

LIGAMENT BALANCING IN PRIMARY TOTAL KNEE ARTHROPLASTY TECHNICAL PEARLS

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Disclosure

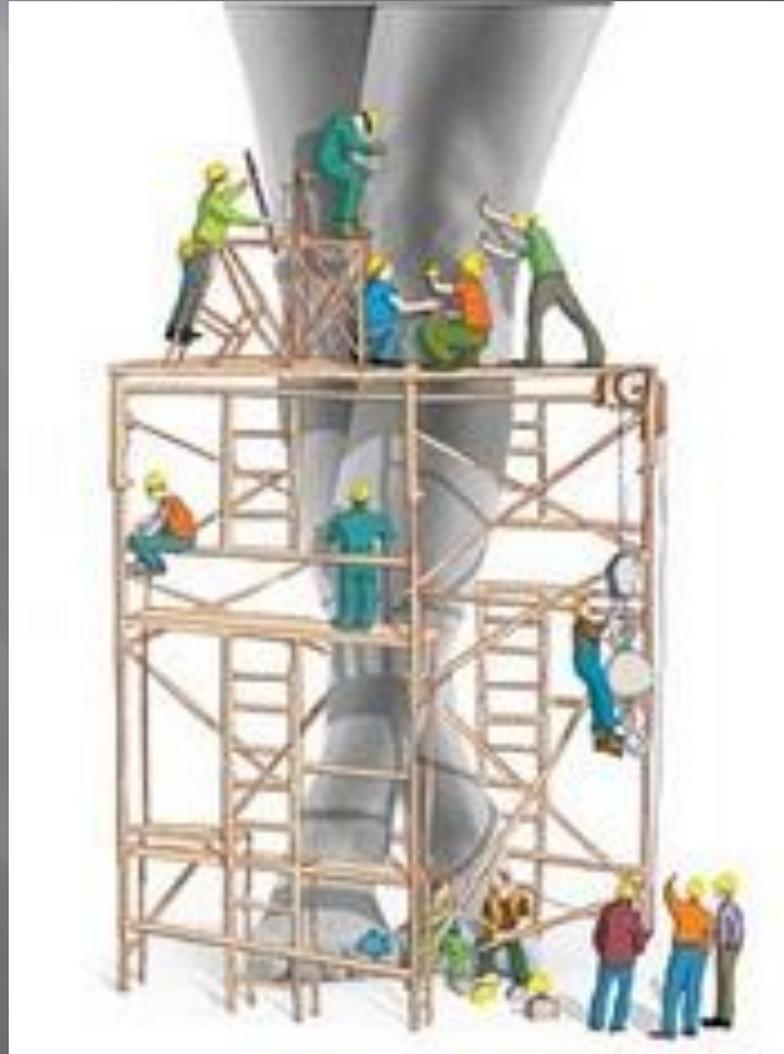
- ▣ Consultant for Aesculap Implants Incl.



It makes a creaking-popping sound every time I get in or out.

That's just your knees, Sir.

Rules for resection and alignment



Essentials for ligament balance

- Lower limb axis parallel to mechanical axis
- Flexion and Extension gap
 - Rectangular
 - Equal (flexion 2mm less for PS Knee) {Ranawat}
- Osteophytes removed
- Femoral and Tibial components –
 - Optimum size
 - Optimum rotation
- Understand deformities before soft tissue release – Varus/Valgus + Flexion

Remember.....

- ▣ Optimal knee function...
 - Correct Varus/Valgus alignment throughout the arc of motion

- ▣ “Ligament release based on function of the ligament”

- ▣ Ligament release...
 - ▣ Does not cause instability

- ▣ Failure to align the knee ...and release tight ligaments
 - Interface overload
 - ▣ Aseptic loosening
 - Plastic overload
 - ▣ Accelerated wear, fatigue and de-lamination
 - Ligament overload
 - ▣ Pain, limits motion
 - Mal-alignment
 - ▣ Instability

Understanding deformities:

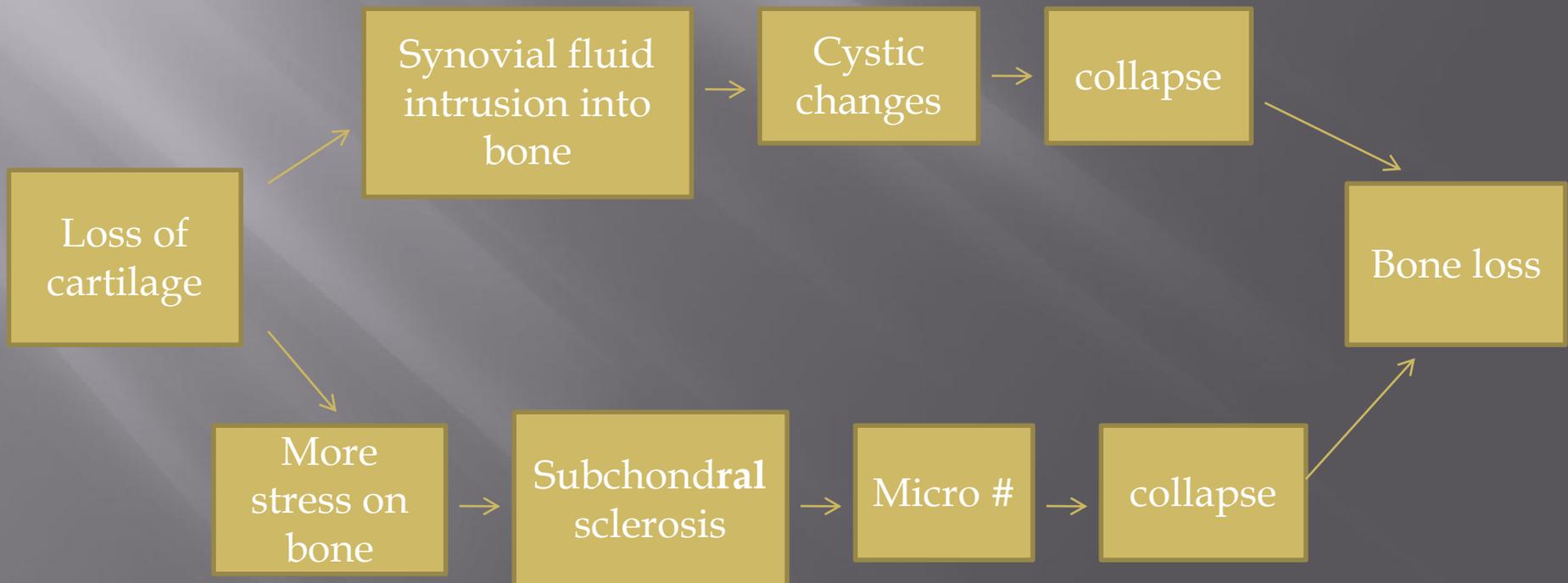
- ▣ 83-90% OA- Varus deformity (Laskin; Ranawat)
- ▣ Fixed – can't be corrected passively
 - Needs release
- ▣ Flexible- can be corrected to neutral alignment
 - Release leads to instability
- ▣ Mixed- partially fixed
 - Selective release
- ▣ Concave side- ligament contracture
- ▣ Convex side- ligament stretched/elongated
- ▣ Continued bone loss + peripheral osteophyte
- ▣ Soft tissue contraction – fixed deformity

Correctable not fixed !!
Problem is bone loss and not ligament
contracture



Understanding deformities:

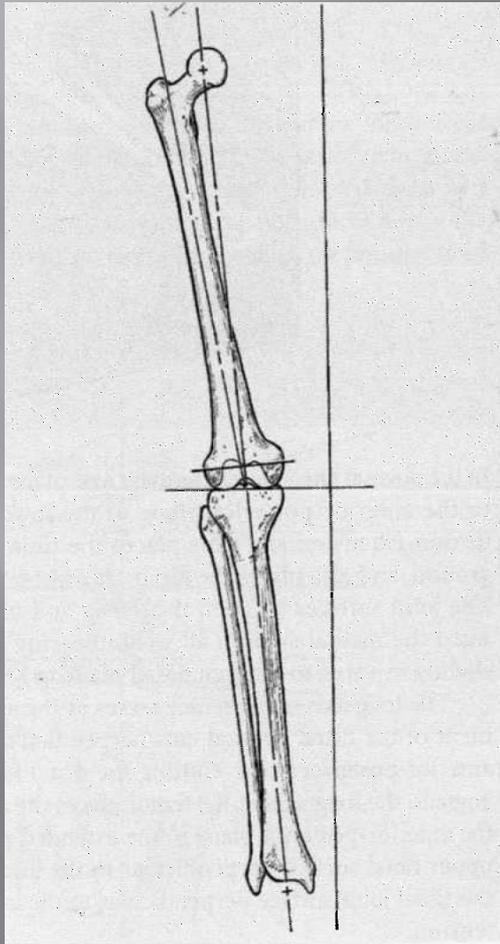
- Medial overload- (Rand Classif. Tibial Bone defects)
 - Asymmetric loss- cartilage + bone
 - Abnormal kinematics; ACL insuff.; total menisectomy;
 - Varus hip; abnormal bowing femur etc..



Understanding deformities:

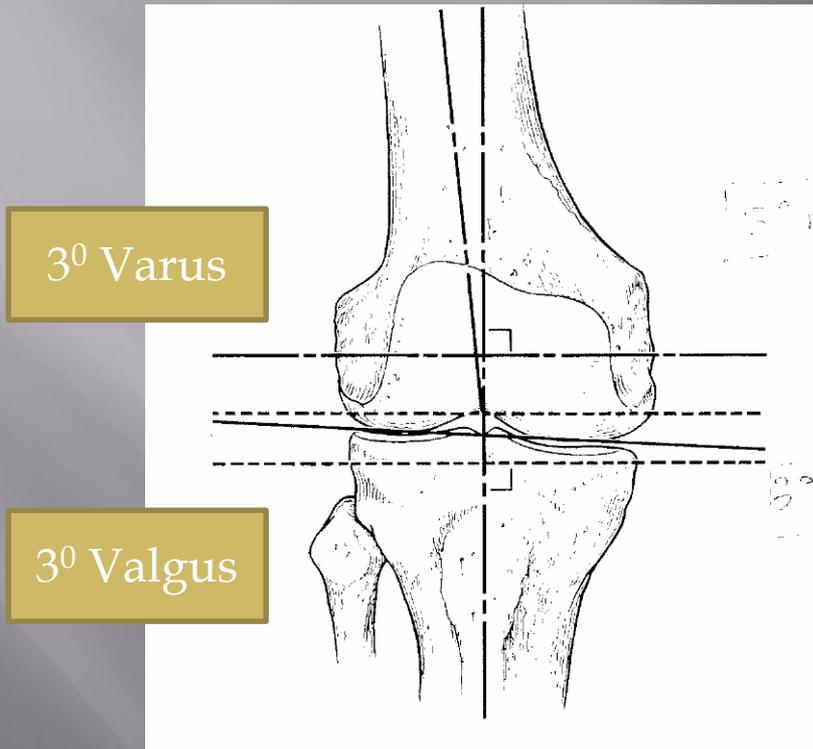
- ▣ Flexion contracture:
- ▣ Limited to soft tissues
- ▣ Minimal or no posterior bony involvement (except RA)
- ▣ Fixed flexion deformity
 - ▣ Posterior osteophytes
 - ▣ Posterior adhesive capsulitis- contracture
- ▣ Contracture
 - ▣ Capsule
 - ▣ Cruciate ligs
 - ▣ hamstrings
- ▣ Flexion deformity: (Lombardi et al)
 - Grade 1 ($<15^{\circ}$)
 - Grade 2 ($15-30^{\circ}$)
 - Grade 3 ($>30^{\circ}$)
- ▣ Addressed:
 - Soft tissue release
 - Bony resection

The lower limb axis



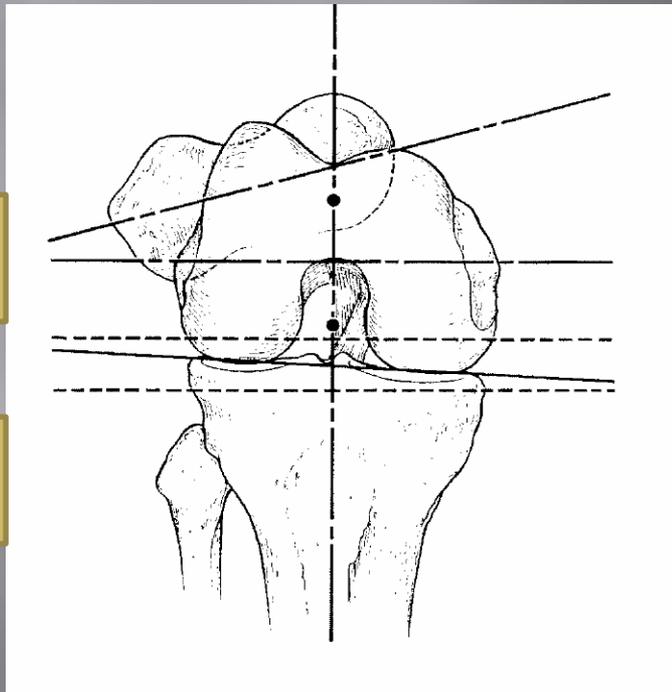
- ▣ Mechanical axis
 - Centers of Hip, Knee and Ankle
- ▣ Anatomical axis of Femur
 - 5 degrees Valgus to MA

Extension Gap



- ▣ Tibial Joint surface medial slope 3°
 - Resection is 3° Valgus
- ▣ Femoral resection is 5° Valgus to A axis..i.e.,
Articular surface resection is 3° Varus
- ▣ 3° error cancel out
- ▣ Rectangular Extension gap.

