Lateralization of Femoral Entry Point in bowed femur

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Lateralization of Femoral Entry Point to Improve the Coronal Alignment During Total Knee Arthroplasty in Patients With Bowed Femur

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Introduction

long-term survival of total knee arthroplasty (TKA) influenced by

- Postoperative limb alignment
- Position of the mechanical axis

LIMB RECONSTRUCTION

Normal post operative Alignment

- Fang et al concluded that the ideal postoperative alignment of TKA should be between 2.4 and 7.2 of valgus.
- Fang et al showed that the risk for tibial collapse is increased by 6.9 times in the presence of overall malalignment of the affected lower limb.
- Matsuda et al found that initial varus position of the total knee implant is likely to worsen with follow-up probably due to abnormal polyethylene wear from malalignment

LIMB
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Bowed femur (Varus)

- The skeletal morphology of Asian patients has been shown to differ from that of the Western population
- Lateral femoral bowing and varus orientation of the joint line are frequent findings in Asian patients undergoing TKA

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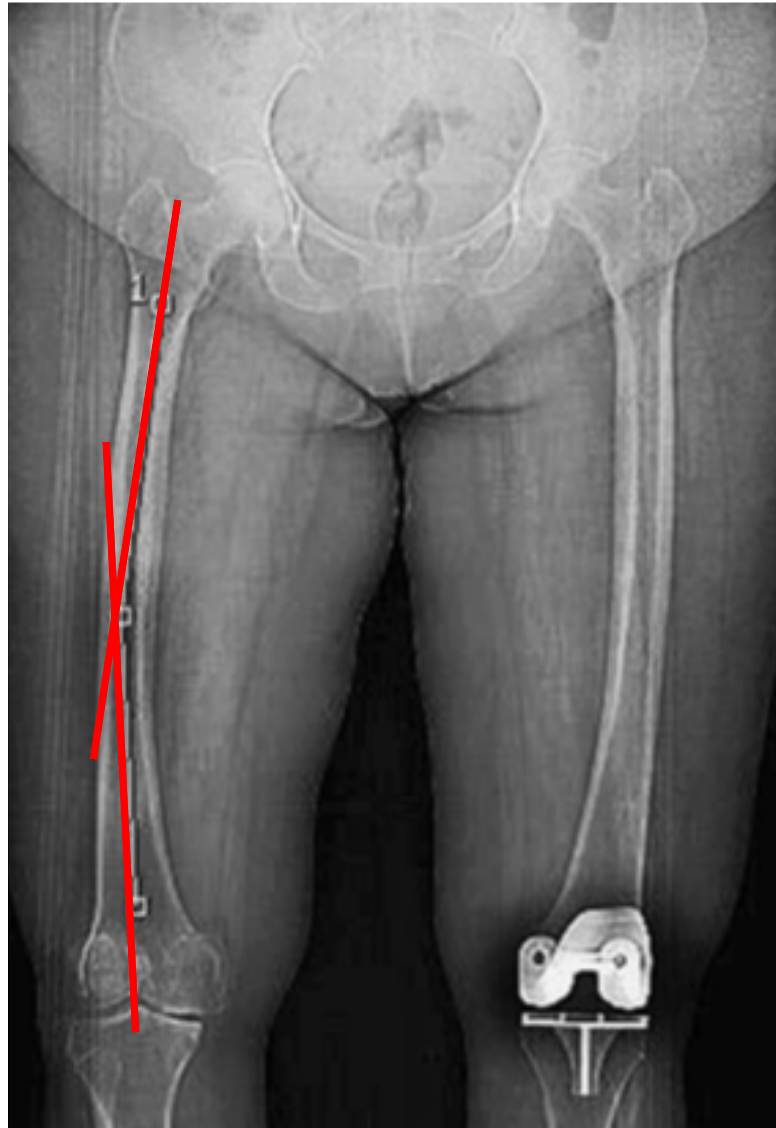

ig. 1. Preoperative scanogram showing bowing of right femur.

LIMB
RECONSTRUCTION

Valgus femur

- Meric et al on a large cohort of patients in the United States showed that nearly 14% of patients undergoing TKA had distal femoral valgus angle outside the mean range of 5.7 ± 2.3 .

LIMB
RECONSTRUCTION

Problems of femoral bowing

- Intramedullary jigs are most often used for femoral side bone cuts.
- Accuracy of bone cuts in the distal femur could be affected by the presence of diaphyseal deformities of the femur.

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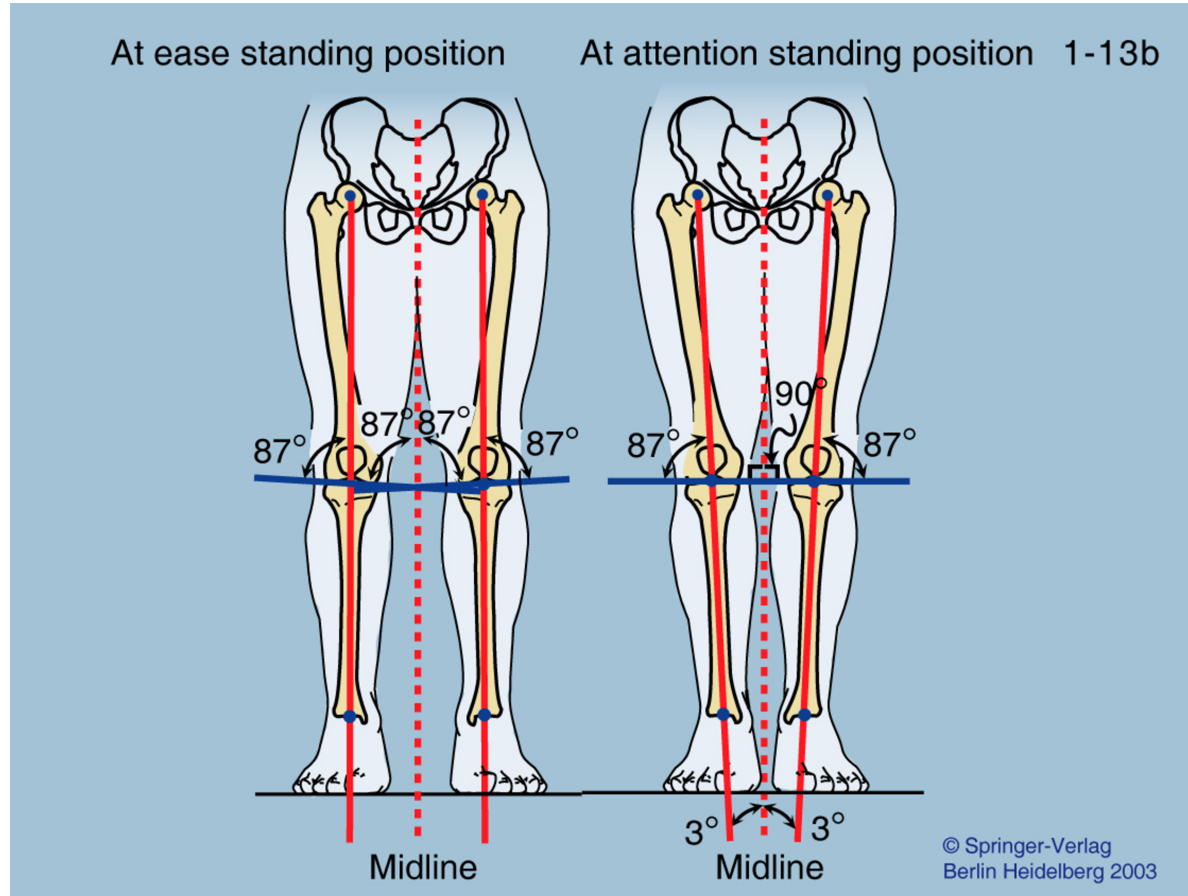
Normal axis of limb



