

Modern

High Tibial Osteotomy

Medial Comp OA Knee

Dr. Milind Chaudhary

Director

Int. Deformity & Lengthening Inst.

Akola

Consultant,

Jaslok Hospital, Mumbai

President

ASAMI INDIA

History & Development

Pathomechanics

Planning

Techniques

Long term results

1. History & Development of HTO

Robert Jones



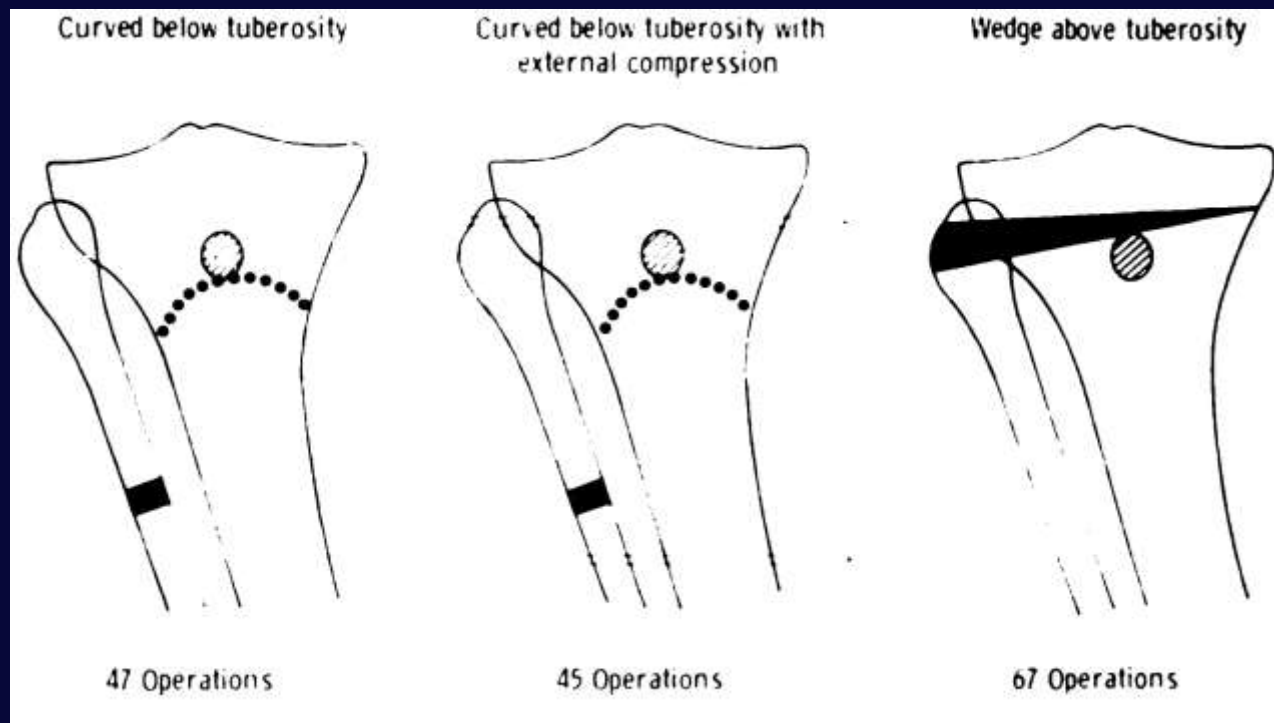
Late 1800's
mid tibial osteotomy
in Liverpool

THE TECHNIQUE AND COMPLICATIONS OF UPPER TIBIAL OSTEOTOMY

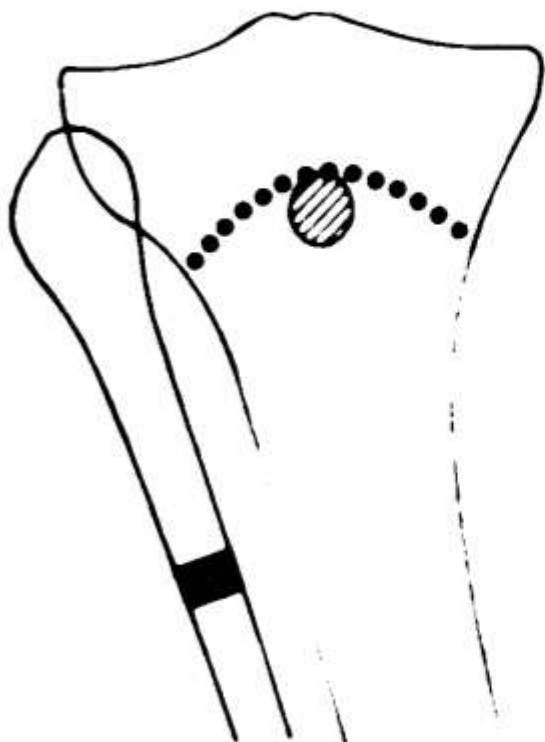
A Review of 226 Operations

J. P. JACKSON and W. WAUGH, NOTTINGHAM, ENGLAND

From the Harlow Wood Orthopaedic Hospital, near Mansfield, Nottinghamshire

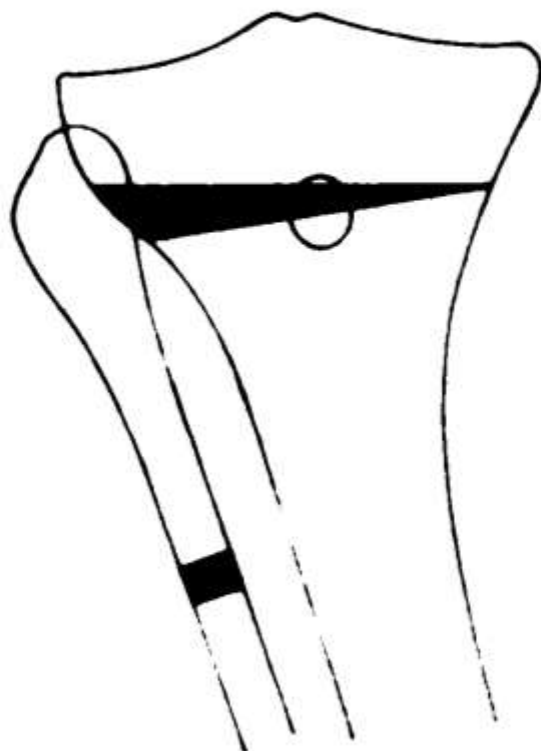


Curved above tuberosity



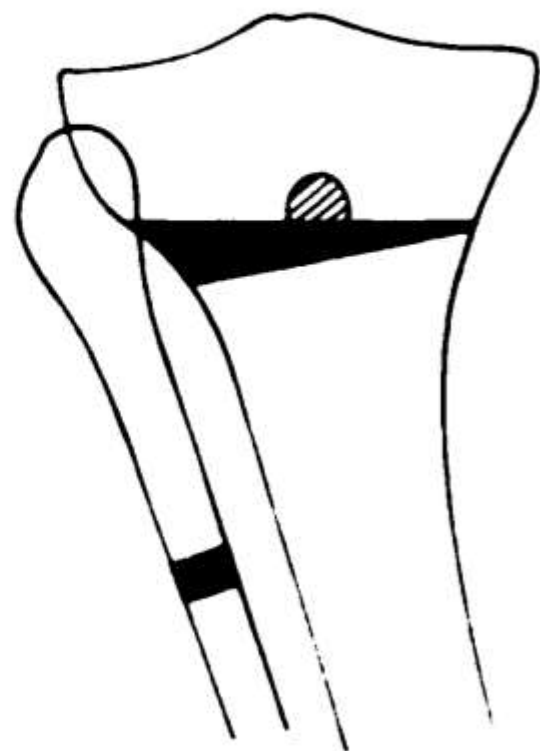
16 Operations

Transposition of tibial tuberosity



30 Operations

Wedge through lowest part of tuberosity



21 Operations

Osteotomy of the Upper Portion of the Tibia for Degenerative Arthritis of the Knee