Flexion Gap

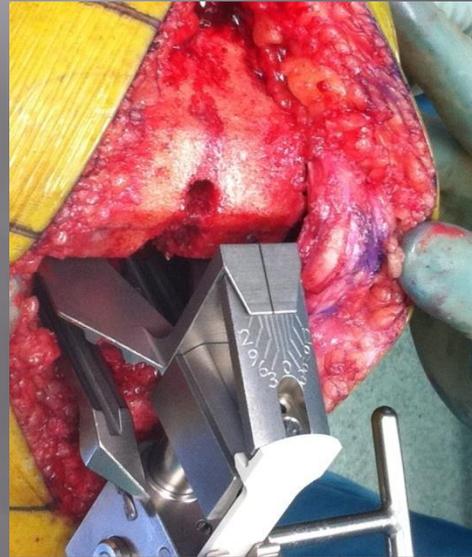


3° Ext.
Rotation

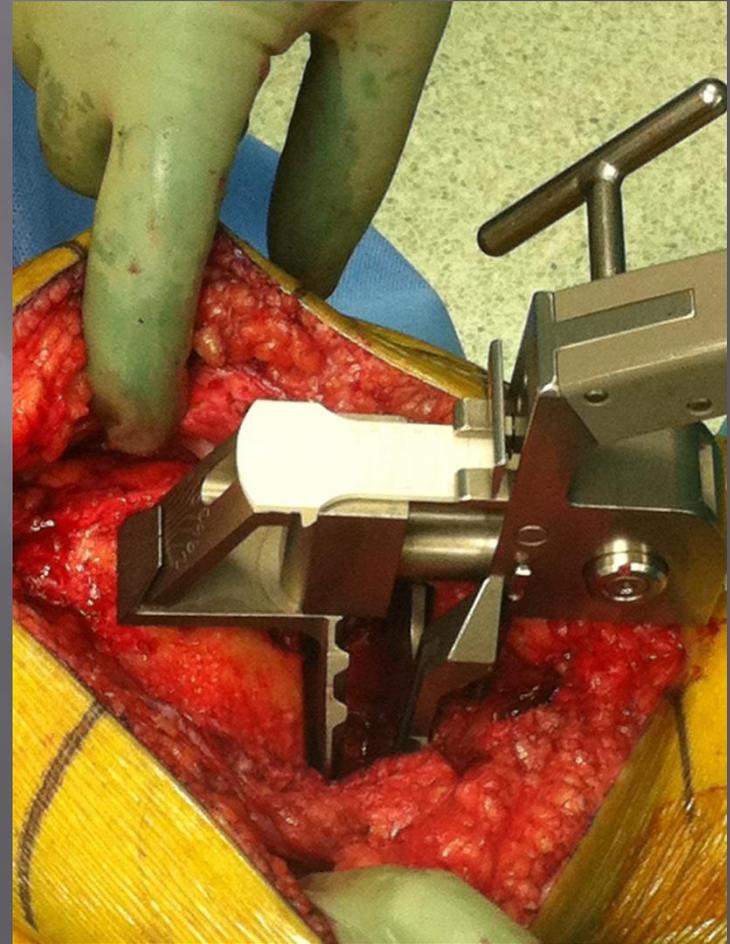
3° Valgus
cut

- Goal is to align it parallel to the Epicondylar axis
- Commonly use posterior condyle as reference
- To adjust for 3 degrees valgus cut in tibia....we externally rotate femur jig by 3 degrees
- **Rectangular Flexion gap**
- **Exceptions !!!** (Berger et al)
3.5 in males and 0.3 in females

Rectangular and equal Flexion /Extension gap

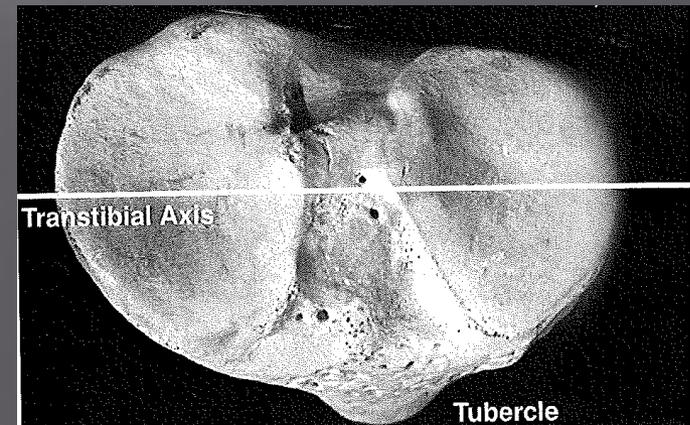
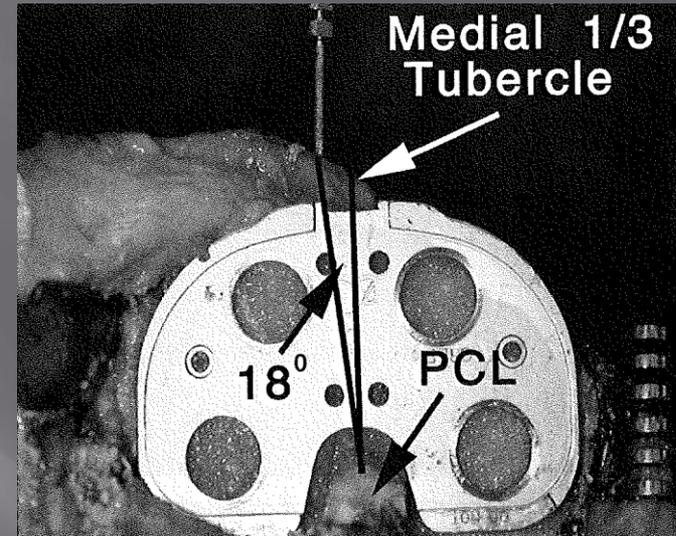


Tensioner



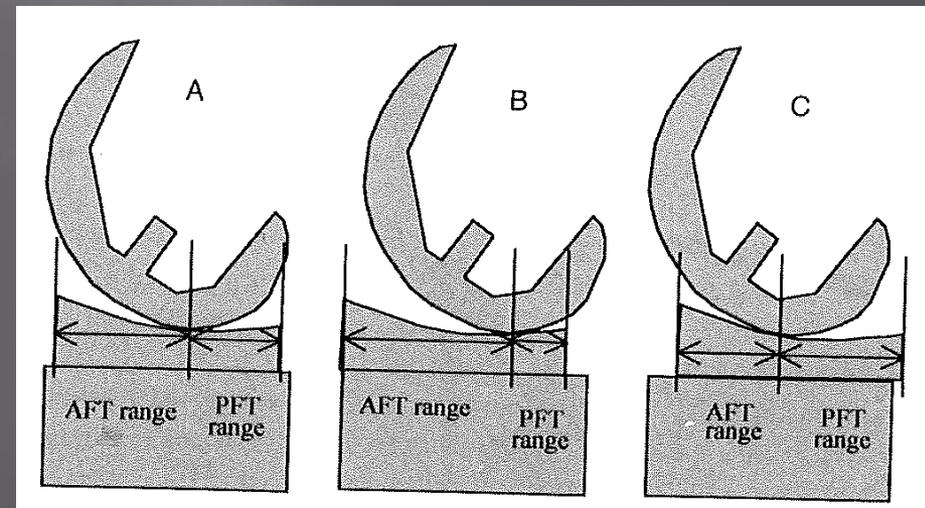
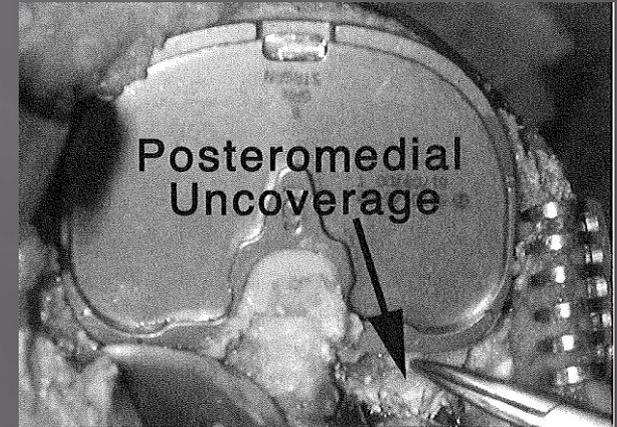
Useful tips.....Accurate Component sizing/ placement- Tibia

- ▣ Medial third of tubercle (Berger)
 - Trans-malleolar axis
 - Tans-tibial axis
- ▣ Bone resection
 - 10mm lateral side
 - 6-8mm medial side
- ▣ (Ref: Dorr & Sculco)
 - Poor bone quality
 - Small tibia- potential mismatch with femur
 - Lateral retinacular structures destabilized.

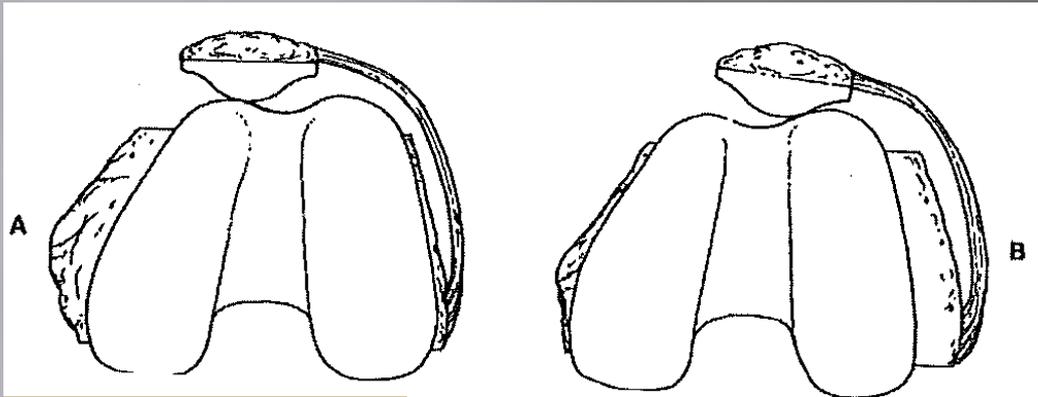


Useful tips..... Accurate component sizing/placement

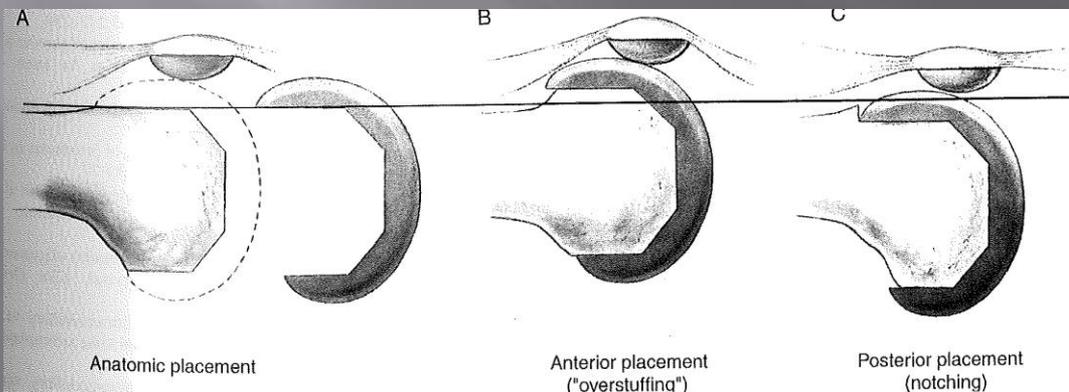
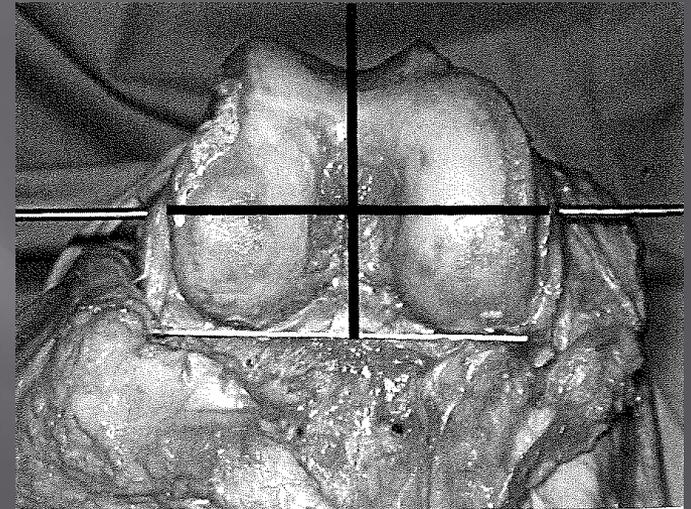
- Tibial component:
 - Ant. edge of component on Ant. edge of tibia
 - Postero-laterally flush with bone
 - Postero-medial uncovered bone
 - “Assess rotation independent of bony coverage”
- Computer analysis (Walker et al)
 - Post displacement by 5mm-
↑ flexion by 5°
 - Ant. Displacement by 5mm-
↓ flexion by 10°