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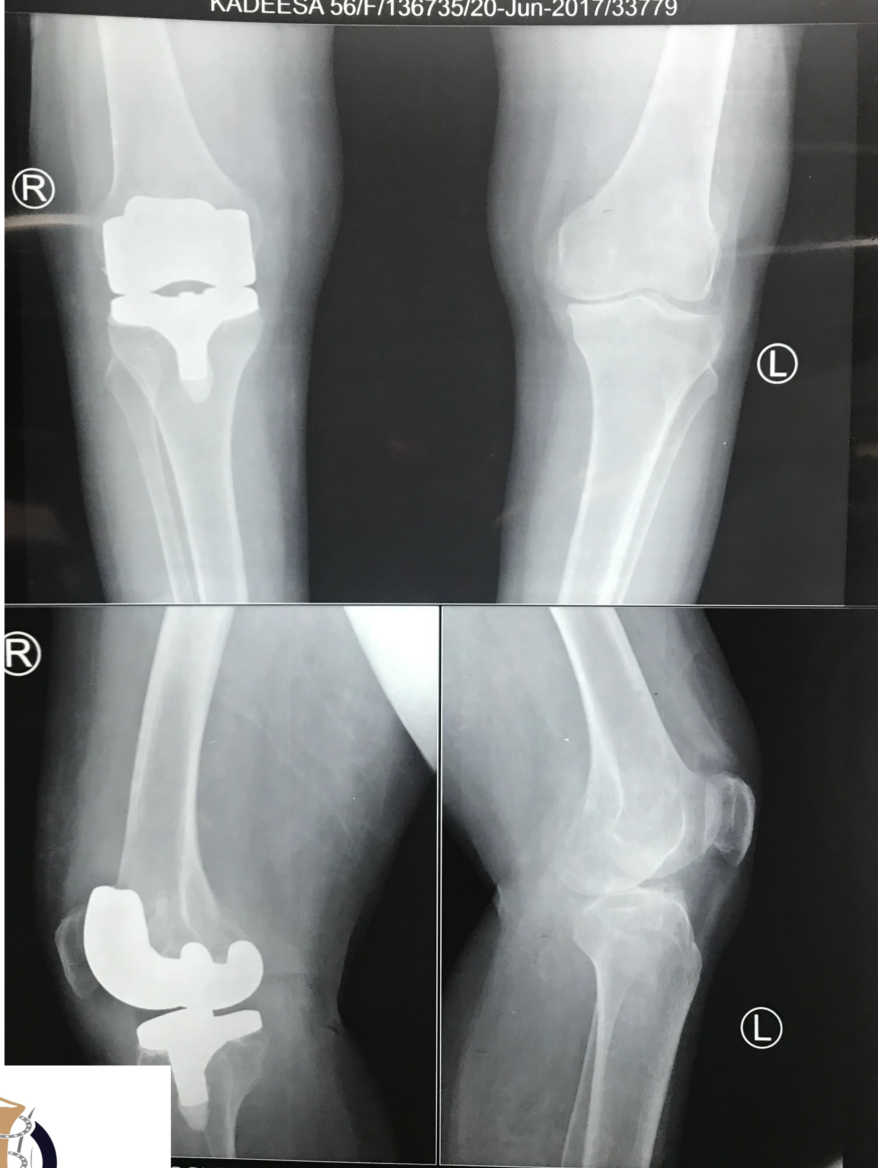