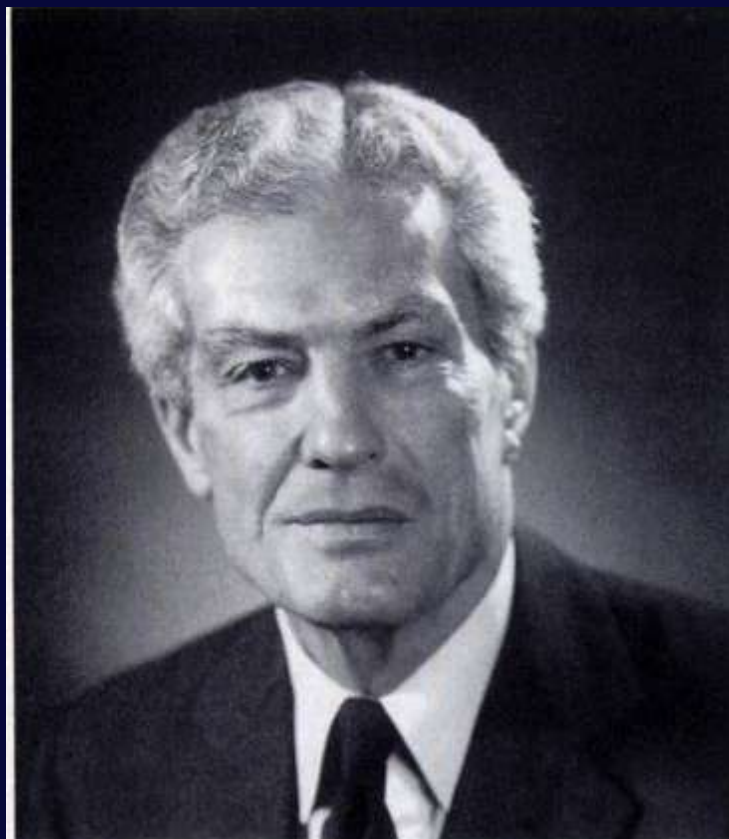
A PRELIMINARY REPORT

BY MARK B. COVENTRY, M.D.*, ROCHESTER, MINNESOTA

From the Section of Orthopedic Surgery, Mayo Clinic and Mayo Foundation, Rochester

July 1965, JBJA 47-A

Mark Coventry



However long term results were not promising and Dr Coventry was also involved in the development of Total Joint replacement surgery and hence HTO development lagged behind.

Tibial Osteotomy in Gonarthrosis (Osteo-Arthritis of the Knee)*

BY GÖRAN C. H. BAUER, M.D.†, JOHN INSALL, M.D.‡, AND TOMIHISA KOSHINO, M.D.‡,
NEW YORK, N.Y.

Prof. T. Koshino

JBJS 51A, Dec. 1969

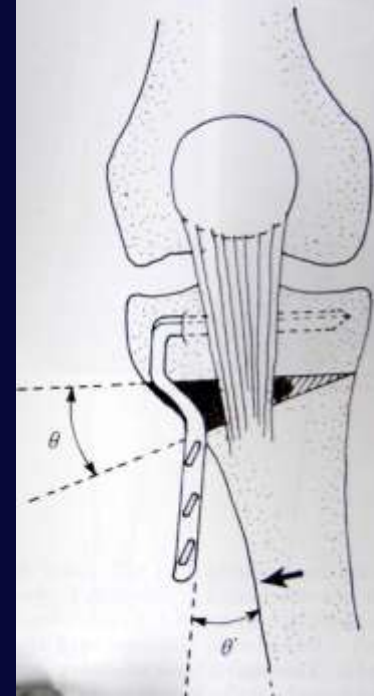


High Tibial Osteotomy with Fixation by a Blade Plate for Medial Compartment Osteoarthritis of the Knee

Tomihisa Koshino, MD, PhD, Takamichi Morii, MD,†*

Orth. Clin. North. Am.

Perfected the art and science of HTO over the last 40 years working in Yokohama Japan. Notable was the use of an innovative Blade Plate for accuracy and maintenance of correction.



Increase in range of knee motion to obtain floor sitting after high tibial osteotomy for osteoarthritis

Tomihisa Koshino^{a,*}, Tomoyuki Saito^a, Keisuke Orito^a, Shigeyuki Mitsuhashi^a, Ryohei Takeuchi^a,



Prof. Koshino's major achievement was to try and improve function and enable full ROM for cultural requirements as in Japan and rest of Asia and Middle east.

Here is Dr Chaudhary visiting Prof Koshino in 2004, the visit that stimulated his interest in HTO using Internal fixation.

Regeneration of degenerated articular cartilage after high tibial valgus osteotomy for medial compartmental osteoarthritis of the knee

Tomihisa Koshino*, Shinichi Wada, Yuki Ara, Tomoyuki Saito

Cartilage Regeneration



At High Tibial Osteotomy

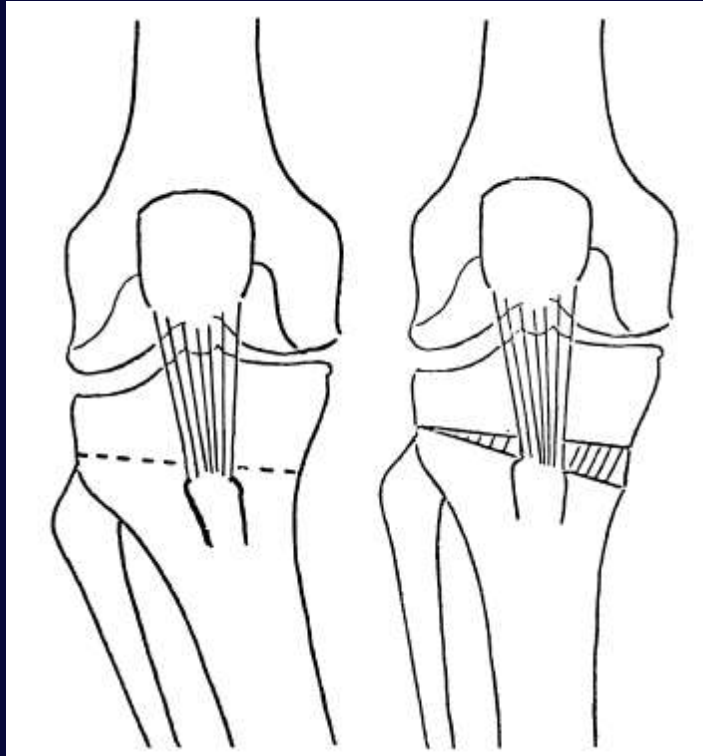


1.5yr After Osteotomy

The cartilage in the knee is capable of repair and regeneration.—given the right conditions.!