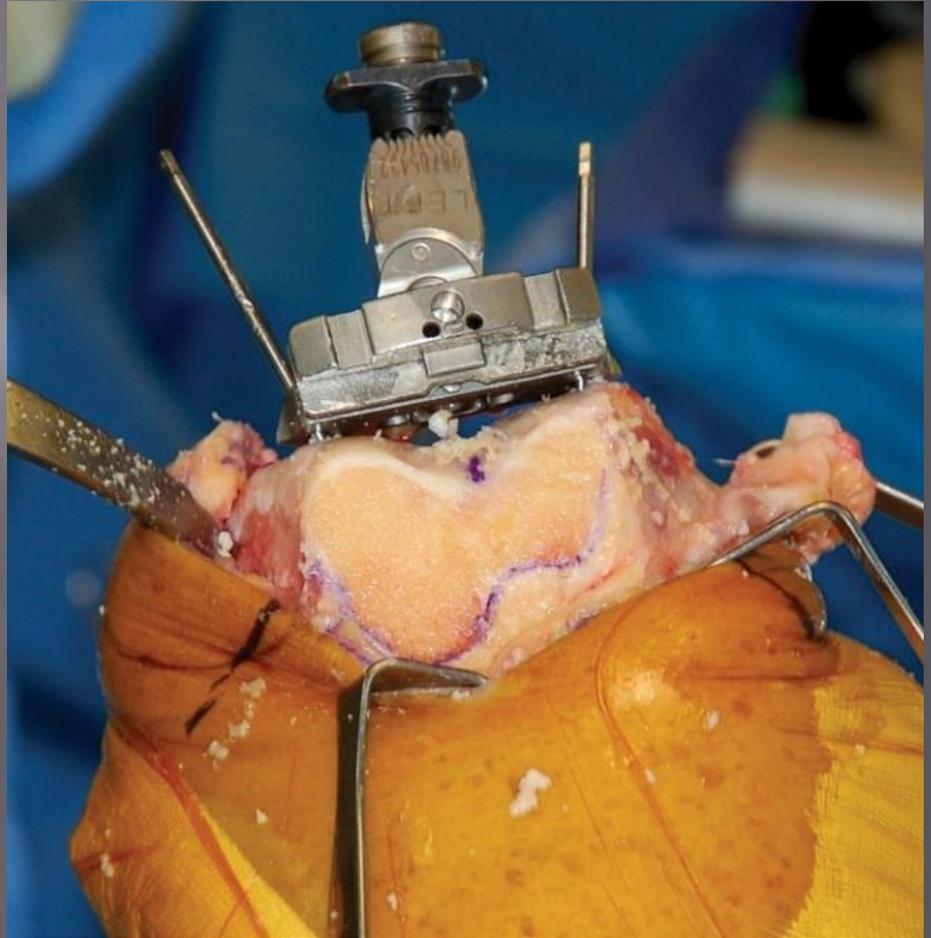
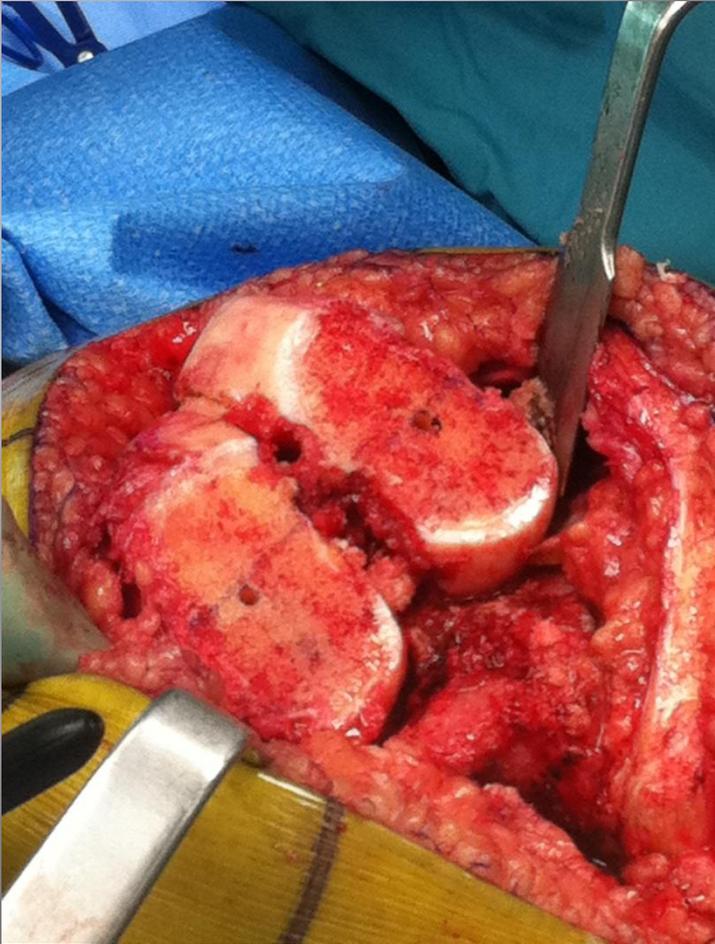
Useful tips.....Accurate component sizing/placement- femoral rotation



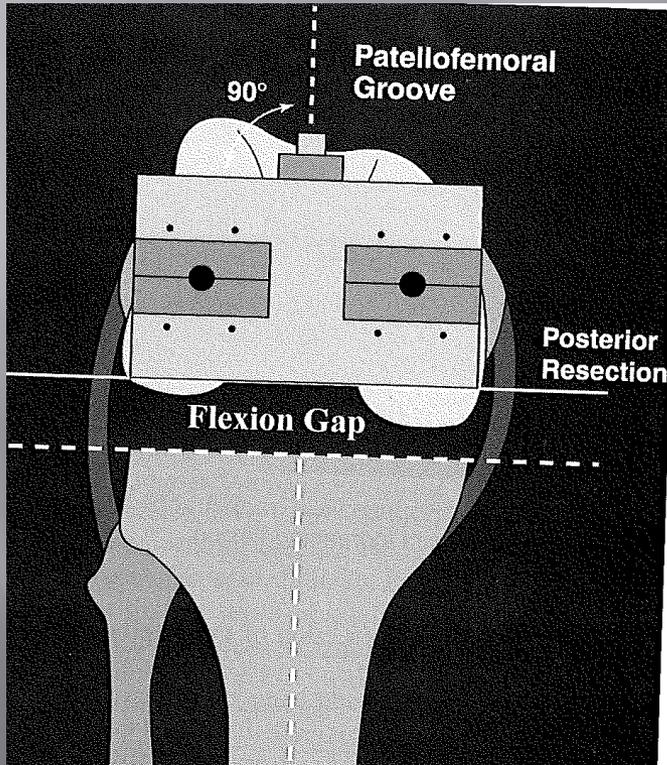
Krackow et al



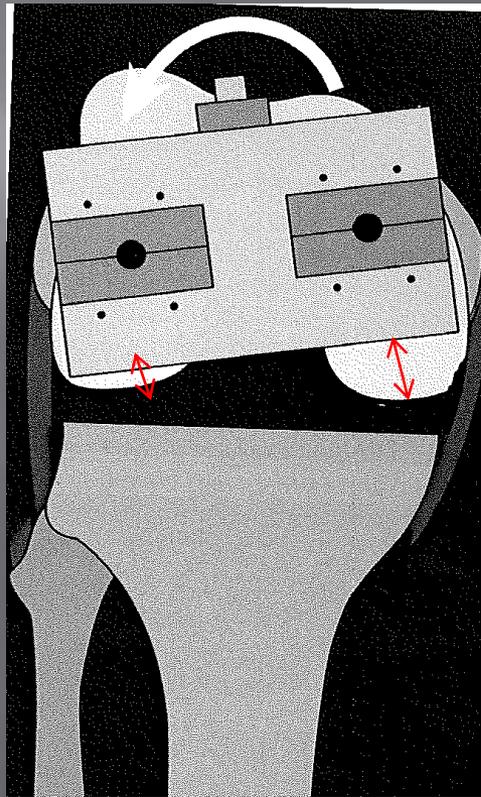
Useful tips.....Accurate component sizing/placement- femoral rotation



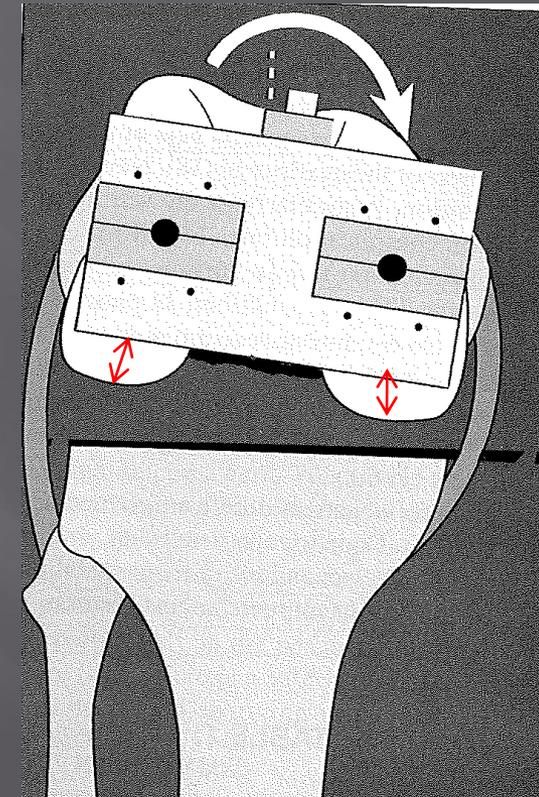
Useful tips.....Accurate component sizing/placement- femoral rotation



Just Right

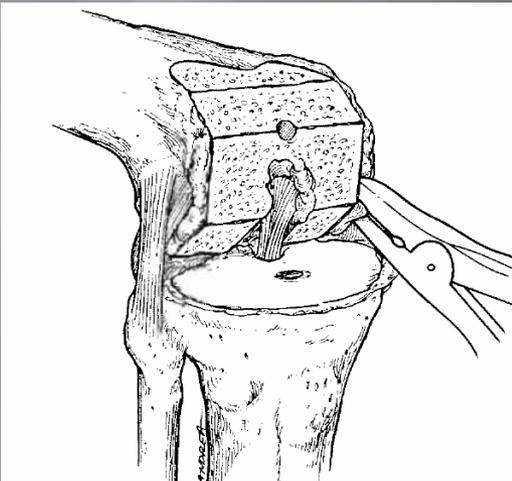
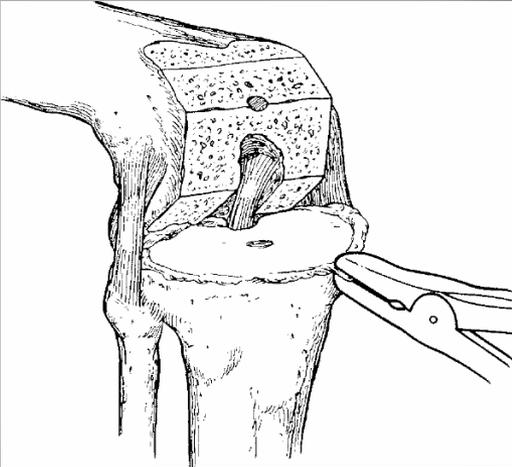


Too much ext.
rotation



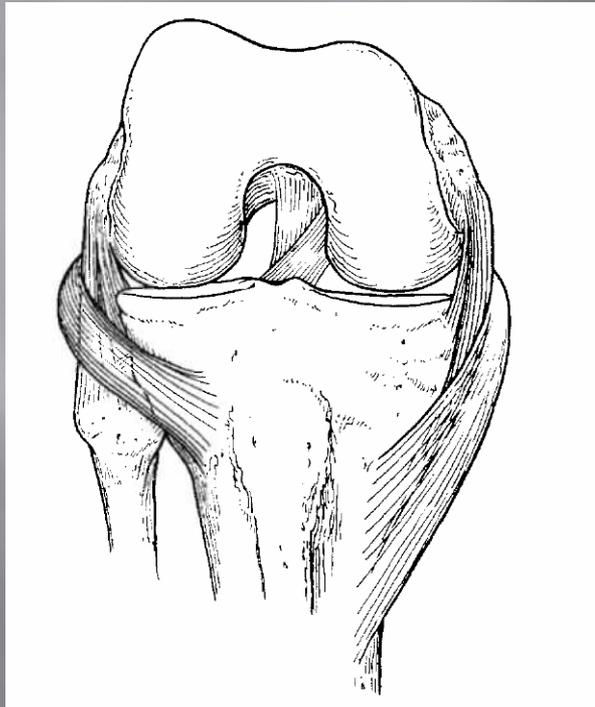
Internal rotation

Remove Osteophytes !!!