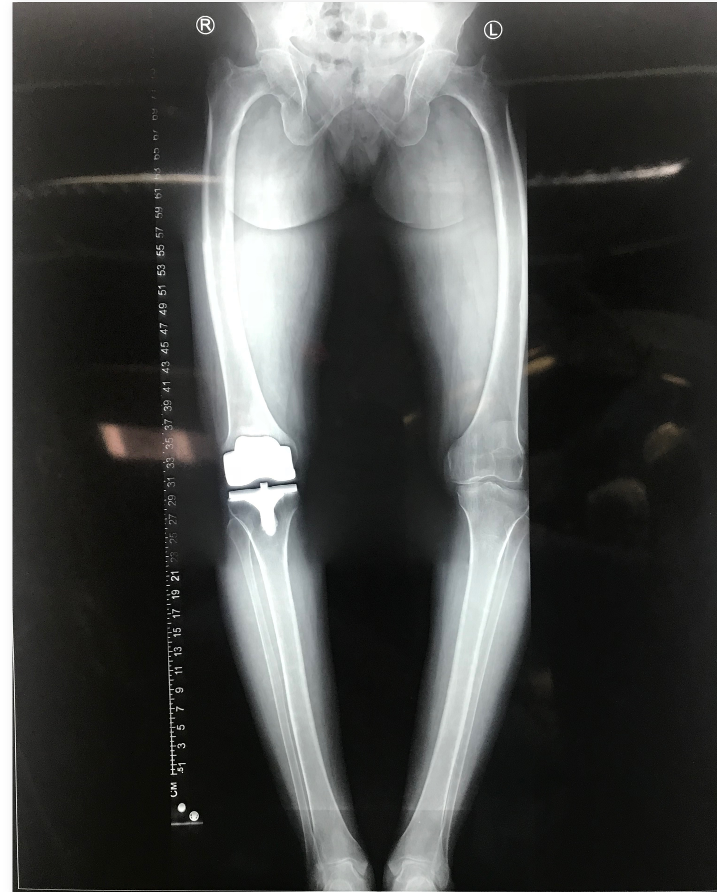

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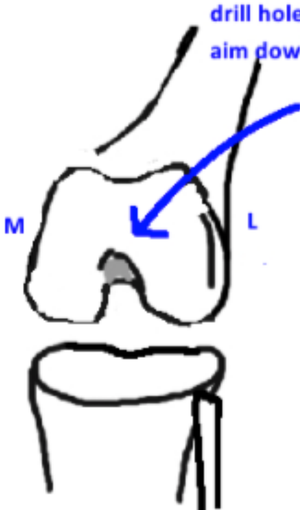
Normal distal femoral cut

DISTAL FEMORAL CUT - SURGICAL TECHNIQUE

PREPARE FEMUR

drill hole just above PCL insert
aim down medullary canal



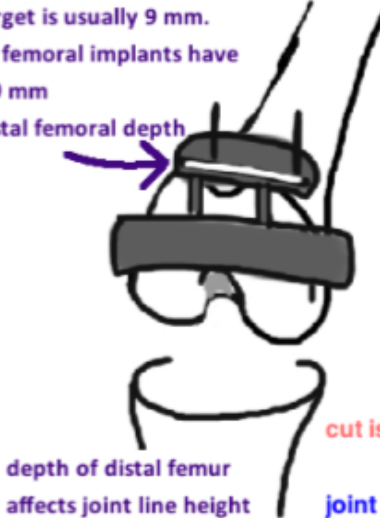
SET ALIGNMENT

the cut is set at 6 degrees
valgus relative to
the intramedullary
guide.

intra-medullary guide
shows the anatomic axis,
which is 9 degrees off
the joint line.
but our target is 6 degrees
because we take 3 off the
tibia. so we set the guide to 6

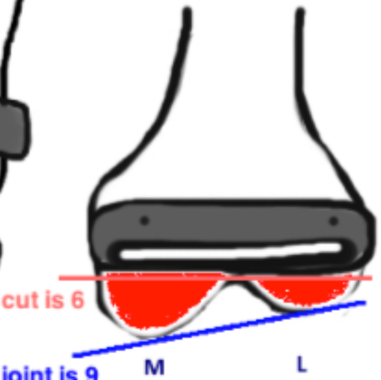
SET DEPTH

this guide sets depth.
target is usually 9 mm.
all femoral implants have
a 9 mm
distal femoral depth



depth of distal femur
affects joint line height

this is what
the distal femoral cut
looks like in
the coronal plane

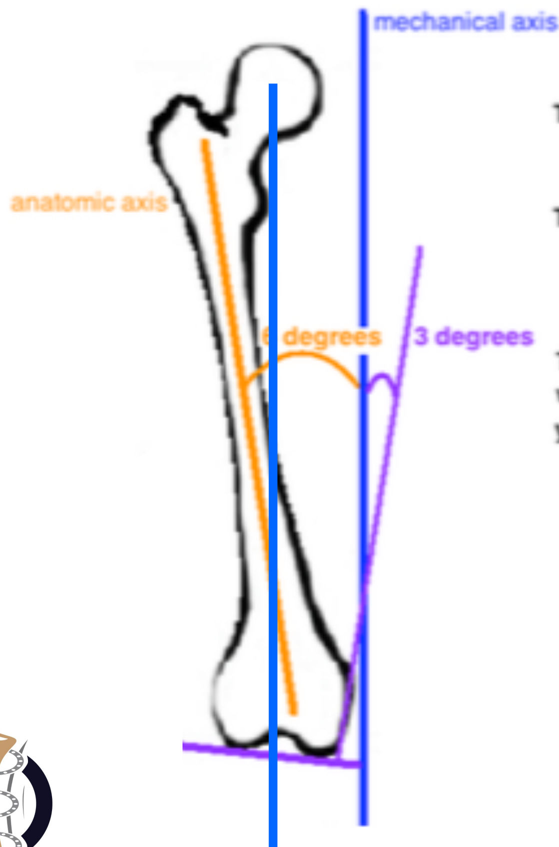


Alignment in TKR

1. MECHANICAL ALIGNMENT

- The goal of TKA alignment is to restore the normal mechanical axis.
- This is not achieved however by attempting bone cuts that recreate the exact joint line between tibia and femur, which would be 3° tibial varus and 3° femoral valgus in the native knee.
- Instead, both the distal femur and the tibia are cut to be perpendicular (0°) to the mechanical axis.

LIMB RECONSTRUCTION



The femur joint line is in 3 degrees of valgus.
relative to the mechanical axis

The femoral shaft is in 6 degrees of valgus
relative to the mechanical axis

Therefore, if planning the distal femoral cut,
with an intramedullary guide
you need to remember a few things.

1. the standard TKA uses cuts that are perpendicular to the mechanical axis
2. therefore, using an intramedullary guide you will use a 6 degree valgus cut
3. some people recommend an "anatomic design" TKA.
   in this case, you try to recreate the joint line.
4. therefore, using an intramedullary guide you will use a 9 degree valgus cut

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RECONSTRUCTION

Goal of TKR

TKA KNEE

MECHANICAL AXIS

Goal of TKA
is to re-create
mechanical
alignment

This is achieved
by positioning
implants to
re-create
6 degree valgus
Knee Angle

Remember
the 6 degrees,
is just an average
to properly realign
a patient,
get a full length XR

Measure
"Knee Angle"
then set this for your
distal femur cut
during surgery

the tibial cut
is 0 degrees.
(its 3 in native knee)

therefore, all
of the knee angle
comes from the
distal femoral cut
(cut is 6, not the 9
in native knee)

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2. KINEMATIC ALIGNMENT

- Some surgeons think that mechanical axis is important, but restoring anatomic alignment around the knee is more important.
- They believe that all of the non- anatomic cuts made to the femur and tibia have a cumulatively detrimental impact on postop TKA function. Therefore, they cut the femur in 9° valgus and the tibia in 3° varus to re-establish the normal joint line.