J. Debeyre, Ph. Hernigou, 1951

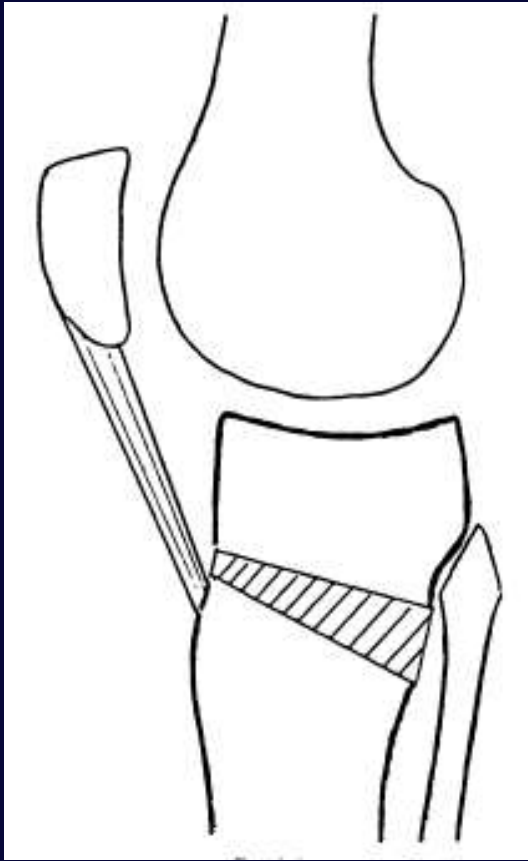
Open wedge Osteotomy + BG



Performed > 3700
osteotomies

Ph. Hernigou, Paris

Ph. Hernigou, J. Debeyre



Recognised the importance of
maintaining Posterior Tibial Slope &
avoiding shortening of Lig. patellae

UPPER TIBIAL VALGUS OSTEOTOMY USING A DYNAMIC EXTERNAL FIXATOR

Turi G, Cassini M, Tomasi PS, Armotti P, Lavini F. L'osteotomia direzionale di ginocchio mediante la "emicallotasi". *Chir Organi Mov* 1987; 72(3):205-9.





■ KNEE

High tibial osteotomy with a dynamic axial fixator

PRECISION IN ACHIEVING ALIGNMENT

V. Bachhal,
S. S. Sankhala,
N. Jindal,
M. S. Dhillon

We report the outcome of 32 patients (37 knees) who underwent hemicallostasis with a dynamic external fixator for osteoarthritis of the medial compartment of the knee. There were 16 men (19 knees) and 16 women (18 knees) with a mean age at operation of 54.6 years (27 to 72). The aim was to achieve a valgus overcorrection of 2° to 8° or mechanical

India 2011

Open-Wedge High-Tibial Osteotomy With Rigid Plate Fixation

PHILIPP LOBENHOFFER, M.D., PH.D.*

*Department of Trauma and Reconstructive Surgery,
Henriettenstiftung Hannover Marienstrasse,
Hannover, Germany*

CARLO DE SIMONI, M.D.†

ALEX E. STAUBLI, M.D.†

*Department of Orthopaedics,
Kantonsspital Luzern,
Luzern, Switzerland*

Tech. Knee Surgery 1(2): 93-105, 2002





BiPlanar osteotomy with medial opening wedge. Tuberosity fragment stays with distal fragment.

Locking Tomofix plate is pre-tensioned and fixed for stability & early mobilization.

Supra Tuberosity

Dome Osteotomy

Dome Osteotomy. Paul Maquet 1984

DOME OSTEOTOMY OF THE TIBIA FOR OSTEOARTHRITIS OF THE KNEE

N. A. SUNDARAM, J. P. HALLETT, M. F. SULLIVAN

From the Royal National Orthopaedic Hospital, London

VOL. 68-B, NO. 5, NOVEMBER 1986

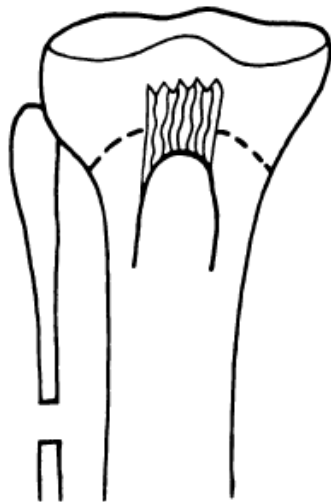


Fig. 1

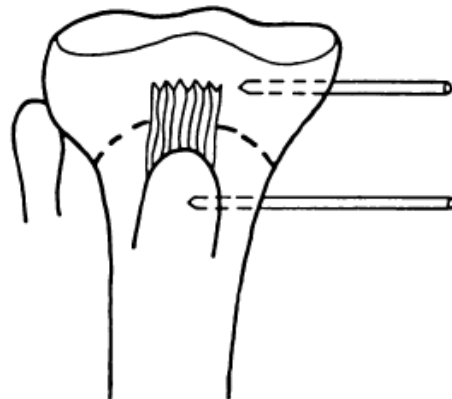


Fig. 2

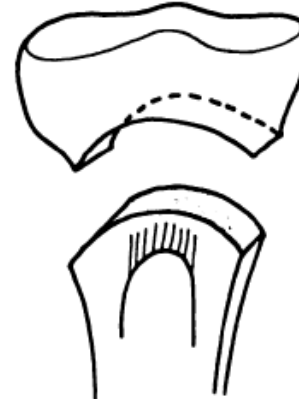


Fig. 3

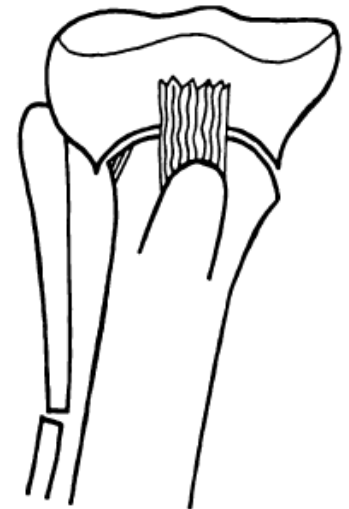


Fig. 4

Surgical technique of upper tibial dome osteotomy showing, from left to right, the sites of the osteotomies, pins placed to check alignment, the shape of the tibial osteotomy (separation exaggerated), and the displacement.

Revival of HTO in the west

* Accurate deformity correction
with Ilizarov fixator

* Sports Medicine group --- Frank
Noyes who elucidated role of HTO
in Ligament laxity with Varus

Focal Dome Osteotomy with Ilizarov Fixator...

Dror Paley



Maurizio Catagni



2. Pathomechanics

Effects of Mal-alignment

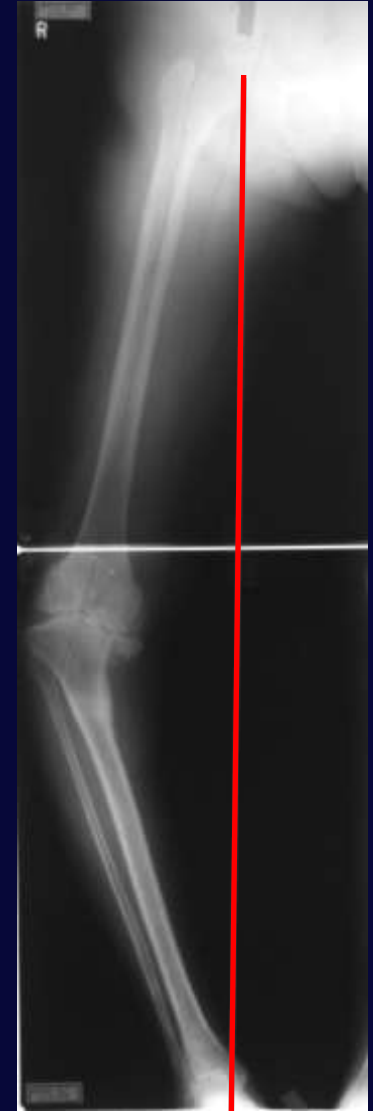
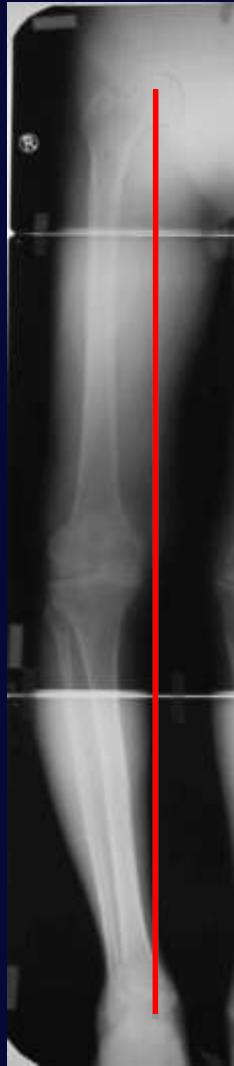
Varus = Medial Compartment

OA

Loads on Medial Comp.