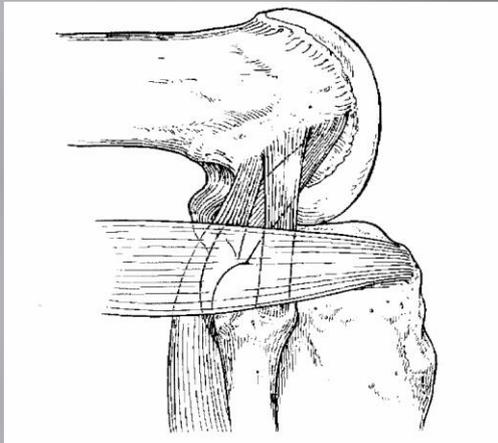
Always
leave a 2-3
mm rim

Knee stabilizers- flexion



- ▣ Medial side
 - Sup and Deep MCL
- ▣ Lateral side
 - LCL and Popliteus
- ▣ PCL
 - Sec Varus/Valgus stabilizer
- ▣ PES & IT band
 - No medial/lateral stability in flexion

Ligament function



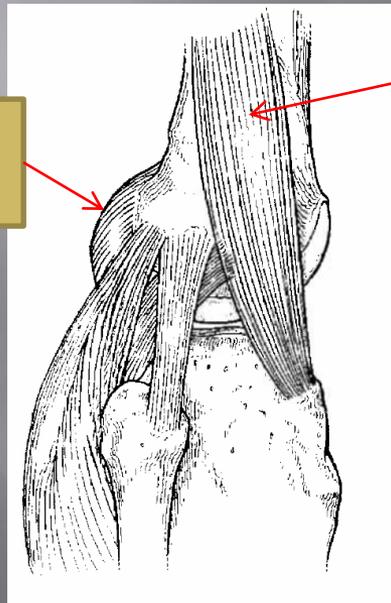
lateral ligaments

▣ FLEXION ARC

- ▣ LCL
- ▣ Popliteus
- ▣ PL Corner capsule
- ▣ Lateral Gastroc

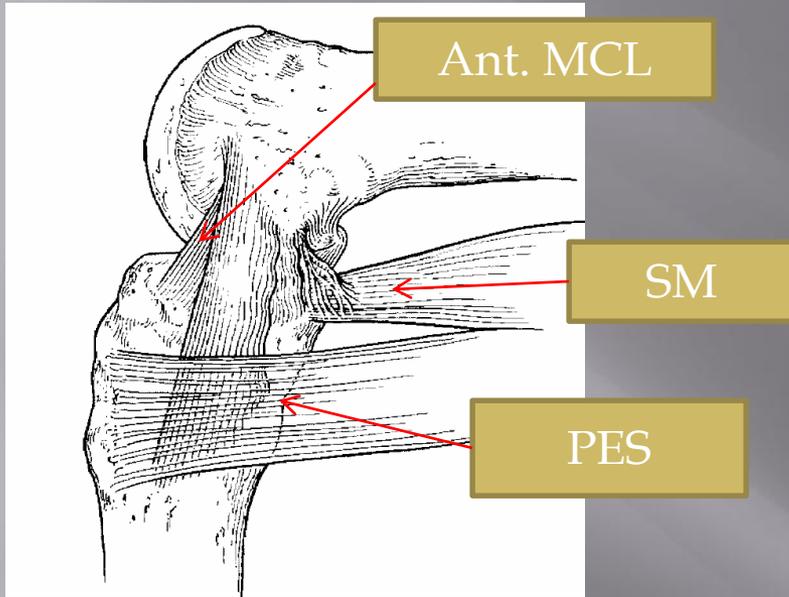
▣ EXTENSION ONLY

- ▣ IT band
- ▣ Post. Capsule- lateral



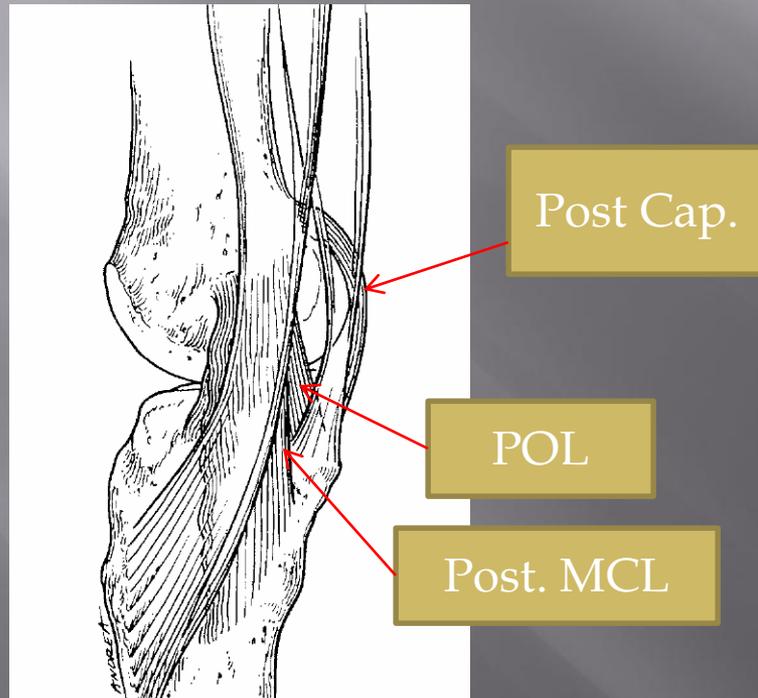
IT Band

Post.
capsule



Medial ligaments

- ▣ **FLEXION**
 - ▣ **Ant.** (Deep+ Sup) MCL
 - ▣ PCL



- ▣ **EXTENSION**
 - ▣ **Post.**(Deep+Sup) MCL
 - ▣ POL (MCL near femur)+ SM sheath
 - ▣ Post. Capsule- medial
- **DYNAMIC/ACTIVE**
 - ▣ PES
 - ▣ SM

Varus knee

- ▣ **Medial tibial plateau defi= most of varus deformity**
- ▣ **MCL contracted + deformed by osteophytes**
- ▣ **Usual surface landmarks for femur in flexion**
 - Post Femoral Condyles
 - **Epicondylar Axis**
 - Long axis of Tibia
 - Tensed supporting Ligaments
 - Anterior Surface of Femur
 - AP axis

(Lateral edge of PCL and deepest part of patellar groove)
- ▣ **Articular surface deformity !!!**
 - Joint surfaces cannot be used a reference landmarks
- ▣ **Anatomical landmarks- 72% of AAHKS members**
- ▣ **Tensioned gap balancing- 28%**

Described methods/principals- Varus Knee

▣ **Soft tissue stripping**

- Release collaterals
- Release tendon attachments on medial tibial flare
- “secondary scarring with periosteal healing in a lengthened position restores balance and stability”

▣ **Joint line release**

- Divide sup and deep MCL at joint line
- Release is done through the bed of medial meniscus under tension
- “preserve POL and postero-medial jt. capsule for residual stability”

Varus...contd.

▣ **Medial Epicondylar Osteotomy**

- Severe varus with FFD
- Knee in 90 flexion
- Wafer of bone 1cm thick x 4 cm in diameter
- Reattach with 2-3 heavy sutures- **distal and posterior position**
- Access to **contracted posterior knee capsule**
- Deep and superficial MCL are not damaged

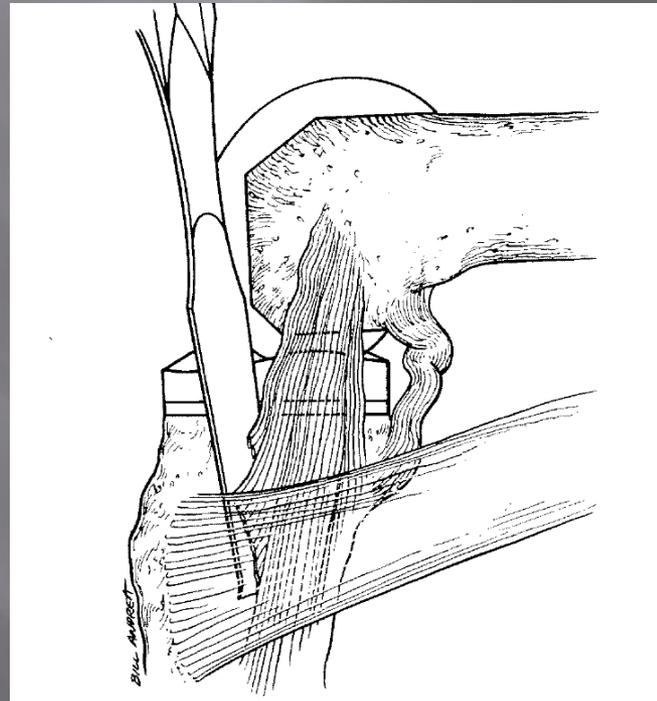
Varus ...contd.

▣ **ACL release**

- Medial structure
 - Frequently contracted
 - Presents as increased femoral roll back in flexion
 - Femoral trial should centre on tibial component in sagittal plane
 - Watch for lift off the tibial component
 - **POLO test- “pull out, lift off.”**
 - **Sacrifice or selective balancing**
 - Release from tibial insertion/femoral origin
 - Osteotomise the tibial insertion with a v- shaped bone
- “With knee in 90 flexion, the femur should sit in the center of the tibial component”**

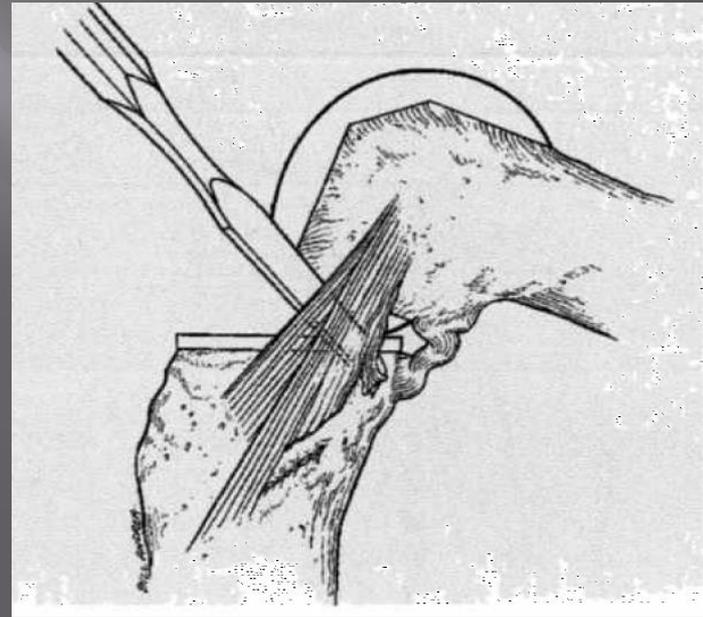
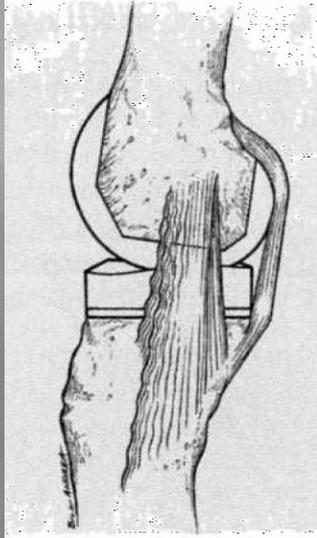
Function based medial release

- ▣ **Medial ligament tight in flexion**
 - ▣ Release ant. portion of MCL (fibers extend 8-10cms distally)



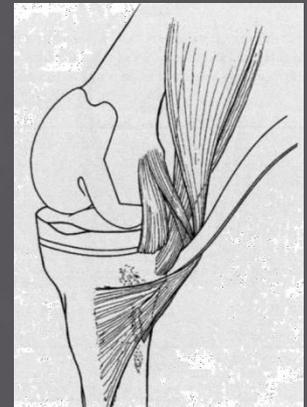
Function based medial release

- ▣ **Medial ligament tight in extension**
 - Release posterior oblique portion of MCL + SM
 - Post. Medial capsule femur/tibia



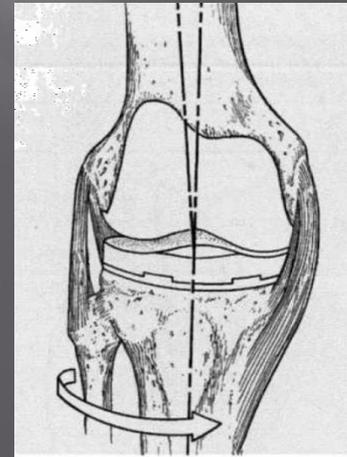
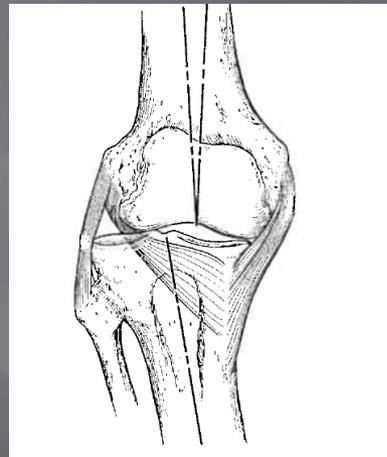
Function based medial release

- ▣ **Knee tight in both flexion and extension**
 - Release the **entire MCL first, then SM slip**
 - ▣ Release **anterior MCL first** (isometric)
 - Assess, if tight- **release posterior medial capsule**
 - Assess, if tight- **consider SM & PES release**
 - Assess, if tight- **downsize tibia** and medial **tibial osteotomy**
 - **Keep very constrained component standby !!**



Function based medial release

- ▣ **Excessive femoral roll back in flexion**
 - Release PCL
- ▣ **Special circumstances:**
 - ▣ Release of tight and contracted popliteus
 - ▣ Tibia is internally rotated; femur sits posterior on tibial tray

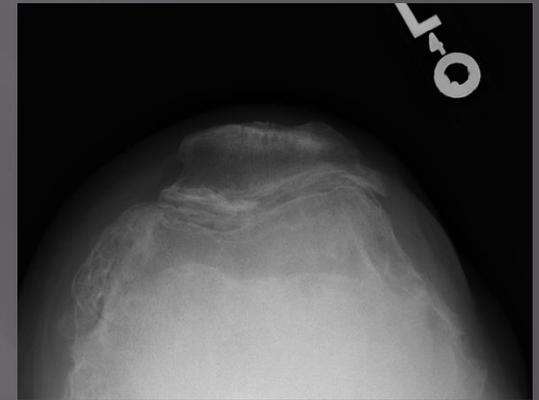


Case Examples!!