LIMB RECONSTRUCTION

Kinematic alignment

mechanical axis

mechanical alignment

femoral component
&
tibial component
perpendicular to
the mechanical axis

anatomic alignment

femoral component
in 3 degree valgus

tibial component
in 3 degrees varus

restore the anatomic knee
joint line, which is 3 degrees
varus relative to the mechanical
axis

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Kinematic alignment

- Proponents of this technique argue that despite older studies showing that over 3.9° of tibial varus leads to increased failure, recent studies on kinematic alignment of the tibia at 3 and 6 years show no evidence of adverse effect of tibial positioning
- Furthermore, when comparing kinematic and mechanical alignment approaches, both show similar mechanical angle (hip-knee-ankle) and knee angle, with the femur being cut on average with 2° more valgus and the tibia with 2° more varus.

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Entry point in bowed femur

- In TKA with conventional entry point for intramedullary femoral jigs, it is often difficult to insert long femoral alignment rods fully up to the isthmus of the femur in the presence of femoral bowing.

LIMB RECONSTRUCTION

- In such cases, short intramedullary alignment rods are often substituted for the distal femoral cut.
- However, proper coronal plane alignment is not assured with the use of short rods in the presence of femoral bowing

LIMB
RECONSTRUCTION

- Mahaluxmivala et al reported wide variation in femoral component angles (between 84 and 115) in their series and attributed this to the use of standard intra- medullary femoral guides

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RECONSTRUCTION

Present study-Give a solution

- In the present study, intramedullary alignment system was used with a lateral entry point in patients with femoral bowing and osteoarthritis.
- They have shown that it is possible to use long femoral alignment rods and obtain accurate balancing of the mechanical axis after knee arthroplasty by shifting the entry point laterally.

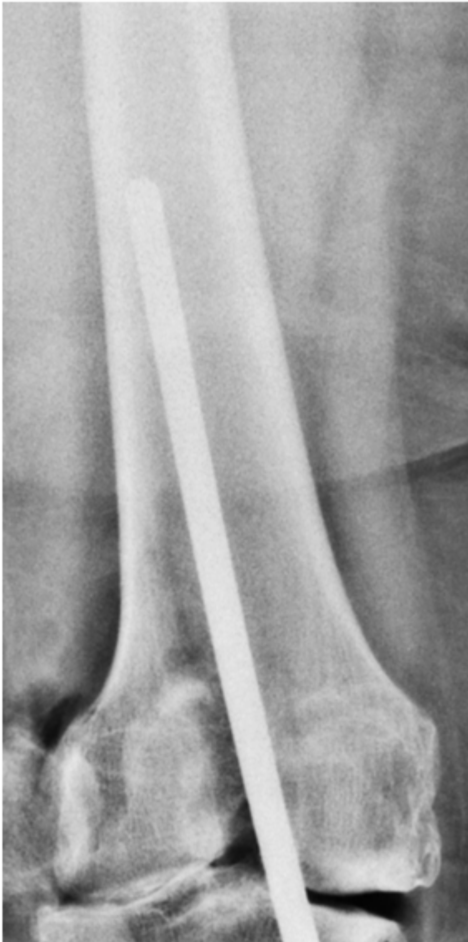

Fig. 3. With the central entry point, the intra medullary rod is abutting against the lateral cortex.

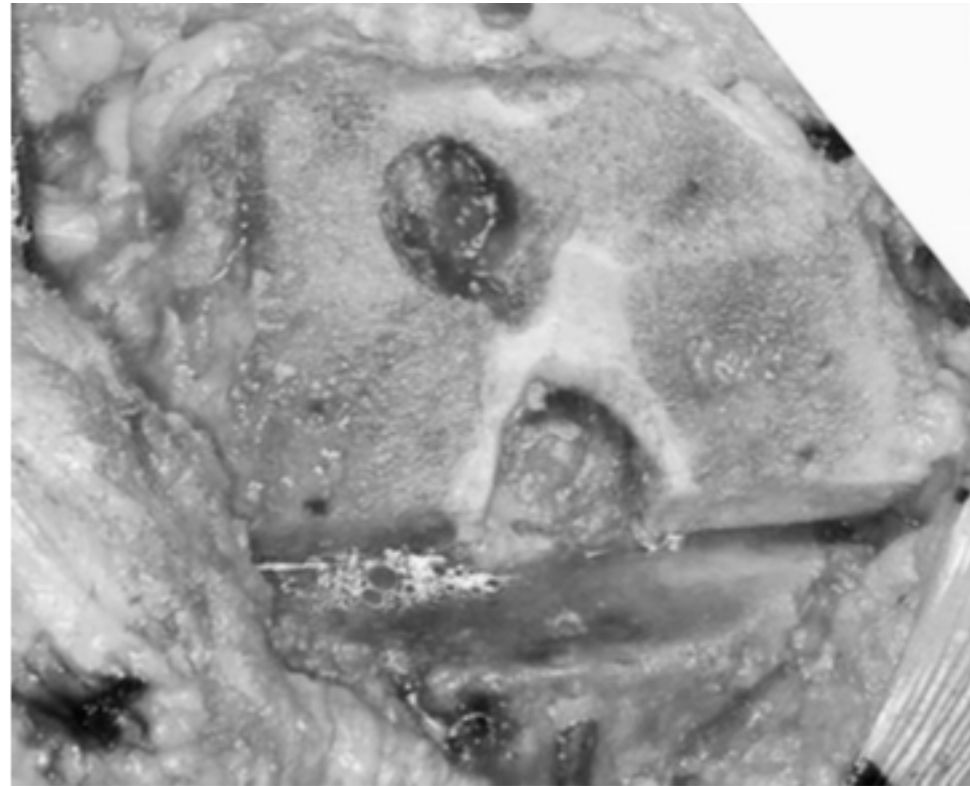

Fig. 4. Intraoperative picture showing entry point lateralized by 12 mm.