- Normal alignment = ~70% of total
- 6° Varus = 97 %
- 4° Valgus = 50 %

Full length xrays showing increasing amounts of varus leading to severe loading on Medial compartment with greater displacements of the mechanical Axis



Nomenclature

Anat Axis :

Mech Axis

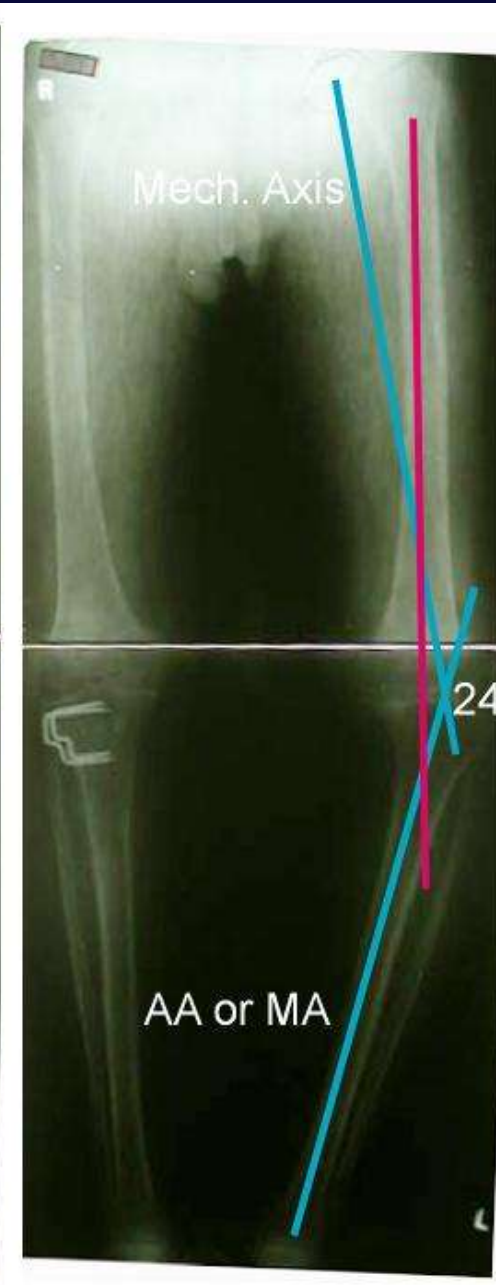
~ 6 to 7°

Using Anat.Axis

Varus is lesser

Using Mech.Axis

Varus is more



Major Factors influencing results

- Frontal Alignment Valgus
- Sagittal alignment & FFD
- High Adduction Moment Arm Gait

Other Factors influencing results

- Obesity
- Internal Rotation of the Tibia
- Loss of correction

Valgus Alignment

allows the Mechanical Axis to pass sufficiently through the lateral compartment... to unload the Medial compartment & regenerate the cartilage.

SHORT term Pain Relief

- Decompression of the Subchondral Hypertension

hence any osteotomy even if undercorrected or ill performed will offer pain relief

MEDIUM term Pain Relief

- Accurate re-alignment of Mech Axis

is needed to unload forces from medial compartment

& allow regeneration of cartilage

LONG Term Pain relief

can only come through

maintenance of alignment!

How much Valgus is needed?

- Coventry.....8° FTA

Or

- Prof. Koshino.....10° FTA

Or

- Yasuda (CORR 2002)... 12 to 16° valgus?

How much Valgus?

- Fixed Formula.....
through the “Fujisawa” Point
@ 62% of the Joint width
- Based on extent of Cartilage Loss
- Based on Dynamic Varus

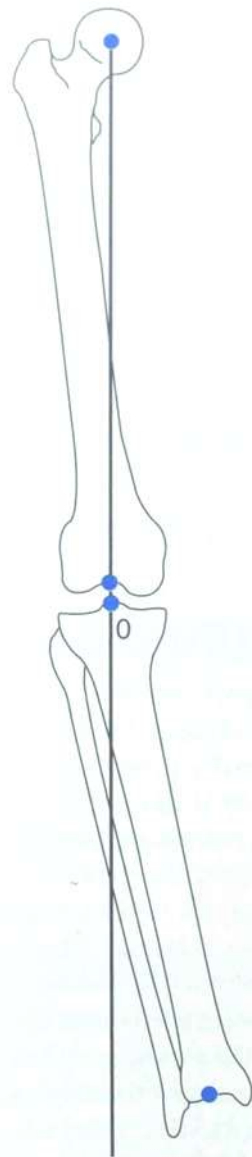
How much to Correct?

As a thumbrule :

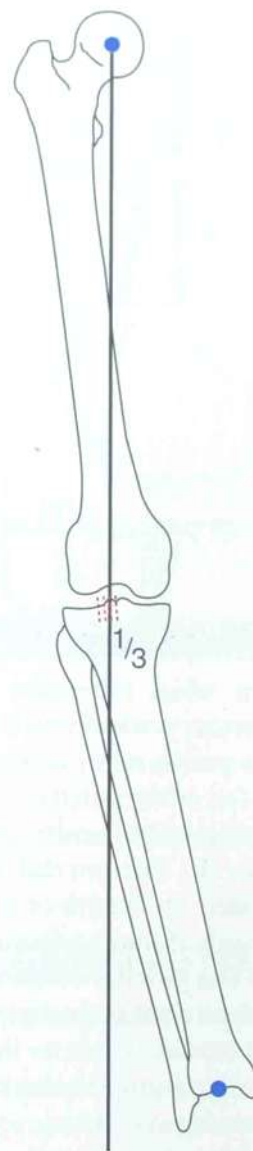
Aim for 10° valgus-- Anatomical Axis

Aim for 3-6 valgus --Mechanical Axis

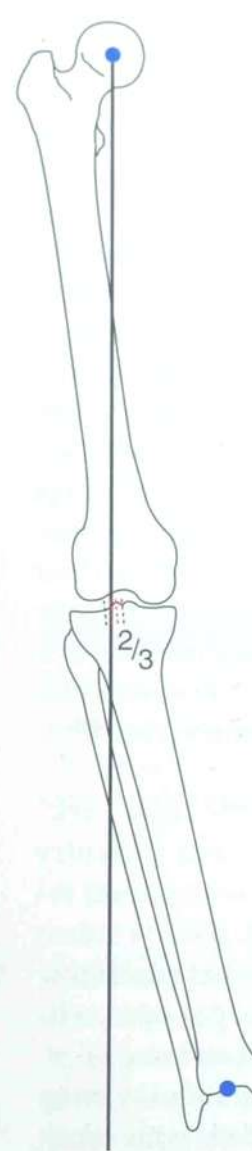
Based on cartilage loss in medial compartment ment