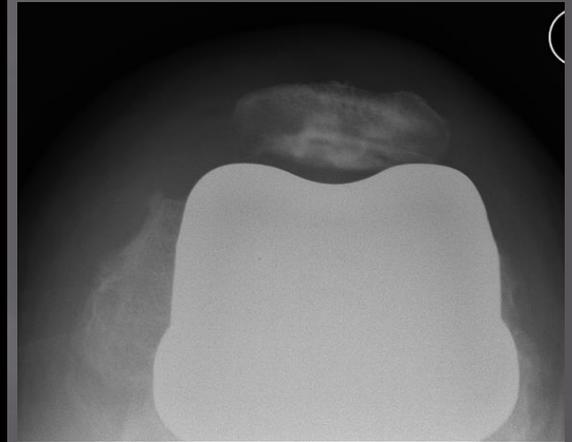
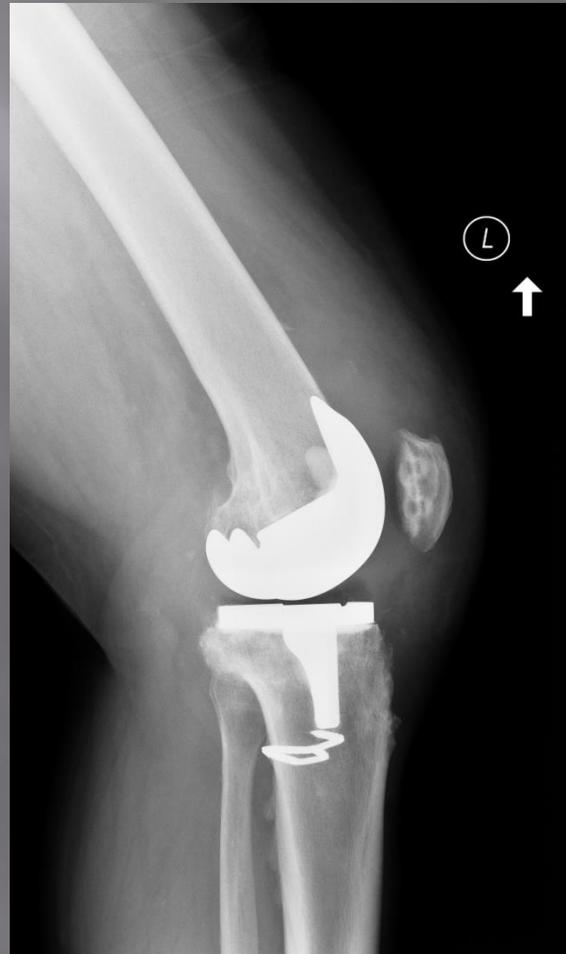


Varus knee- example 1

15 fixed Varus with rom 15 to 80
prior MCL and ACL reconstruction



Varus knee- post-op 1 release MCL-sup+deep; PES and SM + medial plateau osteotomy



Varus knee- example 2

11 fixed varus and 20 flexion



Varus-Example 2 post-op

2mm more distal resection; post-cap release; sup + deep medial release; medial osteotomy tibial

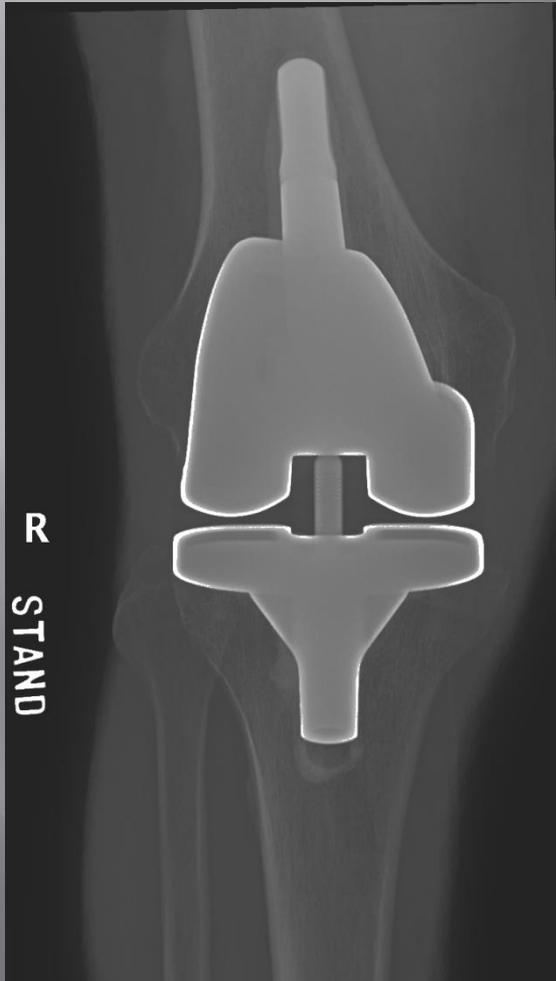


Varus knee- example 3

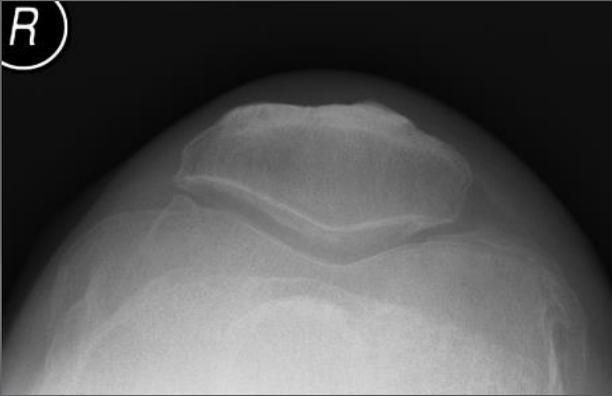
10 varus + recurvatum



Varus -example 3 post-op
navigation failed-extra-med.; distal femur resection
2mm less; recurrent falls-Constrained prosthesis?



Varus- Example 4 Malunited femur

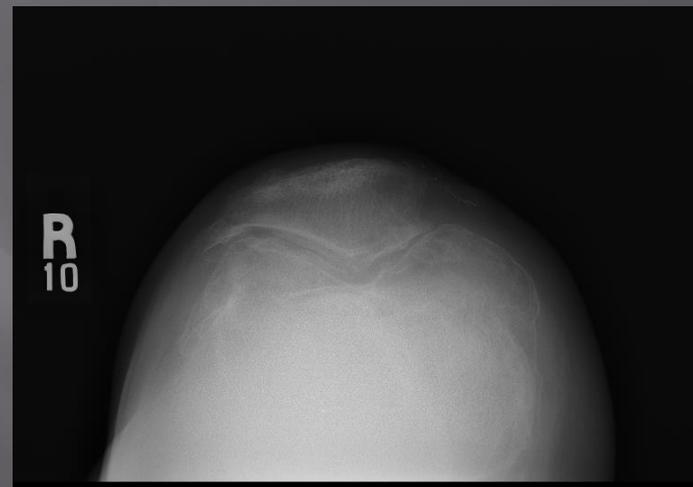


Example 4-post-op computer assisted full medial release; medial cap release; medial tibial osteotomy



Varus knee -example 5

10 to 50 flexion since '69; septic knee



Post-op example 5 - no extra bony resection MUA- 0 to 95 Flexion; tight quads



Varus knee- example 6
10 varus fixed; tibia vara; slope /post.
Subluxation; 10 FFD



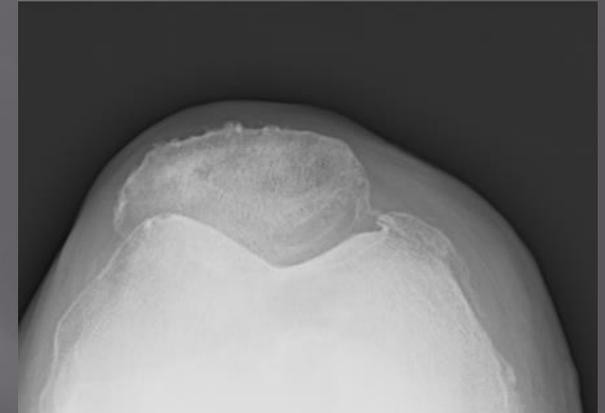
Example 6

down size tibia + reduction osteotomy tibia + postero-medial cap release ; sup and deep MCL release



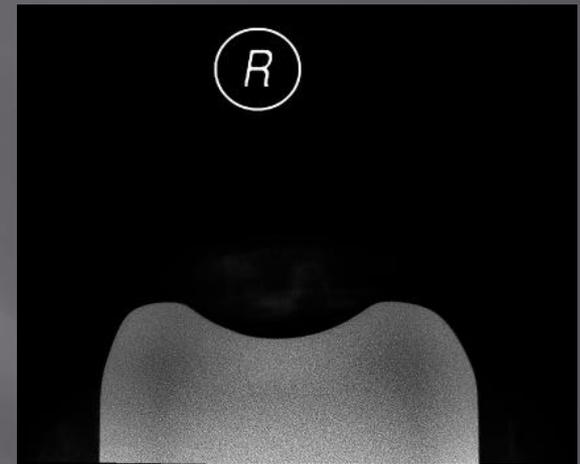
Example 7

varus -fixed with medial bone loss



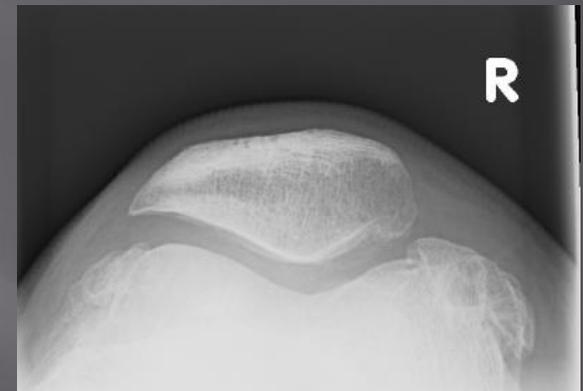
Example 7

varus -post-op medial release mcl + 10mm
augment

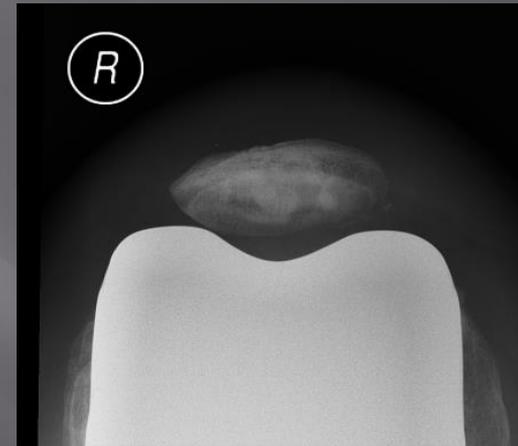


Example 8

15 degrees fixed Varus- medial bone loss



Example 8
varus medial bone loss
medial release extended; 5mm medial augment

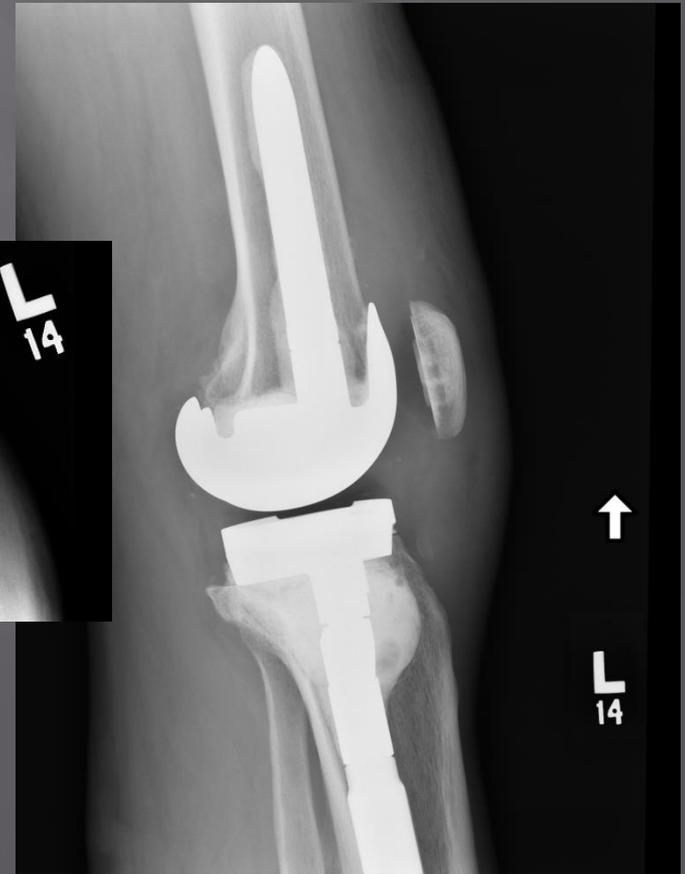
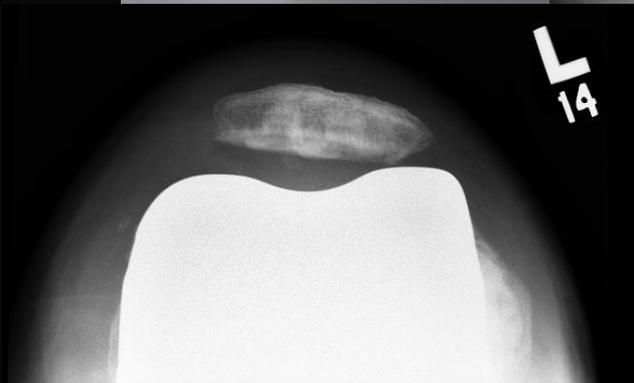