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RECONSTRUCTION

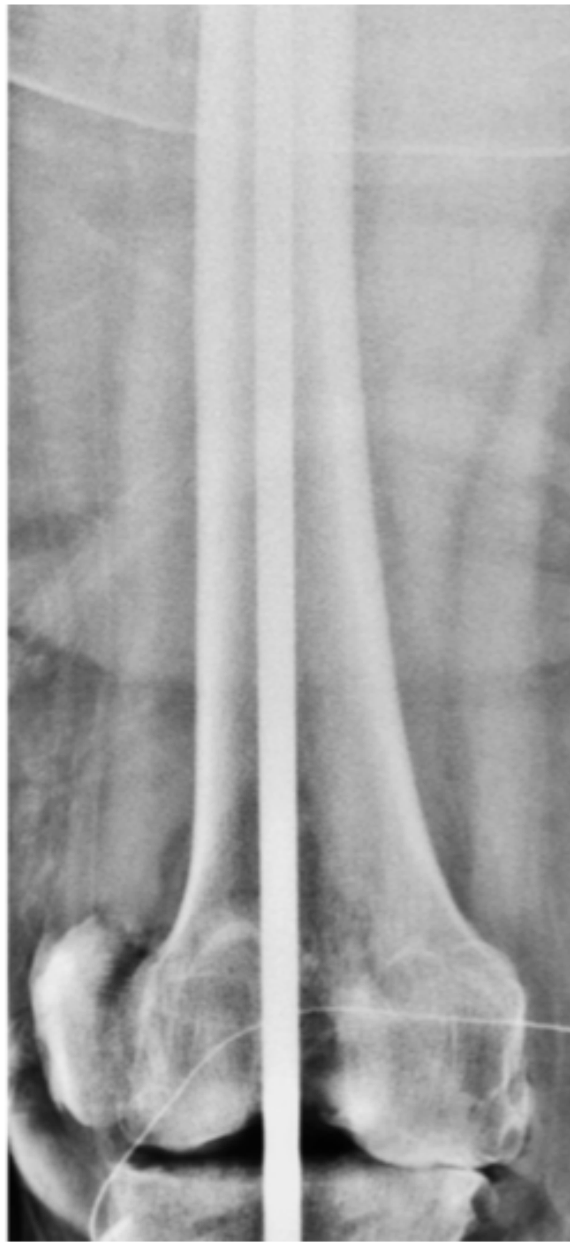

Fig. 5. Intramedullary rod is traversing through the middle of the canal.

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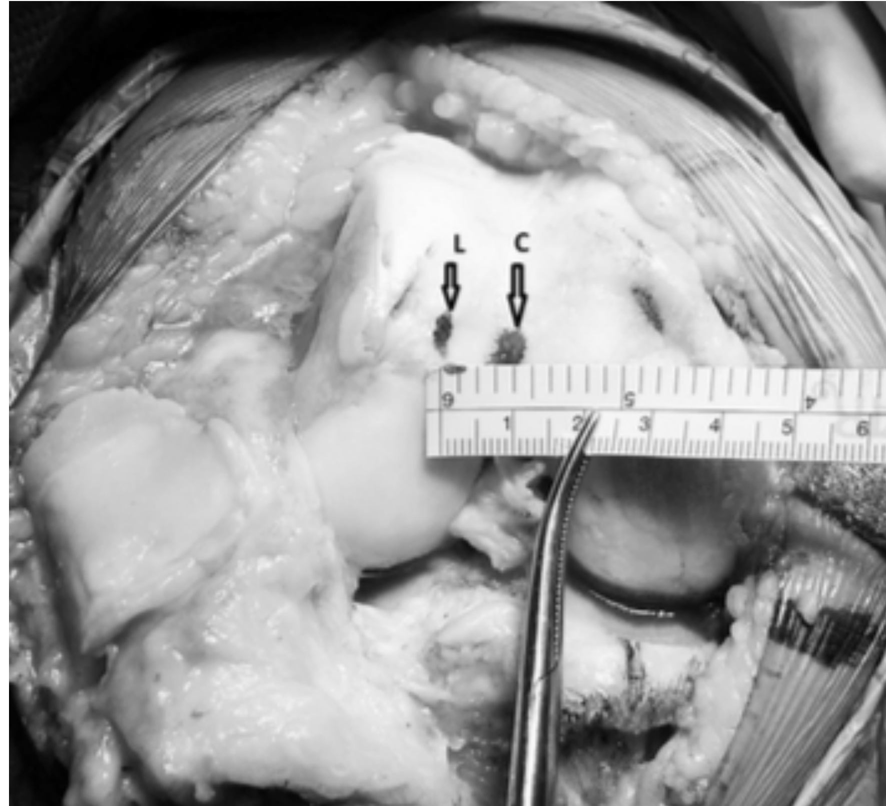
RECONSTRUCTION



2. Intraoperative picture showing both central and lateral entry points. C, central
y point; L, lateral entry point.

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Study–Material and methods

- From January 2011 to July 2014
- 196 TKA procedures were performed in 138 patients.
- 64 patients (88 knees) had coronal plane bowing of the femur (44.9% incidence of bowing). Bowing was defined as coronal plane angulation of at least 5 .
- Of the 88 knees with femoral bowing, 24 patients had bilateral TKAs and 40 patients had uni- lateral TKAs.
- Twenty–three patients (36.5%) were men and 40 patients (63.5%) were women.

LIMB RECONSTRUCTION

Inclusion & exclusion

- Patients undergoing primary TKA for osteoarthritis of the knee with coronal plane femoral bowing were included in the study.
- Patients with post-traumatic knee arthritis, deformities of femur due to old fractures, and patients undergoing revision knee arthroplasties were excluded from the study

LIMB
RECONSTRUCTION

- The mean follow-up period was 3.2 years and minimum follow-up period was 2 years. No patient was lost to follow-up.
- KellgreneLawrence grade of osteoarthritis was grade 4 in 88% of patients and grade 3 in 12% of patients .
- The study was approved by the hospital ethics committee, and informed consent was obtained from all the part