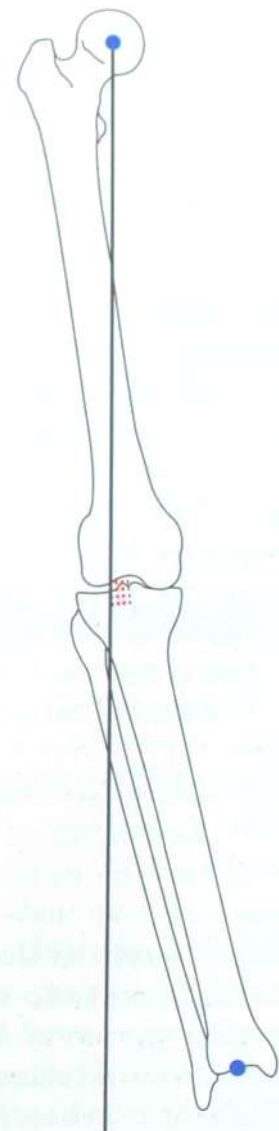
No loss of
medial cartridge



1/3 loss of
medial cartridge

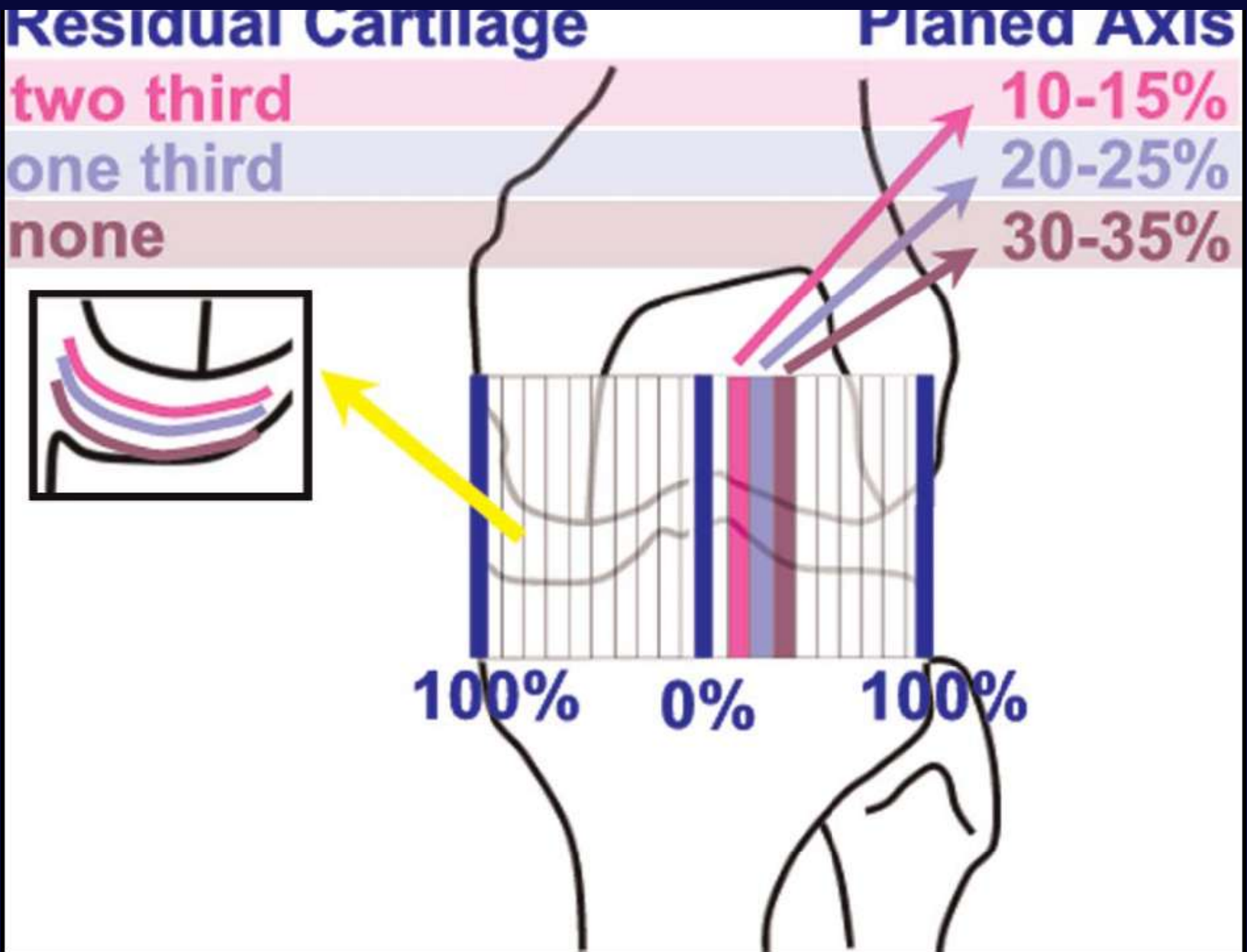


2/3 loss of
medial cartridge



Bone on bone
= Fujisawa MAD

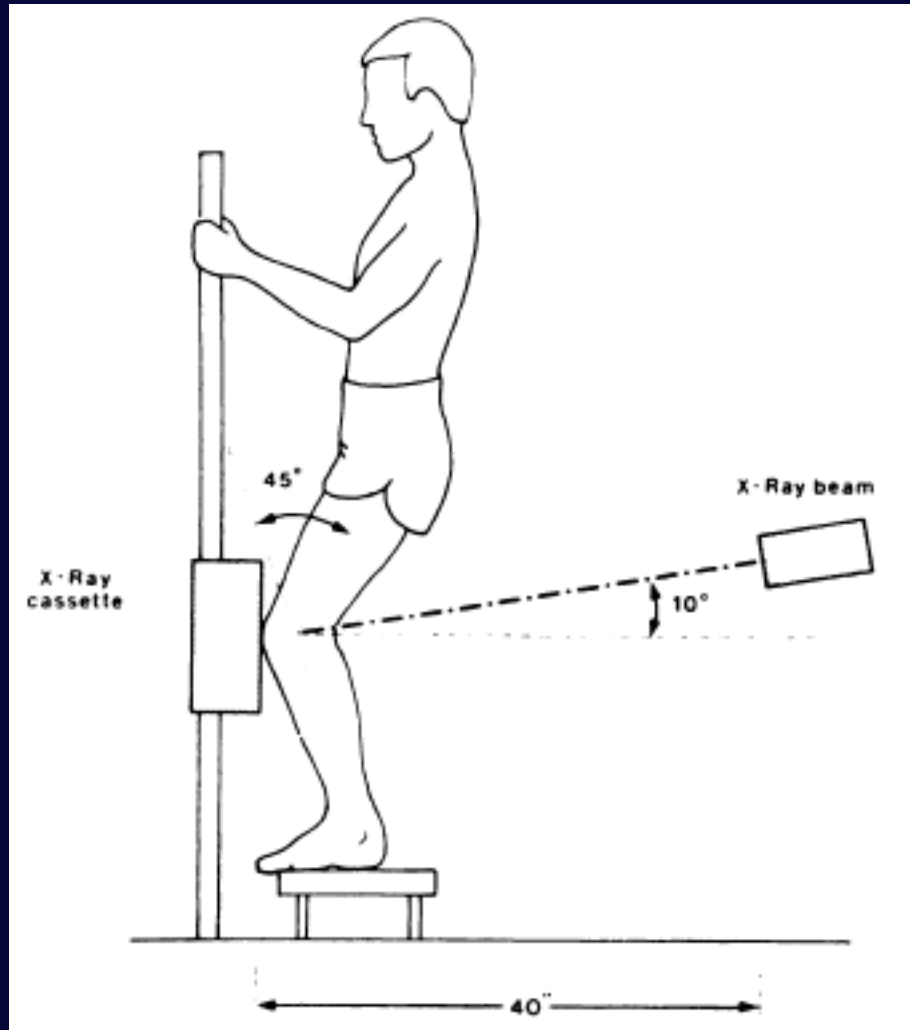
Based on Cartilage Loss



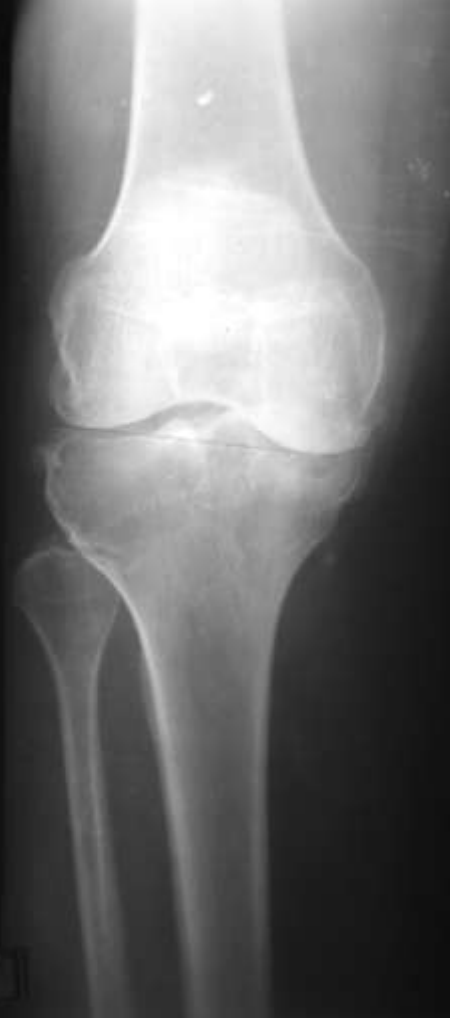
Xray evaluation to determine extent of cartilage loss

- Standing AP weight bearing xray
Ahlback
- Rosenberg View 45° PA view
- Flexion views in varying ° .

Rosenberg view



How much cartilage wear?



This 55 year old lady 's xray showed almost complete loss of Cartilage space in the medial compartment and hence despite her younger age, was advised for a Total Knee Replacement by several Orthopaedicians

Yes, HTO can be done!



By taking a 30 ° flexion view adequate cartilage thickness could be demonstrated. Hence we went ahead for the plan to conduct a HTO. Full length Xray showed Mechanical Axis Deviation



° A fixator assisted Locked TOMOFIX plating was done with an Infra-Tuberosity dome osteotomy. The Mechanical Axis now passes through the FUJISAWA point with an accurate valgus alignment.

3. Planning

4 Steps of Planning

- Finding level of CORA
- Judging Magnitude of Correction
- Deciding Type of Osteotomy
- Choosing Hardware for fixation