Example 9

Varus- Large cysts- tibia, med condyle
correctable varus

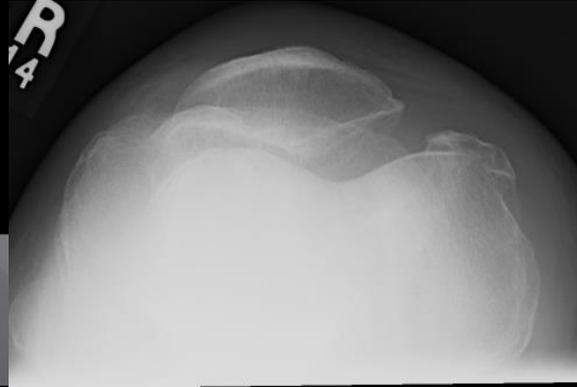


4x6cms cyst -lat condyle; 3cms cyst -medial condyle; large central lytic area in tibia.
10mm medial augment



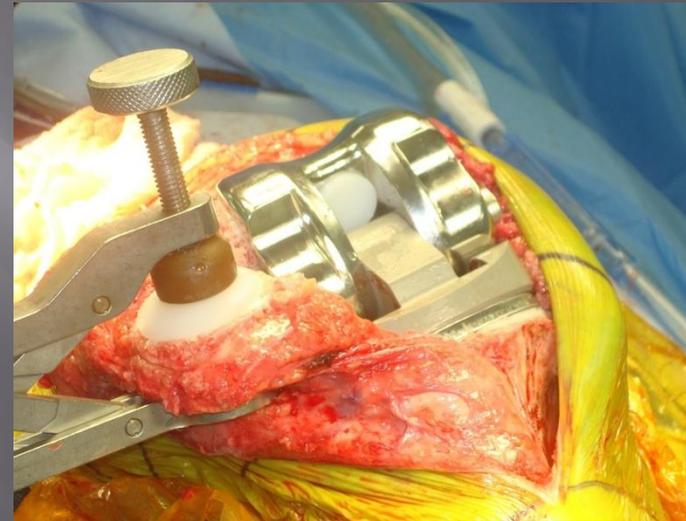
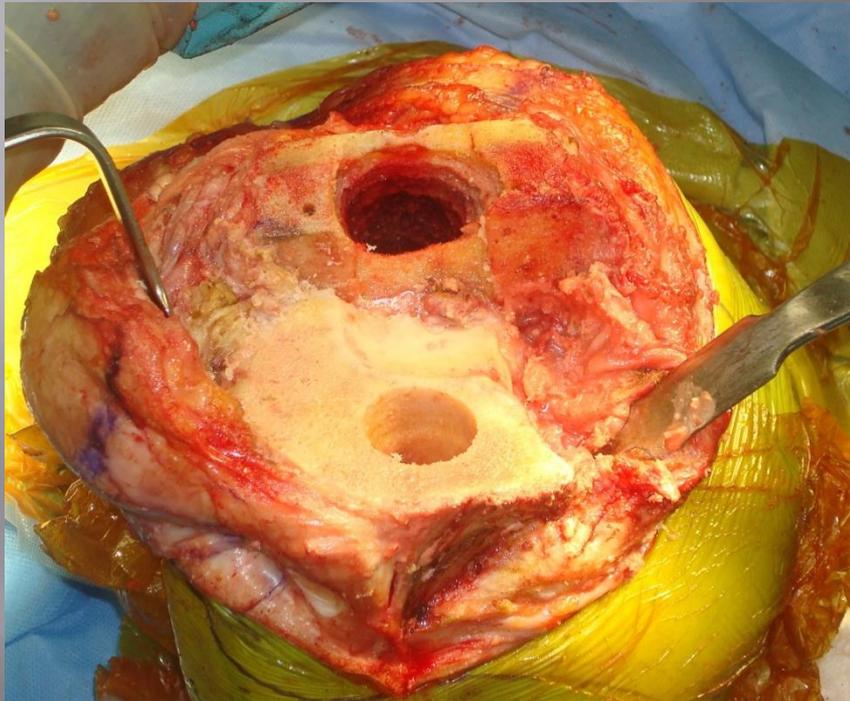
Example 10

Varus-30 ; 10-90 flexion

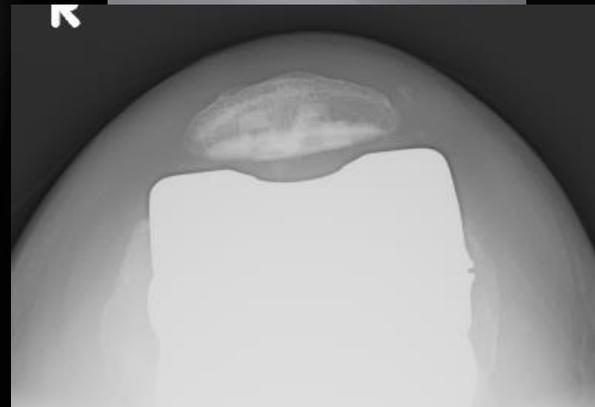


Example 10

Varus- medial and posterior bone loss Modular Rotating Hinge



Modular Rotating Hinge porous sleeve

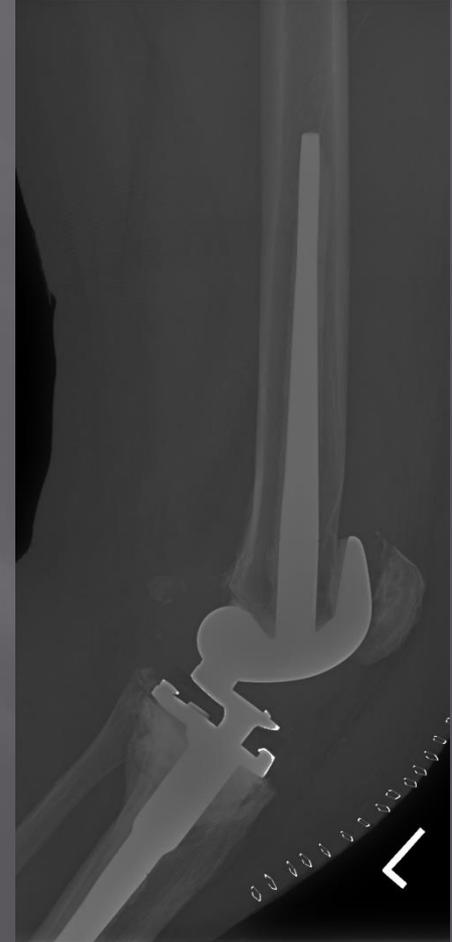
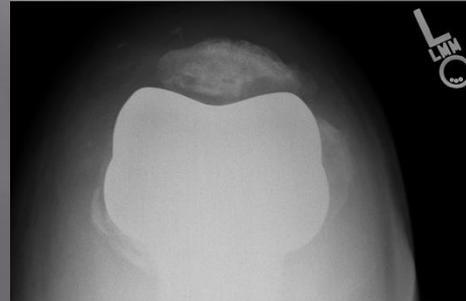


Varus 12



Example 12

Complete lateral lig. Deficiency always...a Hinge !!

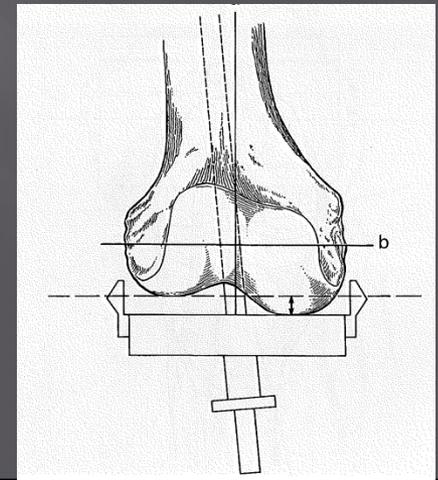


Valgus deformity



Valgus knee

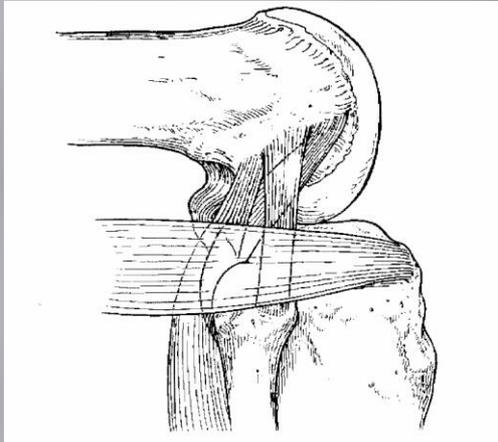
- ❑ Altered Anatomy of distal femur- **dysplastic lateral femoral condyle**
- ❑ Alignment of condyles - 12° to 20° (n= 9° Valgus)
- ❑ **Entry point for IM rod is 5-10 mm medial (Valgus curvature)**
- ❑ Lateral ligaments contracted and **medial stretched out**
- ❑ **Asymmetric bony resection** to restore axial alignment further aggravated ligament imbalance
- ❑ Use medial as reference and augment lateral surface if indicated



Valgus knee contd.

- ▣ Rely on **AP axis/Epicondylar axis/Tibial cut**
 - Posterior condyle- can't be used for rotational rotational guide
 - First goal is “**correct bony alignment**”
 - Rational ligament balancing in flexion and extension.

Ligament function



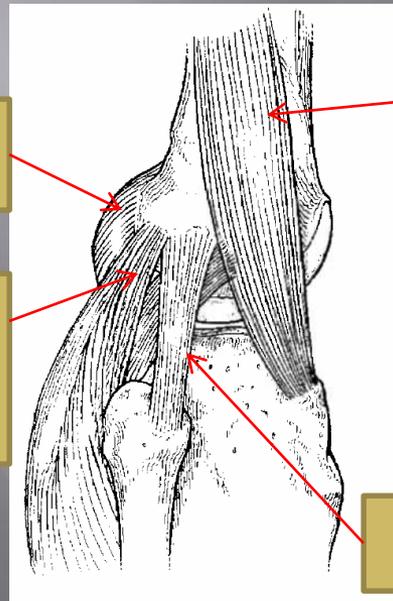
lateral ligaments

▣ FLEXION ARC

- ▣ **LCL**- rotational and Varus stabilizer “more role in extension”
- ▣ **Popliteus**-passive varus + ER stabilizer “more role in flexion”
- ▣ **PL corner capsule**-both flexion+ extension
- ▣ **Lat. Gastroc** “more in extension”

▣ EXTENSION ONLY

- ▣ IT band
- ▣ Post. Capsule- lateral



Post.
capsule

IT band

PL
Corner
capsule

LCL

Function based lateral release

- ▣ Knee tight laterally in flexion and extension
 - “Always assess in flexion and release first” before addressing extension tightness”
 - Release of Popliteus, LCL, and rarely the PL corner capsule (provided PCL intact)
 - Assess in extension and if tight release IT band first and then posterior capsule if needed

- ▣ Knee tight laterally in extension only
 - Release IT band first
 - Assess and release posterior lateral capsule
 - If PCL intact, release lateral gastroc too
 - (rely on PCL, Post capsule and Biceps femoris as stabilisers in extension)

Function based lateral release

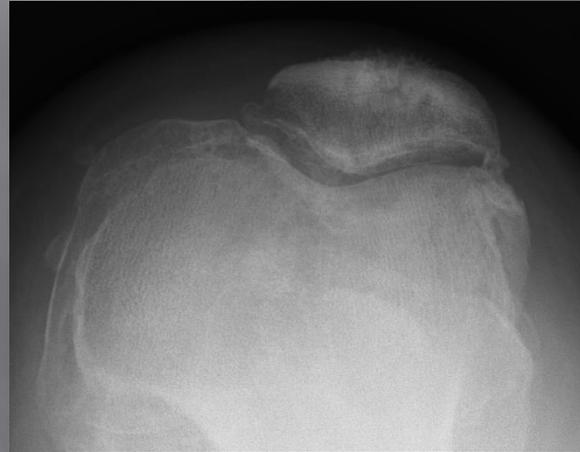
- ▣ Knee tight in flexion only
 - ▣ Popliteus release.....then LCL.....PL Corner capsule
- ▣ Release all static lateral stability structures-
 - ▣ Rely on Biceps Femoris, Gastroc and deep fascia...and a constrained implant ...excessive lat soft tissue releases ..rotatory instability and knee dislocation in deep flexion
- ▣ PS Knee- do not release both PCL and Popliteus !!!..... a
 - ▣ constrained implant
- ▣ PS Knee- “Pie crusting” technique (Ranawat)
 - ▣ Peroneal nerve lies 1.49 cms from the bone edge