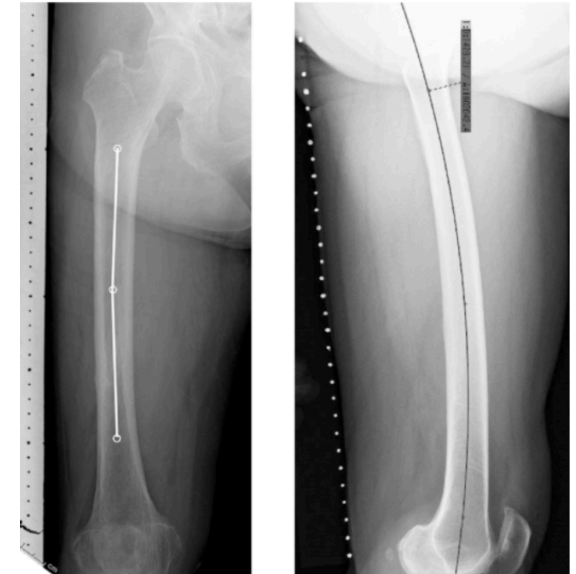
LIMB RECONSTRUCTION

Scanogram measurements

- The following measurements were obtained on the preoperative and postoperative scanograms
- Mechanical axis deviation
- Degree of femoral bowing
- Femoral entry point from the intercondylar sulcus
- distance from the center of the knee to the mechanical axis
- and coronal alignment of femoral and tibial components.
- All the measurements were computerized (DICOM Kriens, Switzerland).

LIMB RECONSTRUCTION

Fig. 2. Radiographic measurement of femoral bowing. The center of the medullary cavity is aligned with precision on anteroposterior and lateral views: (A) Lateral bowing angle and (B) Anterior radius of curvature.



- Bowing was measured according to the method described previously by Mullaji et al .

- From the preoperative scanograms, the femoral entry point was determined and its distance from the intercondylar notch was calculated.
- The same entry point was reproduced intra operatively.

LIMB RECONSTRUCTION

- Linear regression analysis was used to assess the relationship between femoral bowing and lateralization of the femoral entry point from the center of intercondylar notch.

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RECONSTRUCTION

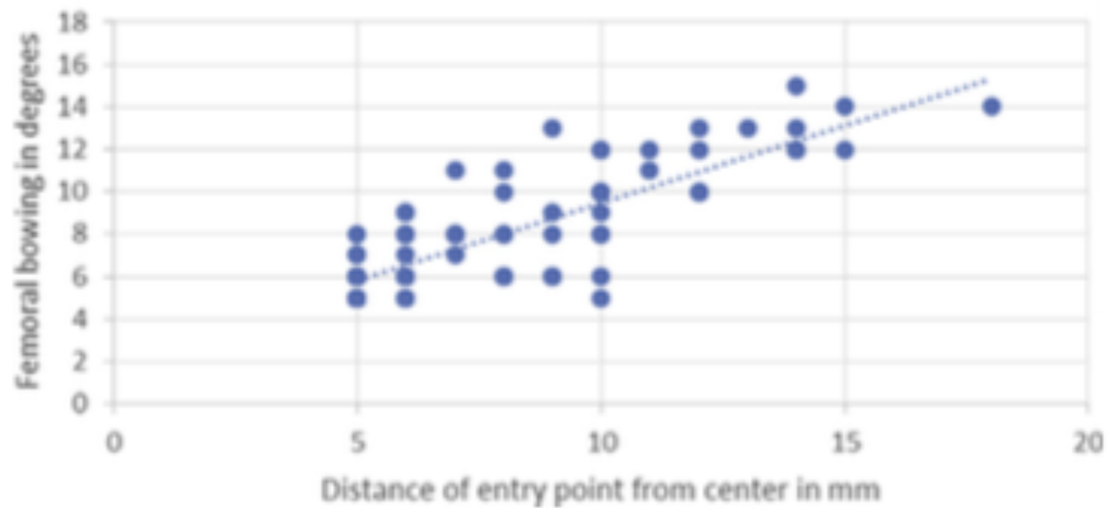


Fig. 8. Relation between femoral bowing and lateral shift of femoral entry point.

LIMB RECONSTRUCTION

Clinical assessment

- Clinical assessment was done with knee pain and functional score preoperatively and postoperatively at 1 year using the Knee Society Score (KSS) .
- Statistical analysis was done with Epidemiological Information Package (EPI 2010, Centre for Disease Con- trol, Atlanta).
- The Student's t test was used to test the significance of difference between preoperative and postoperative scores and a P value less than .05 was taken to denote significant association.

LIMB RECONSTRUCTION

Results

- It was found that 44.9% (88 knees) of femur were bowed in the coronal plane.

Femoral bowing was

- 5–8 in 55 femur (62.5%),
- 9–12 in 18 femora (20.45%),
- More than 12 in 15 femora (17.05%).

Mechanical axis deviation from the center of the knee joint was

- <10 mm in 48 knees,
- 11 and 15 mm in 25 knees
- more than 16 mm in 15 knees.

LIMB RECONSTRUCTION

- The femoral entry point (as determined from the preoperative scanograms) was lateral to the intercondylar notch in all these cases.
- In 48.8% of cases, it was 3–5 mm lateral,
- In 44.4% of cases it was 6–10 mm lateral,
- In 6.8% of cases, it was 10–15 mm lateral to the intercondylar notch.