LEVEL of CORA

Magnitude of Correction

Choice of Osteotomy

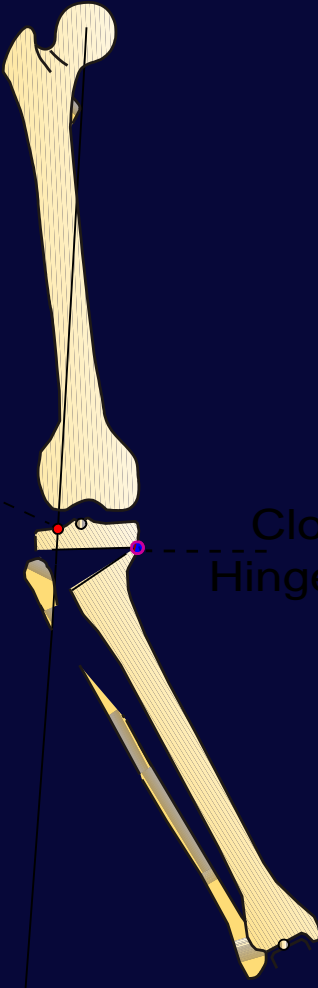
- Closing wedge
- Opening Wedge
- Angulation-Translation or DOME



Closing Wedge Osteotomy

Fujisawa Point

Closing Wedge
Hinge Placement



When is $1\text{mm} = 1^\circ$?

- ONLY
- When parallel cut is 57 mm
- When distal cut is 54.15 mm



If we use $1\text{mm} = 1^\circ$ as a ThumbRule

- Larger Tibiae---

$1\text{mm} = 1^\circ$ will give undercorrection

- Smaller Tibiae---

$1\text{mm} = 1^\circ$ will give overcorrection

How to calculate ?

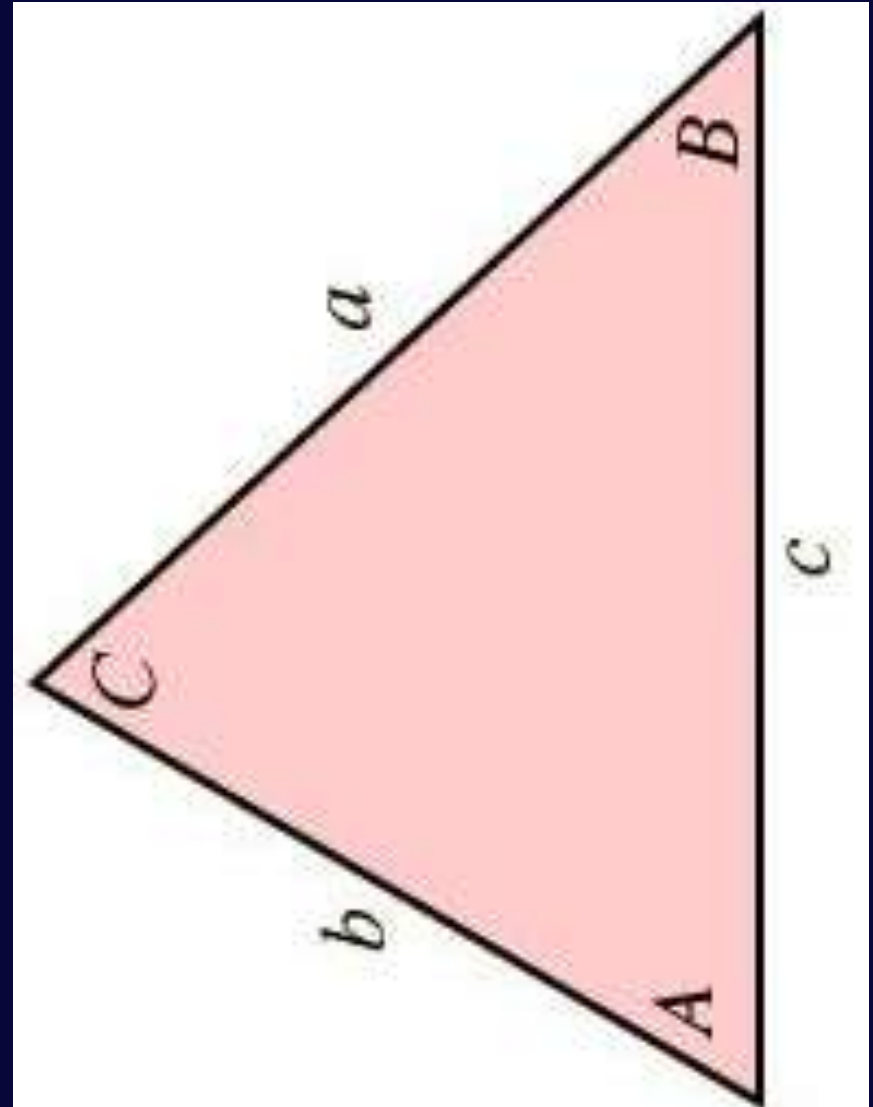
to determine the amount of wedge to be resected,

We use the Law of Cosines ---which is the
Precursor of Pythagoras Theorem---

{ which applies only to Right Angled Triangles }

Law of Cosines

$$c^2 = a^2 + b^2 - 2ab \cos C$$



Disadvantages of Closing wedge osteotomy

- Tendency for Over & UnderCorrection
- Creates Overhang of upper tibia
- Tends to reduce Tibial Slope
- Possible Neuro-Vascular problems
- Adherence of patellar ligament
- Difficulties in future TKR

Dome Osteotomy



56 year old orthopedic Surgeon had Varus with lateral thrust and severe pain. Did not want a TKR & yet wanted a reliable procedure that would allow him pain free active lifestyle over a long period..