Function based lateral release

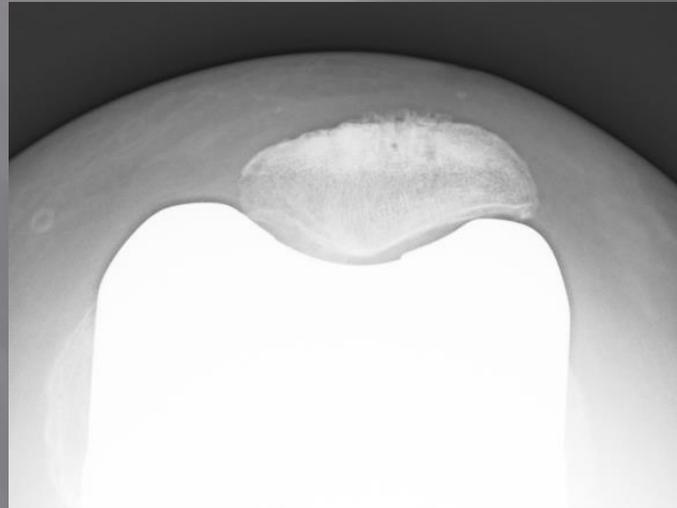
- ▣ Lateral femoral epicondyle osteotomy
 - Indicated for severe deformities
 - Fixed valgus > 20
- ▣ Do not attempt both pie crusting and osteotomy

Valgus Knee- Example 1

28° Valgus



Soft tissue balancing: IT Band , Popliteus release + partial lateral release



Pre-op and post-op

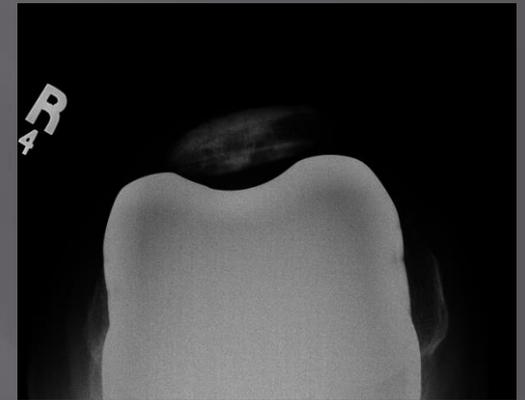


Valgus -Example 2

18 valgus

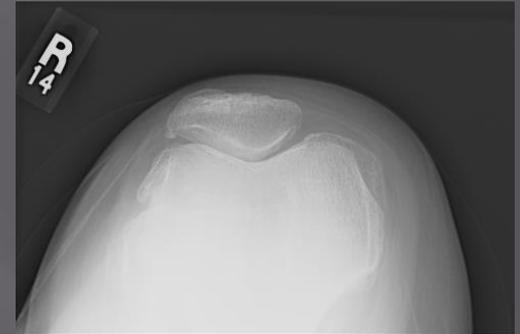


Soft tissue balancing: Popliteus + pie crusting + IT partial release



Valgus knee- example 3

10 fixed valgus



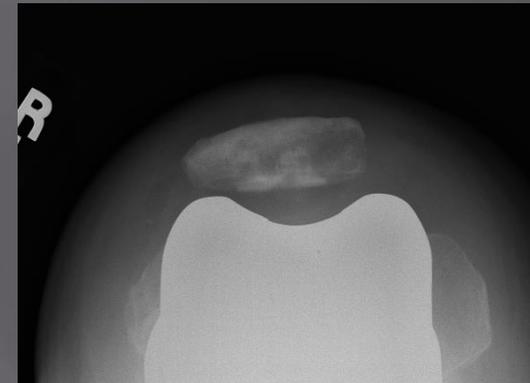
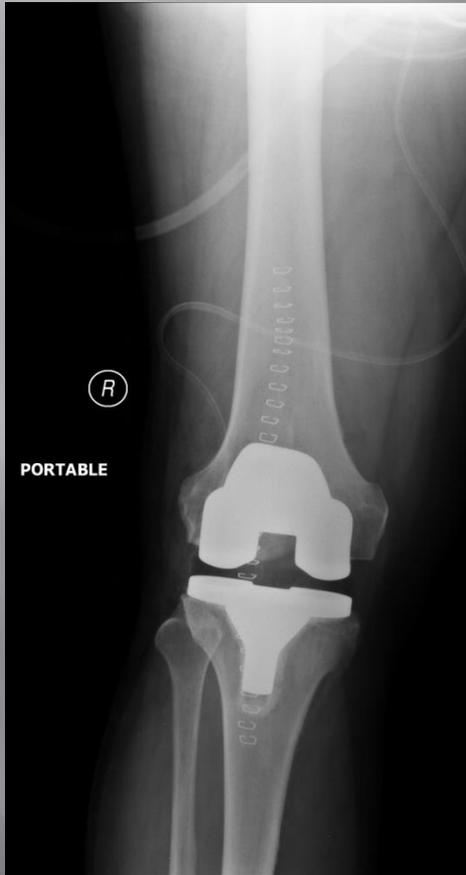
Soft tissue balancing: lat. condyle hypoplasia; limited lat. release



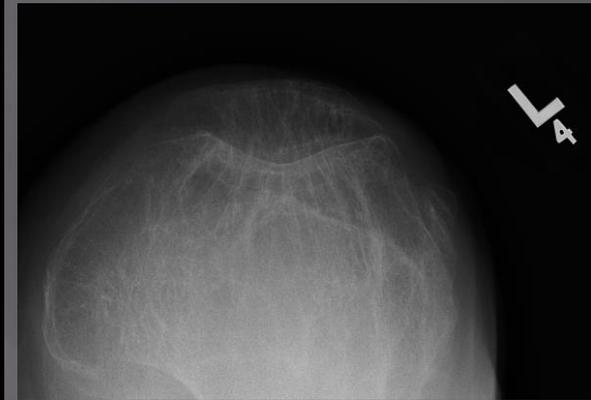
Valgus knee -example 4



Soft tissue balancing: IT band + popliteus release



Valgus knee- example 5
post-traumatic 33 yrs ; patella baja;
deficient lat lig- hinged brace

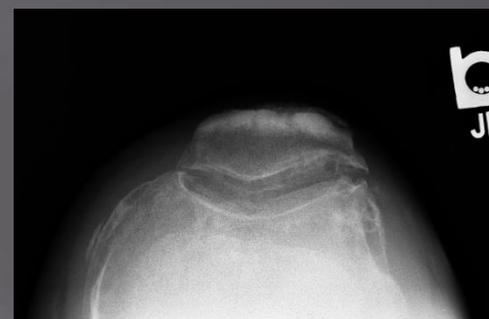


Soft tissue balancing:
deficient lat lig.; multiple cysts; severe
osteopenia; 17.5 poly- 3-4 mm lateral opening



Valgus knee- example 6

15 valgus + 20 FFD to 90 flexion



Soft tissue balancing: 6mm more distal cut; no LR; post cap release

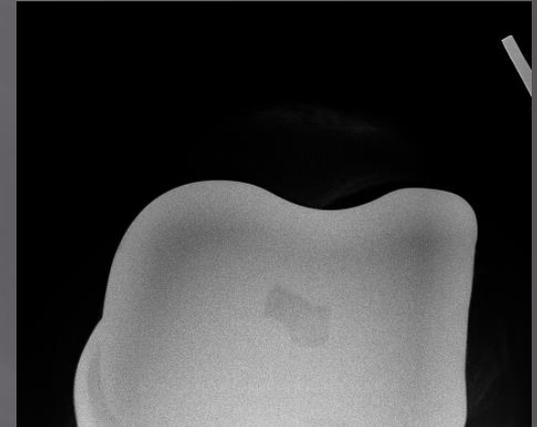


Valgus -example 7

15 valgus



Soft tissue balancing: popliteus + pie crusting LCL; limited lat release

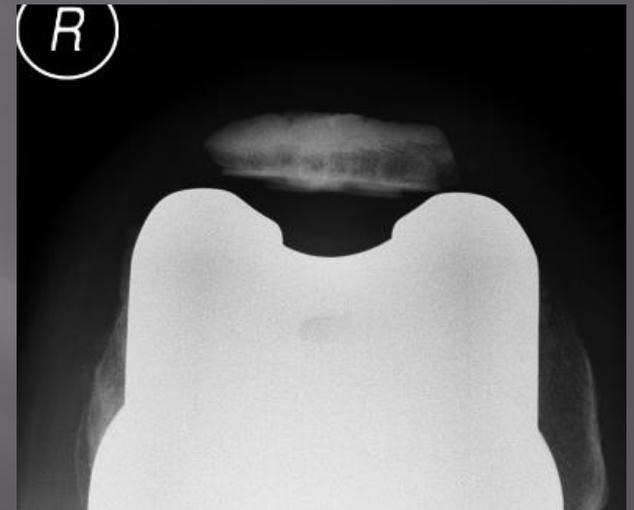


Valgus example 8

14 valgus



Soft tissue balancing: IT band release

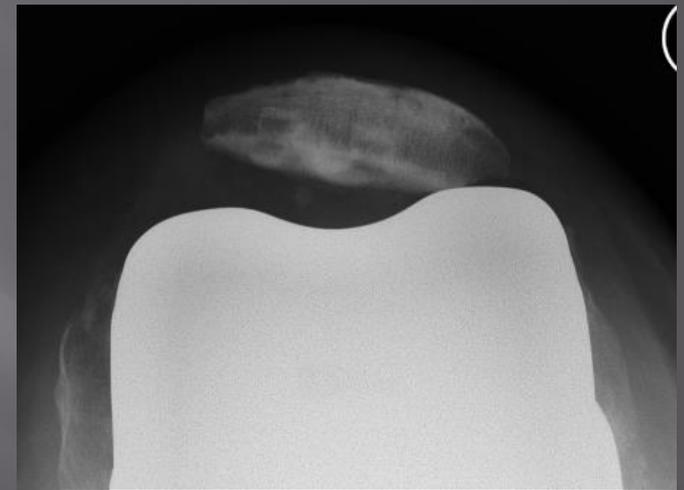
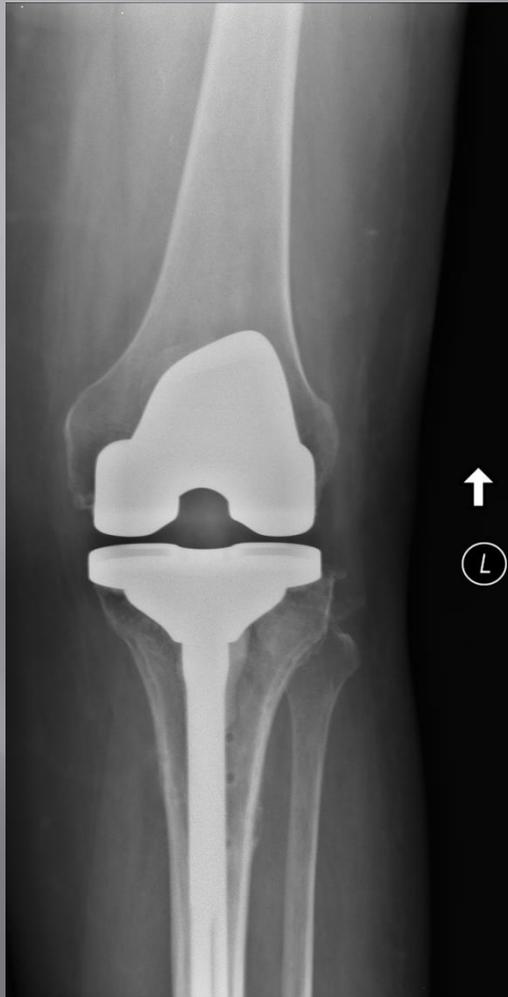


