
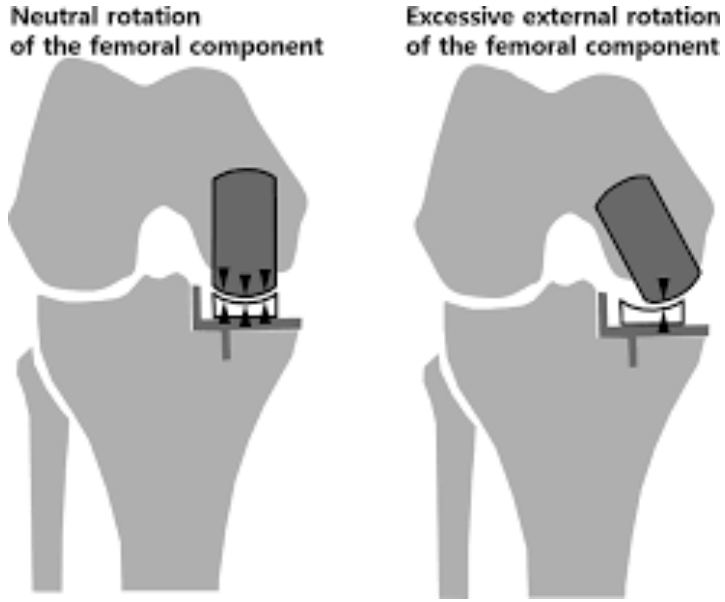


Figure 27

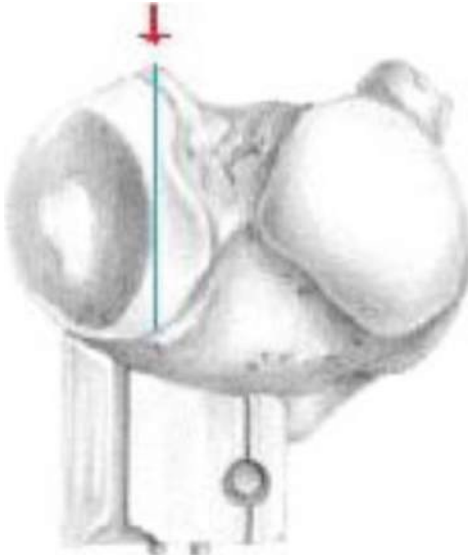
femoral rotation may follow the previously Marked rotation line or

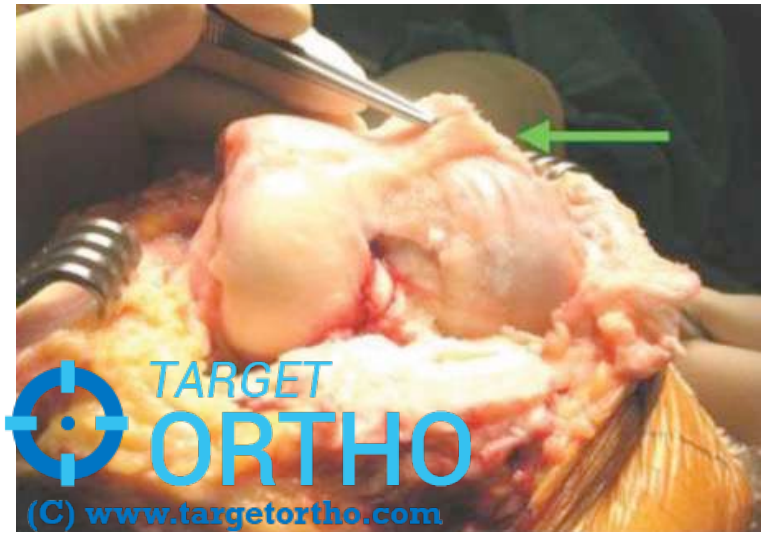
This guide should also be rotationally set so that the posterior cutting surface of femoral condyle is parallel to the resected tibia



The A–P size of the implant is important; a *larger implant should be chosen if the size of the implant is in between sizes* ; however, about 1 mm of cutting surface of the articular portion should be left uncovered

Sizing





Cementing

Tibia

↓

Femur

Intra op checks

Ligament balancing should be examined when the knee is fully extended, flexed to 45° and 90° flexion, respectively.

The medial part neither should be opened by more than 2 mm nor should it be too tightened by the valgus stress test.

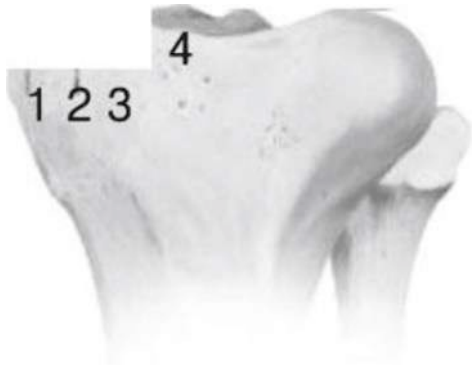
If the ligament is lax or there is a varus or valgus deformity of the knee joint, it is necessary to adjust the thickness of the PE insert.

Complications

The most common mid- to long-term complications include *arthritis of the unreplaced part of the knee joint (MOST COMMON) or of the patellofemoral joint due to overcorrection of the varus deformity.*

Other complications include wear, subsidence or loosening of the prosthesis, break down of the prosthesis, and PE dislocation.

Intra op most common issue is: *Tibial fracture during vertical tibial cut*



THANK YOU