LIMB RECONSTRUCTION

There was no lateral overhang of the femoral implant in any of the patients

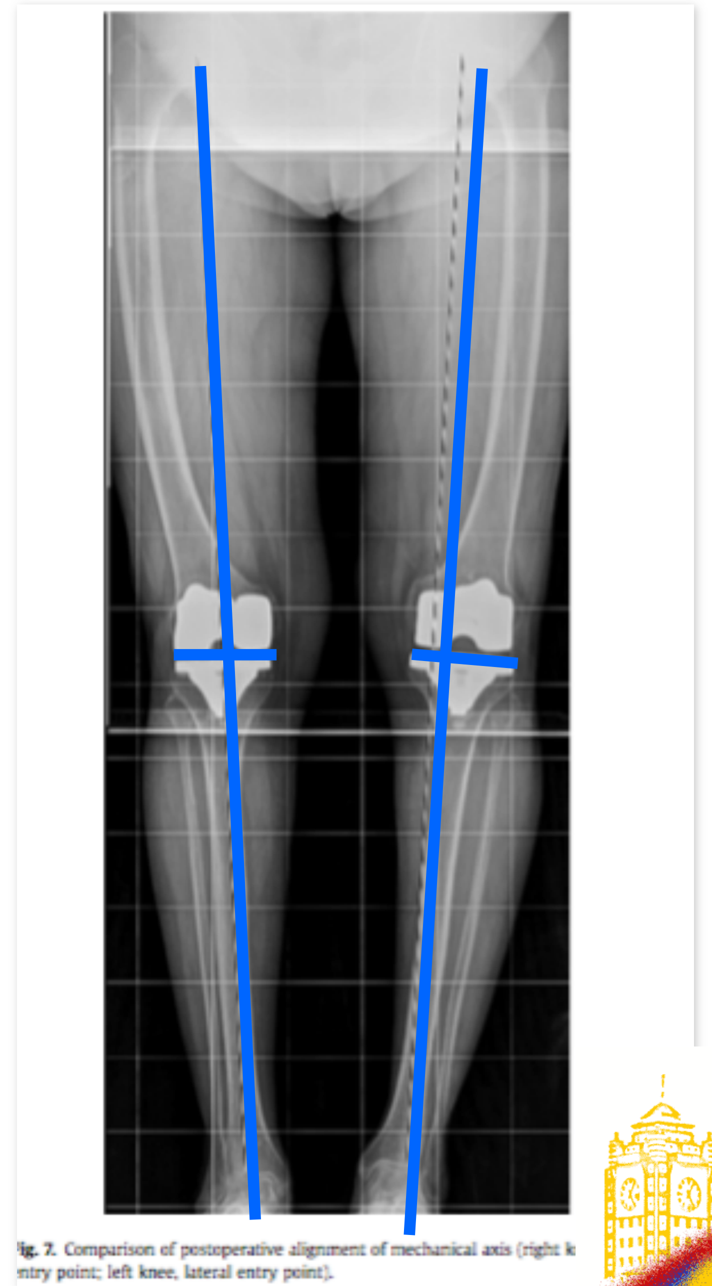
Fig. 6. Intraoperative picture showing that there is no overhang of the femoral component.

LIMB
RECONSTRUCTION

- Postoperatively, the tibio femoral angle was 6–10 of valgus in 96% of cases.
- The postoperative mechanical axis was within 3 mm from the center of the knee in 80 knees (90.9%;).
- more than 3 mm from the center of the knee to the medial side , in 7 knees (8%)
- more than 3 mm to the lateral side , in 1 patient (1.1%)

LIMB RECONSTRUCTION

- The mean medial coronal angle of tibial implant was 90.1 – (standard deviation [SD] 1.6).
- The mean medial coronal angle of femoral implant was 89.4 – (SD 1.7).



ig. 7. Comparison of postoperative alignment of mechanical axis (right k
ntry point; left knee, lateral entry point).

LIMB
RECONSTRUCTION

- Post- operative Anatomic tibiofemoral angle was between 3 and 10 in 82 patients (93.2%).
- Four patients (4.5%) had varus tibiofemoral angle
- 2 patients (2.3%) had valgus above 10 .

LIMB RECONSTRUCTION

- Linear regression analysis showed a positive correlation between the magnitude of femoral bowing and the amount of lateralization of femoral entry point (R2 ¼ 0.67, P ¼ .00).
- For every 1 increase in femoral bowing, the entry point was lateralized by an average of 1.04 mm

LIMB
RECONSTRUCTION

Discussion

- Yau et al studied 53 Chinese patients (93 knees) after TKA for osteoarthritis of the knees and found femoral bowing in 58 of the 93 knees.
- The incidence of potential "unacceptable error" in femoral bone cuts in their study ranged from just over 40% in patients with preoperative femoral bowing compared with 8% in patients without femoral bowing
- (5 times higher potential error in the presence of femoral bowing).

LIMB RECONSTRUCTION

Discussion

- Yau et al felt that intramedullary jigs are best avoided in patients with femoral bowing.
- They recommended the use of either extramedullary jigs or computer-assisted surgery (CAS) in such cases.
- Although extra- medullary alignment systems are recommended in the presence of long bone deformities, the accuracy of extramedullary systems are less than that of intramedullary systems

LIMB RECONSTRUCTION

Discussion

- Lee et al showed increased incidence of postoperative coronal plane malalignment in patients with femoral bowing in whom CAS was not used during TKA.
- Although CAS is useful, its disadvantages include increased cost, lack of universal availability, learning curve, and slight increase in the operating time

LIMB
RECONSTRUCTION

Discussion

- Patient-specific instrumentation (PSI) is another prescribed option in these patients.
- However, recent reports have found no evidence for improved effectiveness of PSI in TKA in terms of limb alignment
- Cost-effectiveness of PSI has also been questioned.

LIMB
RECONSTRUCTION

Discussion

- Extra-articular osteotomy to correct bowing is another option.
- Disadvantages include the need for 2 interventions and the need for stabilization of the osteotomy (using plate osteosynthesis or intramedullary nails or long stemmed femoral component).

LIMB RECONSTRUCTION

Discussion

- Intra- articular bone resection alone was considered sufficient for femoral deformities less than 20 .
- Mullaji et al reported performance of bone cuts up to 9 in patients with femoral bowing.
- However, the currently available instrumentation systems do not permit bone cuts higher than 9 , and this may be a limiting factor.