Dome shaped osteotomy done below tuberosity with a small amount of lateral translation and posterior translation of distal fragment . Excellent bony contact seen with very good fixation in proximal fragment



Early
walking



Return to
Clinic in
3 weeks
And
Surgery
In 6 weeks



Well corrected into Valgus with no lateral thrust and good correction of mechanical axis which now passes through the Fujisawa point.
Pain free at 7 years following surgery



Advantages of Dome osteotomy

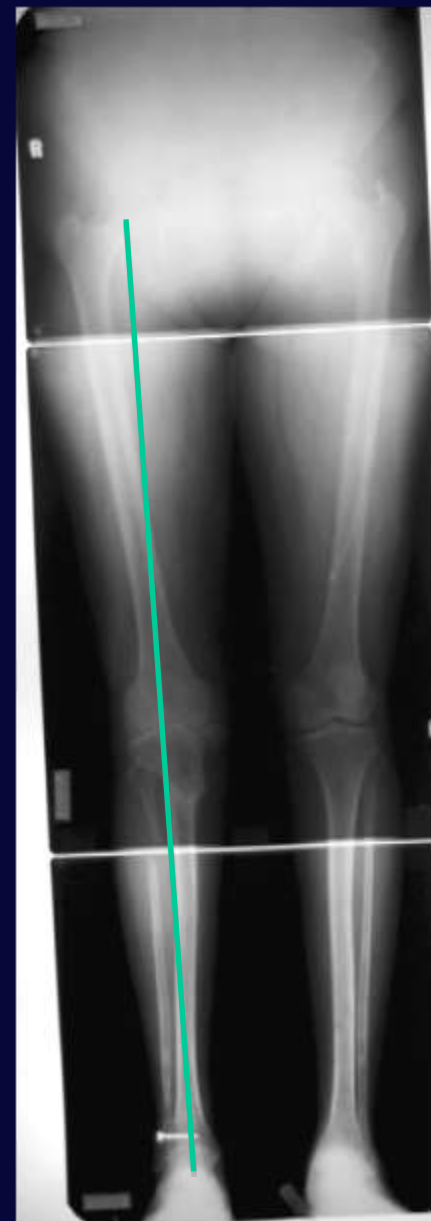
- Done below tuberosity
- Larger corrections possible without resection
- Better fixation for proximal fragment
- Large contact area of bony surfaces
- Less chances of NU
- Long lasting correction as performed through harder bone

Large Deformity

52 yr old with severe varus and Lateral thrust. Gross deviation of Mech Axis.



Very well corrected into Valgus and good relief from Pain



Bilateral

a great advantage of this method
is very good tolerance of doing
both legs at same time.

33 yr old from London



58 yr old widow had severe bilateral knee pain and could get help from married daughter only for 3 months hence chose to have surgeries on both legs at same time.

The treatment was relatively easy to tolerate and she achieved good pain free results for many years.



the myth of Sisyphus.....



For surgeons performing HTO with external fixation, it may seem like a lot of work, to keep patient comfortable and free from pain, with seemingly constant adjustments of the apparatus.

However, its great advantage is that it allows accurate correction of the dynamic Varus as well—which adds to the longevity of results.

Lateral Thrust

- Is best corrected using external fixation methods. It is possible to observe gait after pre-determined correction in the apparatus and then add more valgus to correct the lateral thrust or dynamic varus

Lateral Thrust

- Comprises of Intoeing
- Knee Extension on Heel Strike and Foot Flat
- Broad based gait with delay of trunk sway

Can also be described as “Lazy Gait”

Treating Lateral Thrust

- **By Gait Training**
- Out-toeing
- Short stride
- Knee Flexion on Heel-strike

Treating Lateral Thrust

- *in Surgery by*
- **External rotation of distal fragment**
- **Overcorrection into valgus**

**Varus with internal
Rotation in the
Tibia causing lateral
thrust gait**



Dome osteotomy done with mild External rotation of distal fragment visible as a posterior translation of distal fragment.

