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Hospital del Mar

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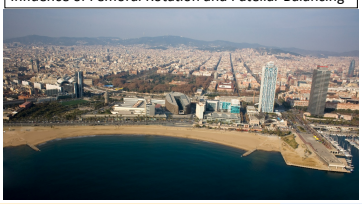
Gap Balancing in TKR
Influence of Femoral Rotation and Patellar Balancing



5th Advanced course on knee surgery
February 2nd to 7th 2014.Val d'Isère. France

Malrotation and TKA

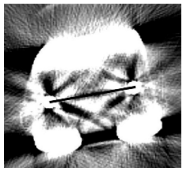
➔ Rotational malalignment of the femoral component may cause

- Luxation of the extensor mechanism
- Ligament imbalance
- Torsional stress on the tibia component
- Painful TKA
- Wear or loosening

Anouchi YS, Whiteside LA. *Clin Orthop* 1993

PF complications after TKA

- Thirty pts with isolated PF complications after TKA were compared with 20 pts with well functioning TKA
- Quantitative rotational alignment of tibial and femoral components using CT Scan measurement



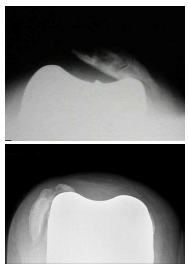
Berger et al. *CORR* 1998

PF complications after TKA

RESULTS

PF complications group

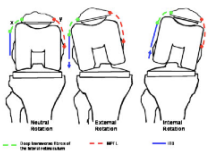
- Excessive combined internal component rotation
- Directly proportional to the severity of complications
  - 1º-3º ➔ tilt
  - 3º-8º ➔ subluxation
  - 7º-17º ➔ dislocation and late failure



Berger et al. *CORR* 1998

Malrotation and TKA

- Internal rotation shortened the MPFL significantly from 0º to 100º flexion.
- External rotation lengthened the MPFL significantly from 0º to 90º extension.



Kanishka M et al. The Effect of Femoral Component Rotation on the Extensor Retinaculum of the Knee. *JOR* 2010

External Femoral Rotation of the femoral component

- Less patellar dislocation/subluxation
- Less patellar lateral release need
- Better ligament balance in flexion

Femoral Component Alignment

- Surgeons have performed the distal femoral resection based on two methods:
  - Gap balancing (Insall's method)
  - Mesured resection technique (Hungerford's method)

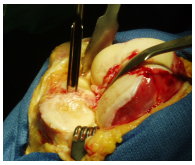


Femoral Component Alignment

The classic balanced gap approach

Philosophy →

- the knee must be balanced (equal tension in medial and lateral soft tissue structures) in extension and flexion to achieve proper kinematics and stability

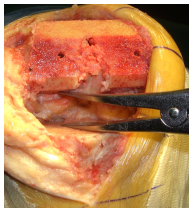


- the tibial cut is made first
- a PS model is needed

Soft Tissue tensioning

(flexion gap symmetry)

- Focuses on the of the flexion gap to determine the femoral component rotation
  - *Place a tensor in the knee in flexion and rotate the femoral cutting block so that its posterior edge is parallel to the top of the tibia*

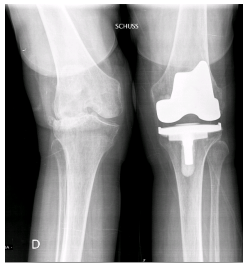


Scuderi and Insall. *Orthop Clin N Am* 1989

Soft Tissue tensioning

(flexion gap symmetry)

- Posterior condilar axis is in relative internal rotation
  - Particularly in valgus knees
- The femoral cut should be in various degrees of external rotation to this landmark

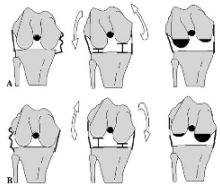


Scuderi and Insall. *Orthop Clin N Am* 1989

Consequences of the balanced gap technique

(A) Medial ligament release→ the femur will **exorotate** as a result of the enlarged medial ligament

(B) Lateral ligament release→ the femur will **endorotate** as a result of the enlarged lateral ligament.



The femur component of the prosthesis will be placed in endo or exorotation with respect to the femur as the posterior cut is parallel to the tibia cut

Femoral Component Alignment

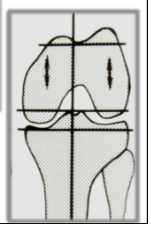
The classic measured resection technique

1. Three degrees of external rotation off the posterior condyles
2. The Transepicondylar axis (TEA)
3. Whiteside's Line (the transtrochlear axis or anteroposterior axis)

1. Three degrees of External Rotation

Neutral femoral rotational alignment and a **3º varus tibial cut** (anatomic) results in a **symmetric** flexion gap

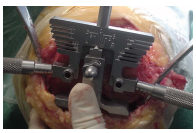
Neutral femoral rotational alignment and a **neutral (90º) tibial cut** results in an **asymmetric** flexion gap (tight medially)

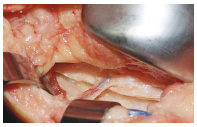


➔ **3º of external rotation of the femoral component** results in restoration of a **symmetric** flexion gap

1. Three degrees of External Rotation

- Setting the femoral component in 3º to 5º external rotation
  - improves the patellar tracking
  - reduces the need for lateral retinacular release rate
    - 6% vs 34% in neutral position



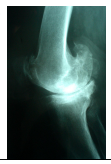


Akagi et al. Effect of rotational alignment on patellar tracking in total knee arthroplasty. *Clin Orthop* 1999

1. Three degrees of External Rotation

Using as a reference the posterior condylar axis can be difficult in cases of:

- **Condyle Dysplasia**
- **Posterior Osteofites**



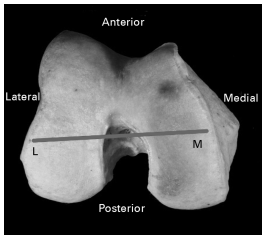
2. The Transepicondylar axis (TEA)

- Is supposed to represent the axis of the knee movement in flexion- extension

  Hollister et al. 1993

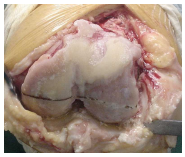
- May be the most reliable method for determining rotational alignment of the femoral component

  Olcott and Scott 1999



2. The Transepicondylar axis

- **reproducibility may be influenced by ➔**
  - the anatomical shape of epicondyles
  - soft tissue coverage (it may be the difficult to precisely define the most prominent point)



Berger et al. 1993, Arima et al. 1995

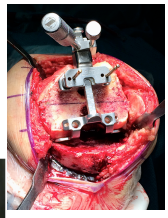
2. The Transepicondylar axis

- TEA more consistently recreate a balanced flexion space than 3º of external rotation

  Olcott and Scott 2000

- Retinacular release rate
  - 72% in valgus knees
  - 16.8% in varus knees

  Poilvache et al. 1996

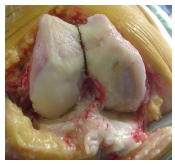


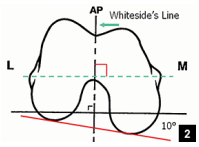
3. Whiteside's Line

(the transtrochlear axis or anteroposterior axis)

- Runs from the deepest part of the trochlear groove to the centre of the intercondylar notch
- Tends to place the femoral component 4.4º – 5.5º externally rotated relative to the TEA

Arima et al. 1995





3. Whiteside's Line

(the transtrochlear axis or anteroposte

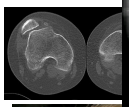
Criticisms

- Difficulty in its identification in trochlear dysplasia

Griffin et al. 2000

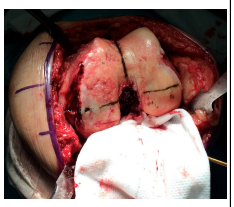
- Excessive rotation in knees with significant varus/valgus deformity

Nagamine et al. 1998



How to achive **correct** rotation

- Landmarks for femoral rotation alignment have a potential for error
- None of the methods have been shown to reproducibly and consistently give the optimal rotation

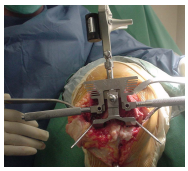


How to achive correct rotation

NAVIGATED TKA

- Femoral rotation alignment is achived by using the 3 same anatomical landmarks
  - epicondyles
  - posterior condylar axis
  - Whiteside line

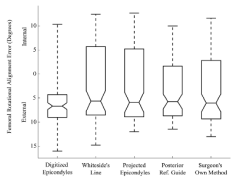
No substantial differences can be expected



Siston et al. The variability of femoral rotational alignment in total knee arthro-plasty. *J Bone Joint Surg Am* 2005

Controversy

- 11 experienced surgeons
- Four traditional and one navigated alignment techniques
- No differences between the mean errors of all techniques $p>0.11$
- High variable rotational alignment
  - from 13º int rot to 17º ext rot

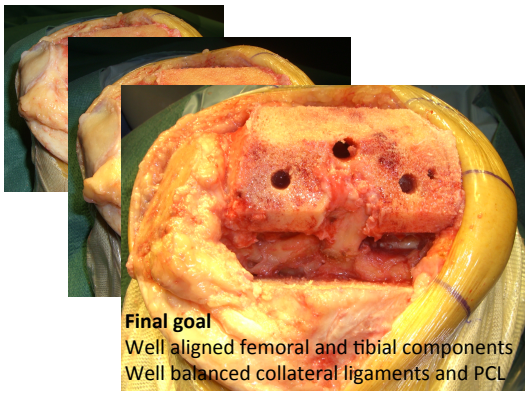


Siston et al. The variability of femoral rotational alignment in total knee arthro-plasty. *J Bone Joint Surg Am* 2005

Femoral Component Rotation

Our preferred Technique

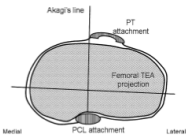
- Use bony landmarks
  - 0º to 6º (mean 3º) of external rotation relative to the posterior femoral condyles
  - Parallel to the TEA
  - Perpendicular to Whiteside's line
- Cross-checking using at least two landmarks before completing the femoral cuts

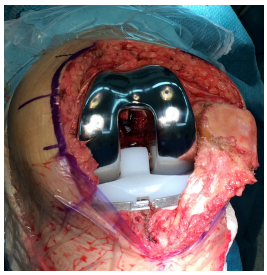


Final goal
Well aligned femoral and tibial components
Well balanced collateral ligaments and PCL

Tibial Component Rotation

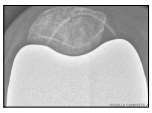
Be aware of tibial component rotation
- Relationship with ATT

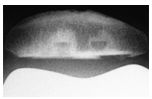


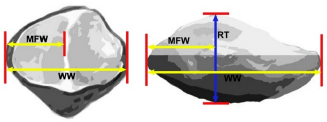


Patellar Component Position

Be aware of patellar button positioning
- Relationship with patellar crest







In Summary

- Component rotational positioning is critical and malrotation has several negative consequences
- On the femoral side there is a linear relationship between coronal deformity and Rotational alignment
- The surgeon must manage to position correctly the femoral component