Valgus example 9

10 valgus-post-traumatic

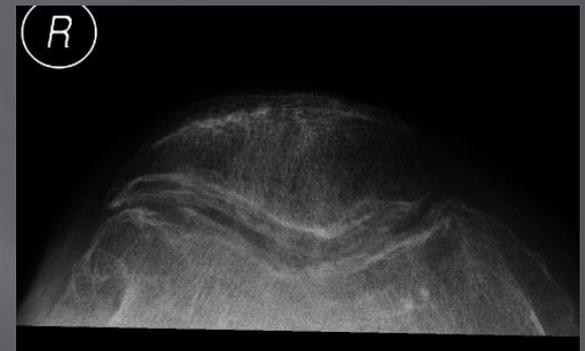


Soft tissue balancing: No soft tissue release



Valgus Example 10

18 Fixed valgus with 20 FFD; Flexion to 80

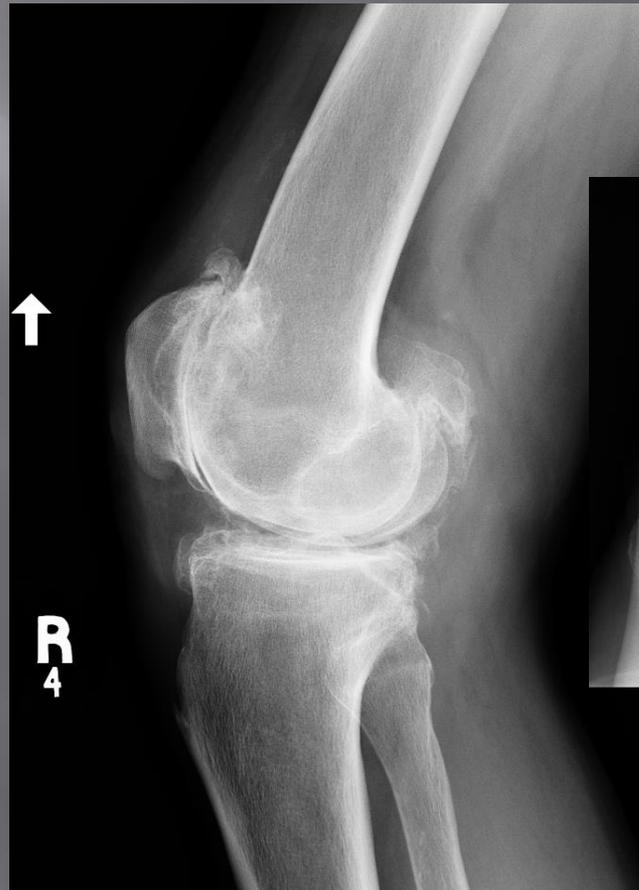
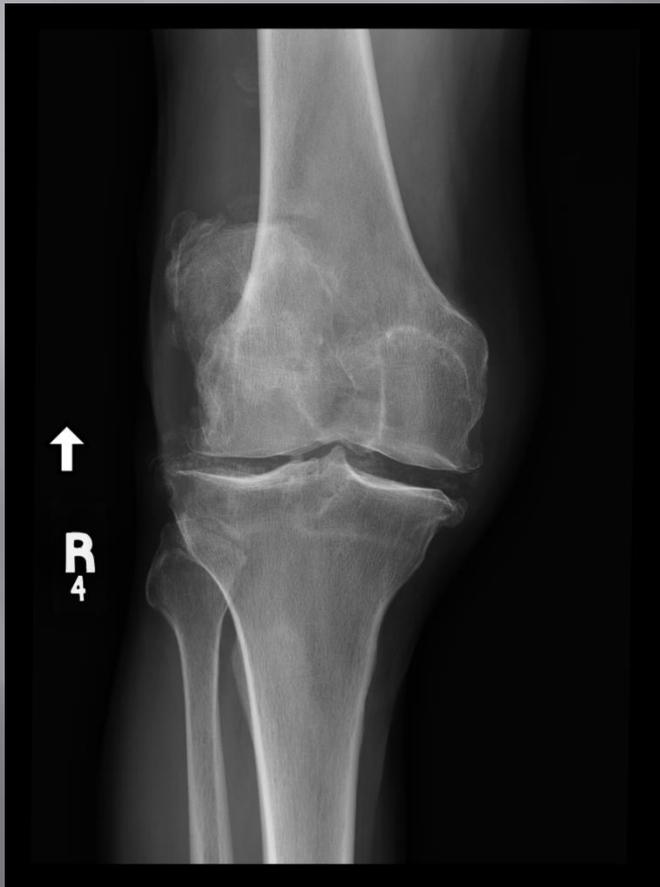


Soft tissue balancing: IT band release; no additional distal resection



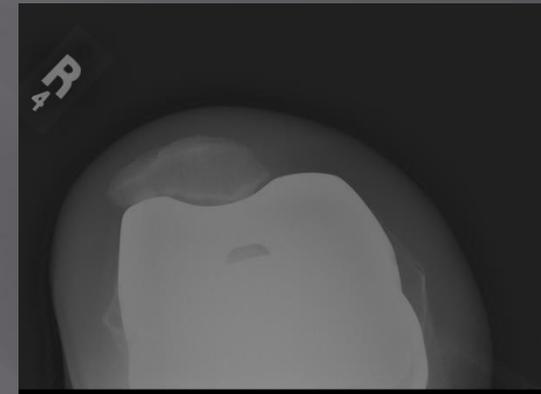
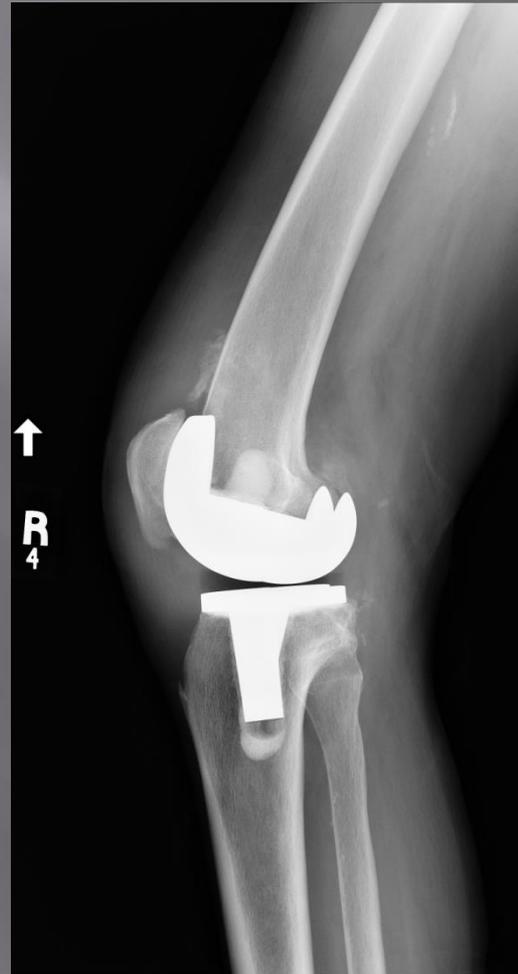
Valgus knee - example 11

8 valgus with 30 FFD- 90 flexion



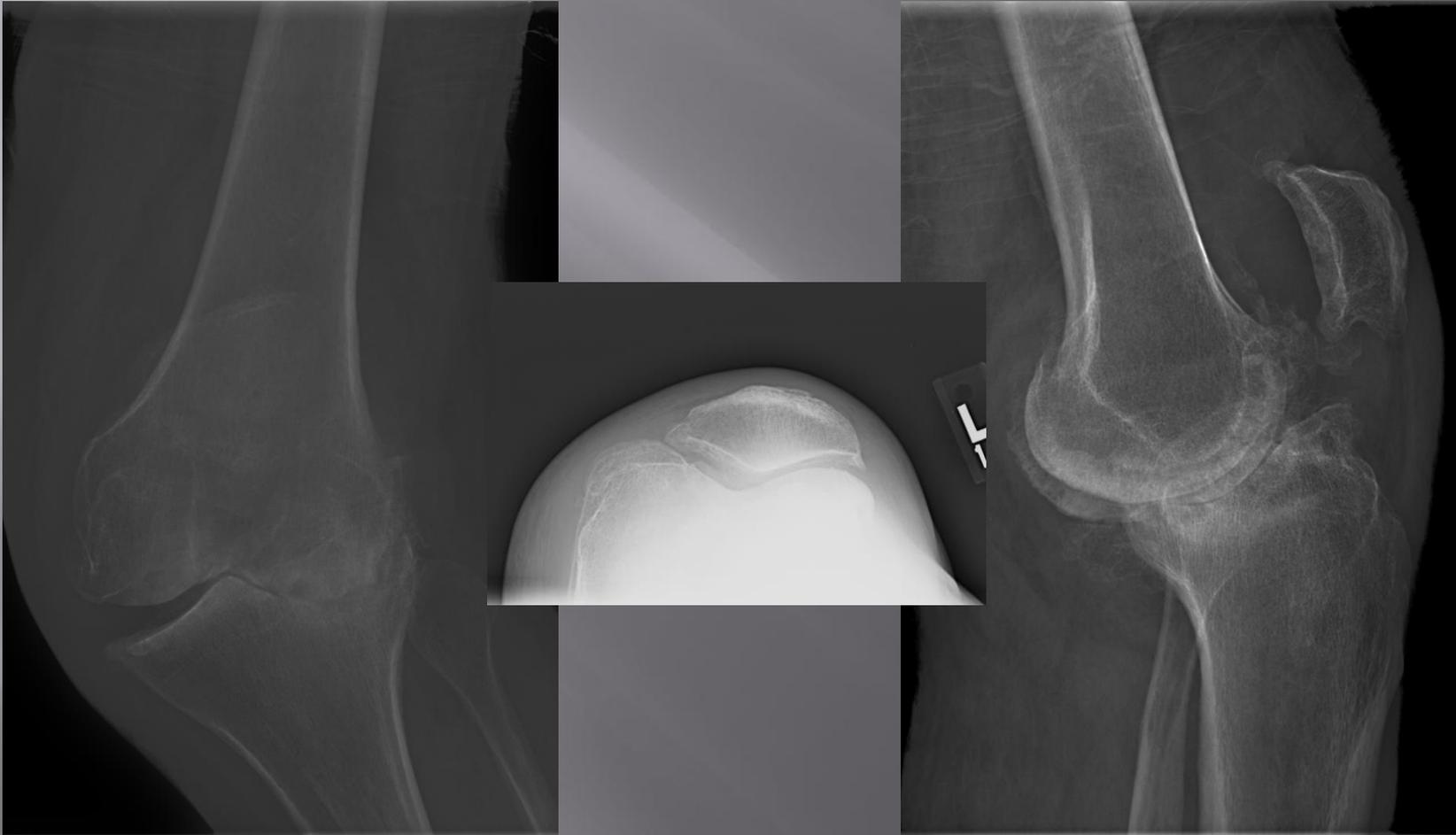
Soft tissue balancing:

4mm extra distal resection; lateral facet excision + lat release; pie crusting with popliteus release; excessive lateral facet erosion- patella not resurfaced

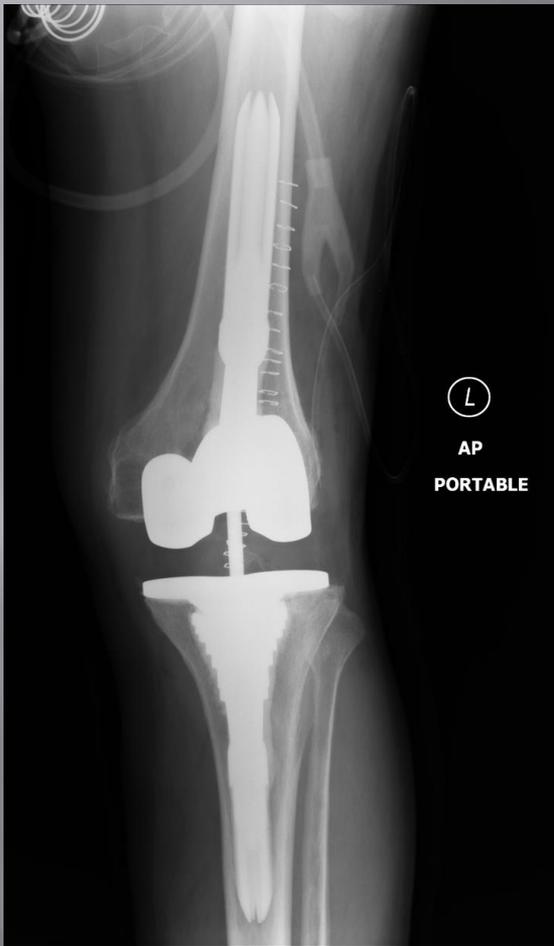


Example 12

Valgus 35- correctable; 10 recurvatum with post. subluxation



Soft tissue balancing: valgus- no lateral ligament release



Ten commandments for mal-alignments- DONOT !!

Femoral component- (increases the Q angle)

- Internal rotation
- Medial displacement
- Valgus mal-alignment
- Over sizing/ anterior displacement

tibial component- (lateralizes tibial tubercle)

- Internal rotation
- Medial displacement
- Valgus mal-alignment (increases Q angle)/ Varus

Patellar component-

- Under / Over resection of patella (tightens lat. retinaculum)
- Lateralization of the patellar component (increases Q angle)
- Asymmetric resection of the patella (tightens lateral retinaculum)

AAHKS Survey 2009/10-

▣ **Approach**

- Median parapatellar- 71%
- Mid-vastus- 23%
- Sub-vastus- 7%

▣ **Design**

- Posterior stabilized- 60%
- Cruciate retaining- 40%

▣ **Cement**

- All the time- 83%
- Add. 9% cement >90% of the time
 - ▣ (separate survey- 9% use un-cemented 1-9% of pts.)

▣ **Antibiotic Cement**

- Antibiotic impregnated-37%
- High risk cases-45%
- Never use it- 17%

AAHKS survey...contd

▣ **CPM Machine**

- Routine use- 58%

▣ **fixed/mobile bearing**

- Modular fixed bearing tibia- 83%
- Mobile bearing only- 13%
- Mono block tibia- 4%

▣ **Uni-compartmental**

- 1-9% of pts.....by 60% Surgeons
- 10-24%.....by 11% Surgeons
- 25-50%.....by 5% Surgeons

▣ **Drains**

- 65% routine use

AAHKS survey ..contd.

- ▣ **Patella resurfacing**
 - 76%- virtually all patients
 - 16%- 90 to 95% of patients
 - 3%- 10 to 89% of patients
 - 2%- Never resurface
- ▣ 54%- occ. Mobile bearing
- ▣ 22%- occ. metal back non-modular
- ▣ 24%- all polyethylene tibia component

Plan Carefully !!!



DEFORMITY CORRECTION IS GRADUAL
AND PROGRESSIVE



- Thank you!!!

Oklahoma City



Downtown- Oklahoma City