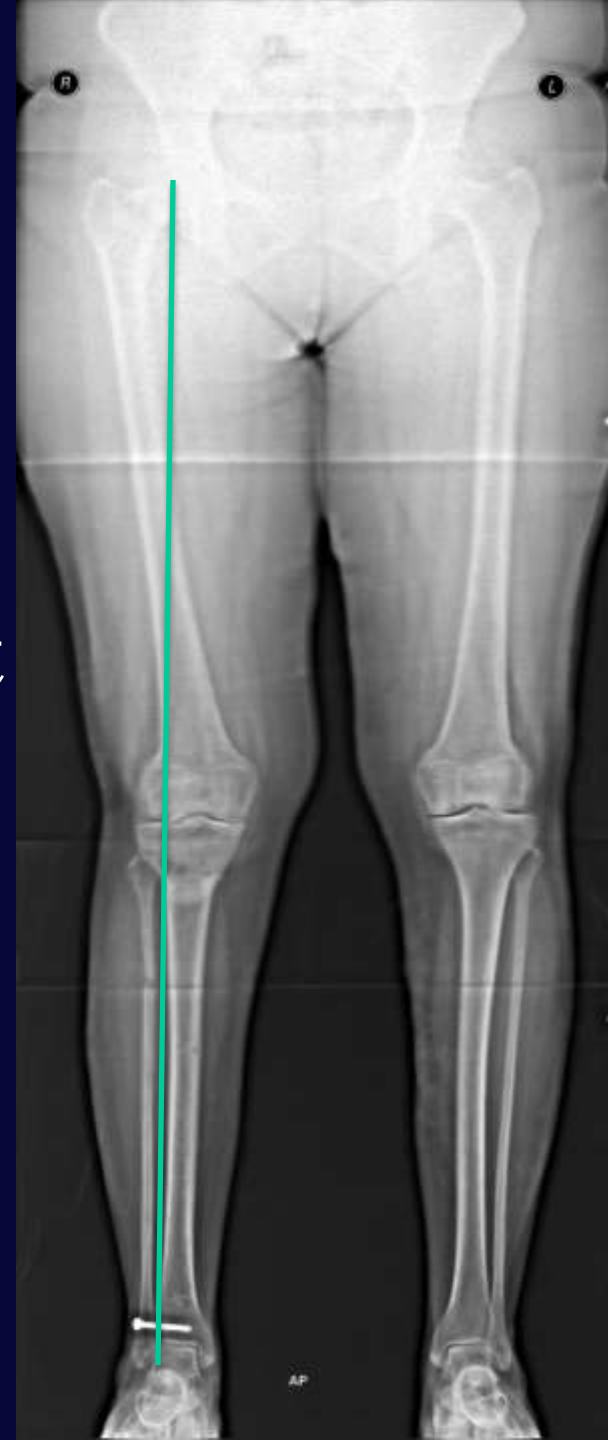


Internal Rotation corrected

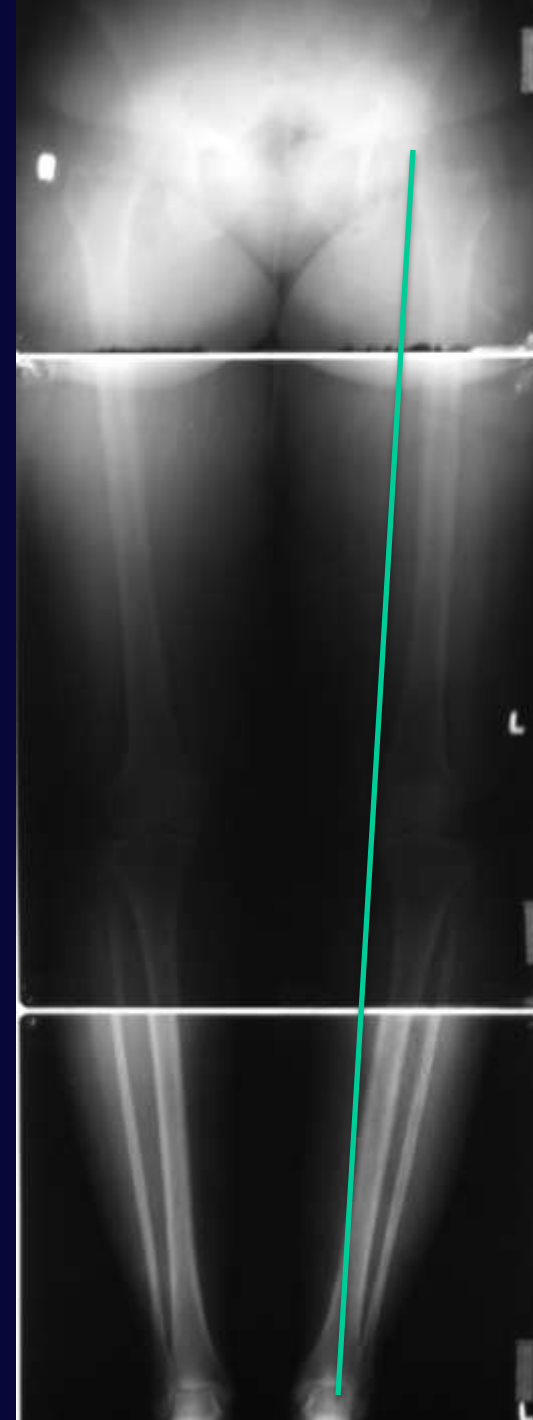




**Excellent result
with accurate
correction
and no pain
during treatment**



**42 yr old with
Lateral Thrust
which
exacerbates the
Varus Deformity**



External fixation allows us to examine the gait during treatment & compensate for the lateral thrust by overcorrecting into Valgus





Overcorrection solves
the lateral thrust
&
ensures a
long term result
with a pain free knee.



Fixator Assisted Plating

Infra Tuberosity

Focal Dome

High Tibial Osteotomy

External Fixation

Used as

Intra-Op Alignment tool

65 yr old with severe MCOA was a good candidate for HTO but not external fixation. The Dome osteotomy was chosen , but with lateral TOMOFIX plating as hardware for fixation.



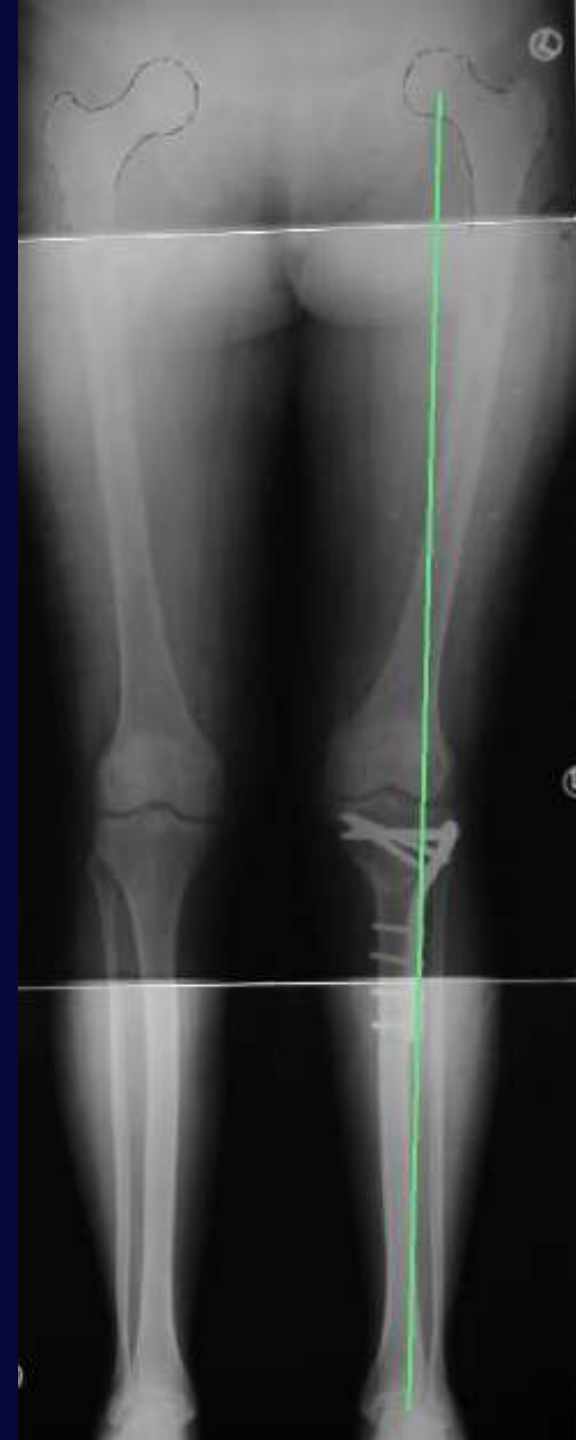
Fibulectomy done. A longitudinal incision allowed patellar retinacular release. Ex Fix pins inserted and drill holes outline osteotomy . Fixator holds osteotomy position for confirmation before fixing with a plate.



Special high Xray machine takes a FULL length Xray on the table to confirm correction of Mechanical Axis. Lateral locking plate fixed.



Lateral & Posterior translation of distal fragment is possible and is fixed in situ with locking plate after applying compression. Accuracy can be achieved.







Long Term Results

- **Good Long term results**
Koshino, Akizuki, Majima, Yasuda
- **Coventry, Rinonapoli etc**

Not as promising...
using all older techniques

Koshino 15 to 28 yrs .

- **93.2% @ 15 yrs & 87% @ 28 yrs**
- Closing wedge osteotomy with plates
- AKSS from 37 ± 20 to 87 ± 13 @ 15 yrs
 80 ± 19 @ 28 yrs
- PreOp Alignment 6° Varus PO 9° Valgus

Majima CORR 2000

- 48 knees FU at 10 to 15 yrs
- Best alignment is 10° FTA
valgus

Coventry 1993

- **Valgus of 8°**

BMI < 27.5%

better predictor of survival

Flecher, Parrate et.al

- Staple & Plate Fixation
- 85% Survival after 20 yrs

Akizuki .et.al

- 118 Knees Prospective Study at 16.4 years
- Giebel Plate fixation
- 97.6% Survival at 10 years & 90.4% @ 15 yrs
- TKR for 9% at mean of 13.5 yrs
- BMI < 27.5% and ROM > 100° for good res.

M. Chaudhary

- 152 knees
- FU from 2 to 19 years
- > 98% survival @ 5 years (no pain + no TKR)
- >95% survival @ 11 years
- >92% survival @ 15 years





56 yr old math teacher with moderate varus and lateral thrust with severe pain.

Could not walk more than a few steps



At end of surgery for Right leg
Showing good valgus and slight
External rotation of distal fragment.

Left leg operated upon after 10 yrs.

16 Yr SURVIVAL



HTO with Shortening

52 yr old with Polio and shortening in R leg leading to severe varus and MCOA in Left leg. With a valgus osteotomy the leg length difference would have increased. Valgus correction was combined with shortening to reduce LLD as well.



18 YEAR SURVIVAL

Has no pain
at 18 years
post surgery
With equal
Leg lengths



Thank you

milind.chaudhary@gmail.com