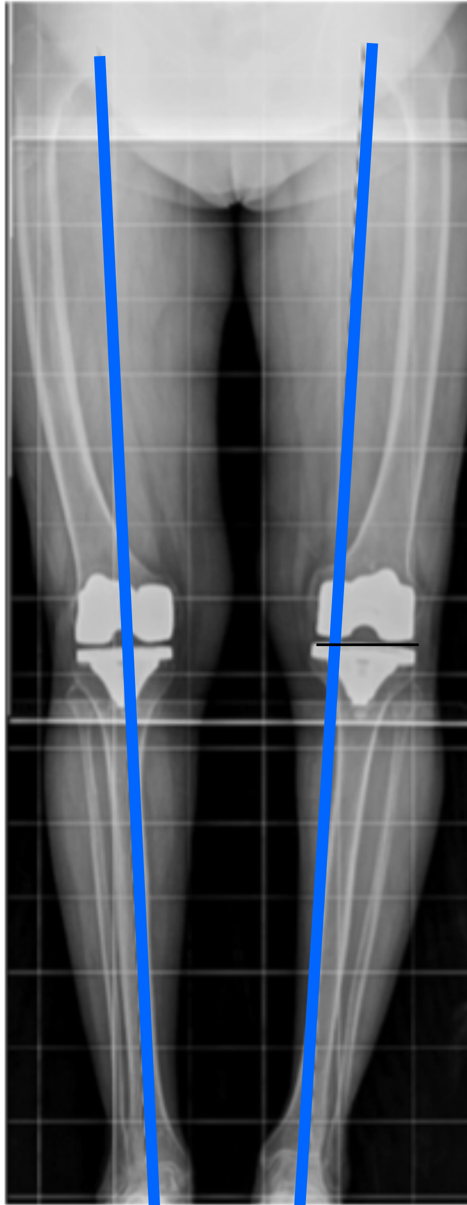
LIMB RECONSTRUCTION

Discussion

Advantages of lateral entry

- Shifting of the entry point laterally has the advantage of retaining intramedullary alignment jigs and avoidance of additional osteotomies of the femur.
- This technique does not demand the use of CAS or PSI.
- The lateral entry point allows the insertion of long intramedullary alignment rod up to the isthmus of the femur without abutting against the femoral cortex.
- It has been shown that lateral entry point for intramedullary alignment rod has a tendency to increase the amount of valgus on the femoral side.

LIMB RECONSTRUCTION



mparison of postoperative alignment of mechanical axis (right knee, central
nt; left knee, lateral entry point).

This is Comparison of postoperative alignment of mechanical axis (right knee, central entry point; left knee, lateral entry point). an added advantage of lateral entry point in varus knees with femoral bowing.

LIMB
RECONSTRUCTION

- In the present study, the femoral entry point was located 3–5 mm lateral to the center of the intercondylar notch 48.8% of knees,
- 6–10 mm lateral in 44.4% of knees
- between 11 and 15 mm lateral in 6.8% of knees. Only in 8 knees, the entry point was more than 10 mm from the center.
- In general, it can be said that each degree increase in bowing, the femoral entry point can be expected to be lateralized by 1.04 mm.

LIMB RECONSTRUCTION

- In patients undergoing cruciate substituting TKA, lateral entry point of up to 10 mm can be expected to fall within the zone of the “box-cut” in the intercondylar notch.
- A problem with an entry point more than 10 mm from the center is that a portion of the medial wall of the lateral condyle may be outside the area of the box cut.
- This may need reconstruction with bone graft . The graft was obtained from the resected bone itself. This was seen in 2 of 88 knees in our series.

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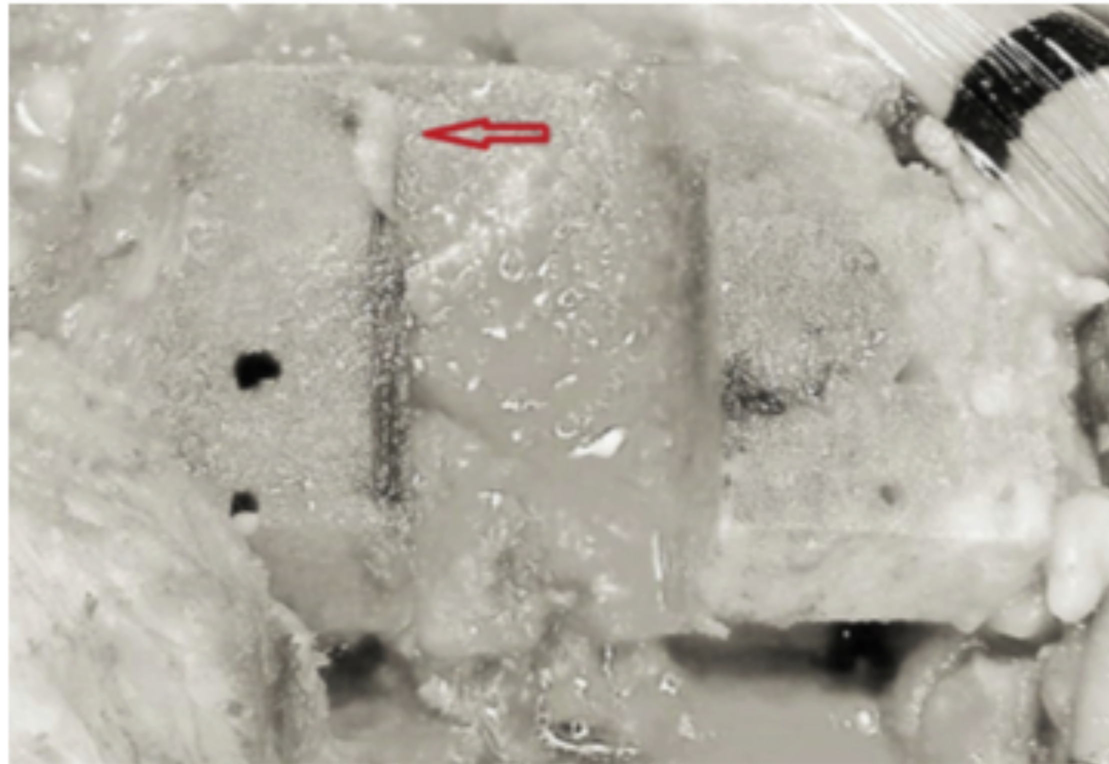

Fig. 10. Bone grafting has been performed (shown by the arrow) to fill the defect.

LIMB RECONSTRUCTION

Success of study

- Use of preoperative scanogram of the whole lower limb and selection of the appropriate entry point that suits the femoral bowing was effective in restoring the postoperative mechanical axis to values between 0 ± 3 in slightly over 93% of patients with femoral bowing.
- This position of the mechanical axis is said to result in optimal loading stresses on the knee

LIMB RECONSTRUCTION

- This study further emphasizes the value of full length scanograms in patients undergoing TKA that has been reported previously by a few authors .

- McGrory et al felt that routine long leg radiographs are not useful in achieving mechanical axis correction after TKA. However, in patients with coronal plane deformities of femur, long leg radiographs are certainly useful

LIMB RECONSTRUCTION

Conclusion:

- The location of femoral entry point is important in TKA in patients with coronal plane deformity of the femur.
- In patients with lateral femoral bowing of 5 or more, a lateralized femoral entry point is useful in allowing straighter passage of long intramedullary femoral rod and this resulted in good mechanical axis alignment and femoro tibial component alignment in over 90% of patients .

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Thank you

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