

# How to manage the third space in TKA?

David Barrett

- Orthopaedic Knee Surgeon
- King Edward VIIth Hospital
- Marylebone
- London
- UK

Professor  
Orthopaedic BioEngineering  
School of Engineering Science  
University of Southampton  
UK

# What is the “third space”?

- First and second spaces – historically important flexion and extension spaces (the Third Space)
- We accept we will balance these as part of knee surgery
- Third space is patello femoral joint AND extensor hood apparatus AND soft tissue of quads AND medial AND lateral retinaculum
- Highly innervated soft tissue, highly variable movement, highly demanding for the surgeon!

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- ✓ 20% patients dissatisfied with TKR
- ✓ 45% Anterior Knee pain (AKP)



*Third space =  
Patella and  
extensor hood  
NOT just if the  
patella is  
resurfaced or  
native*

# And how do we know that?

- AKP is the same, Native = Resurfaced
- Secondary patella resurfacing does not address AKP
- Its about the whole highly innervated extensor hood, its tracking and tension and balance
- It's a function of tibio-femoral stability

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# What do we know about patello- femoral kinematics?

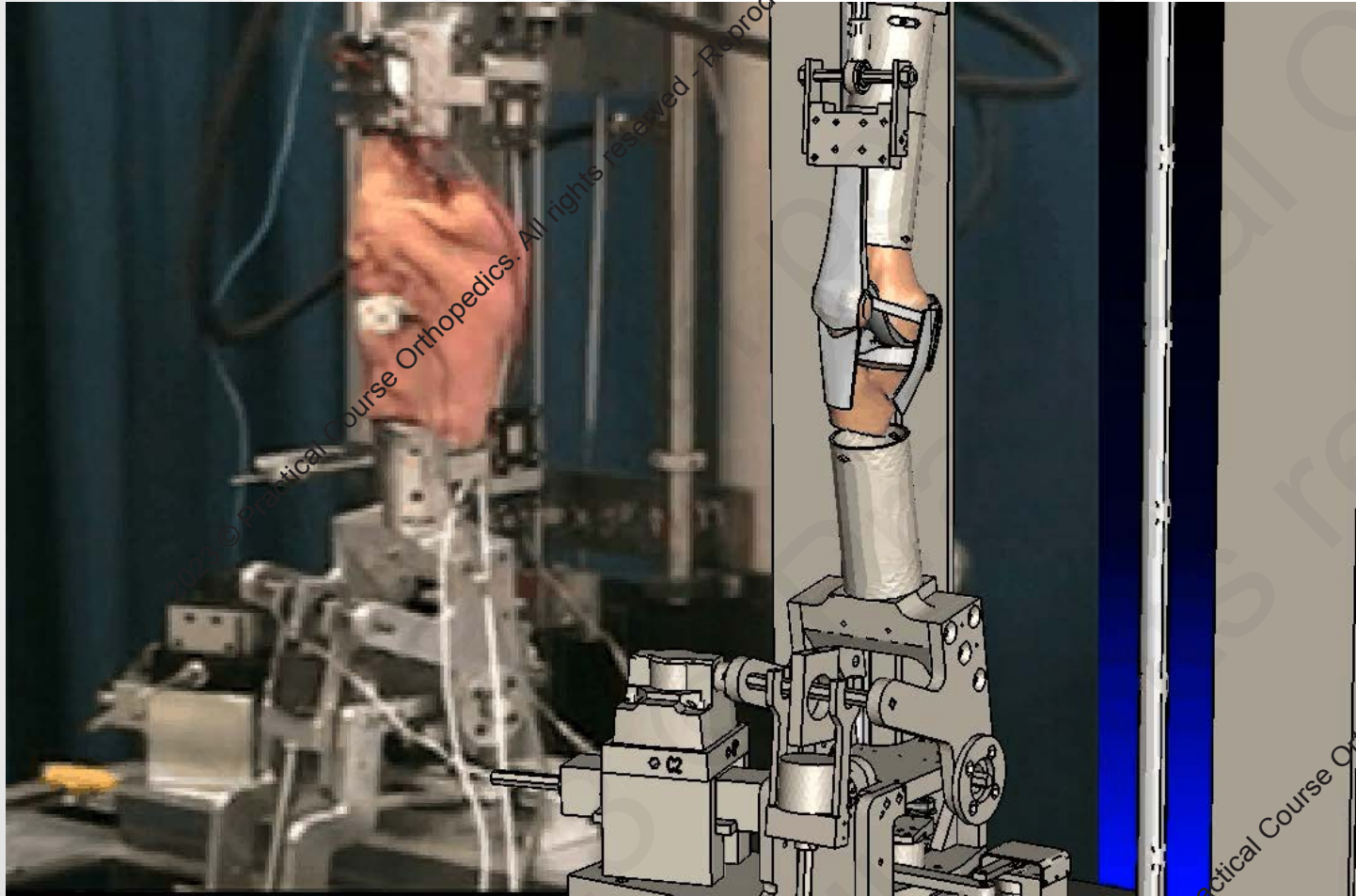
- Not much



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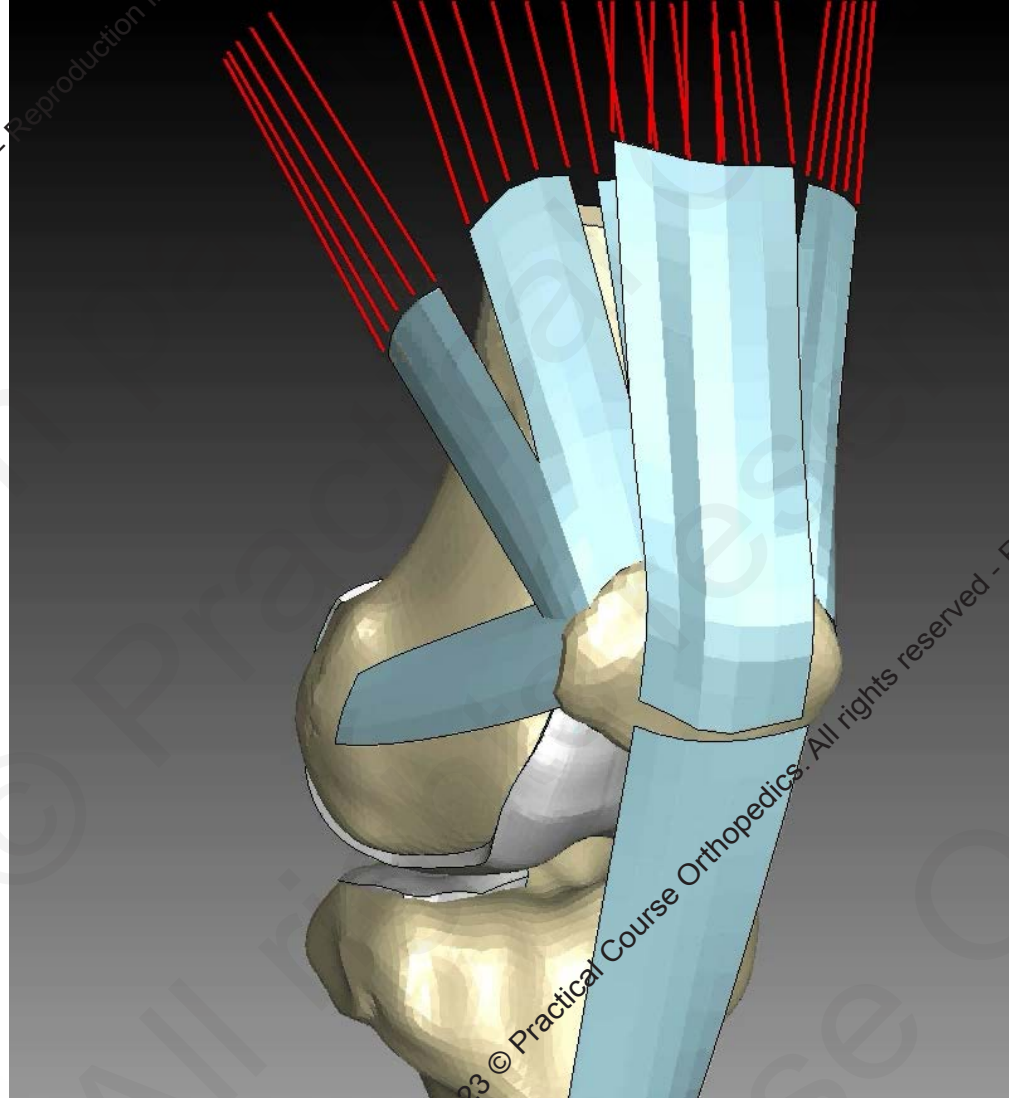
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# Dynamic FEA Model



*Allowed rapid prediction  
of different design ideas  
on motion of the knee.  
Allows appreciation of 3  
Dimensional dynamic  
movements*

# Model for soft tissues



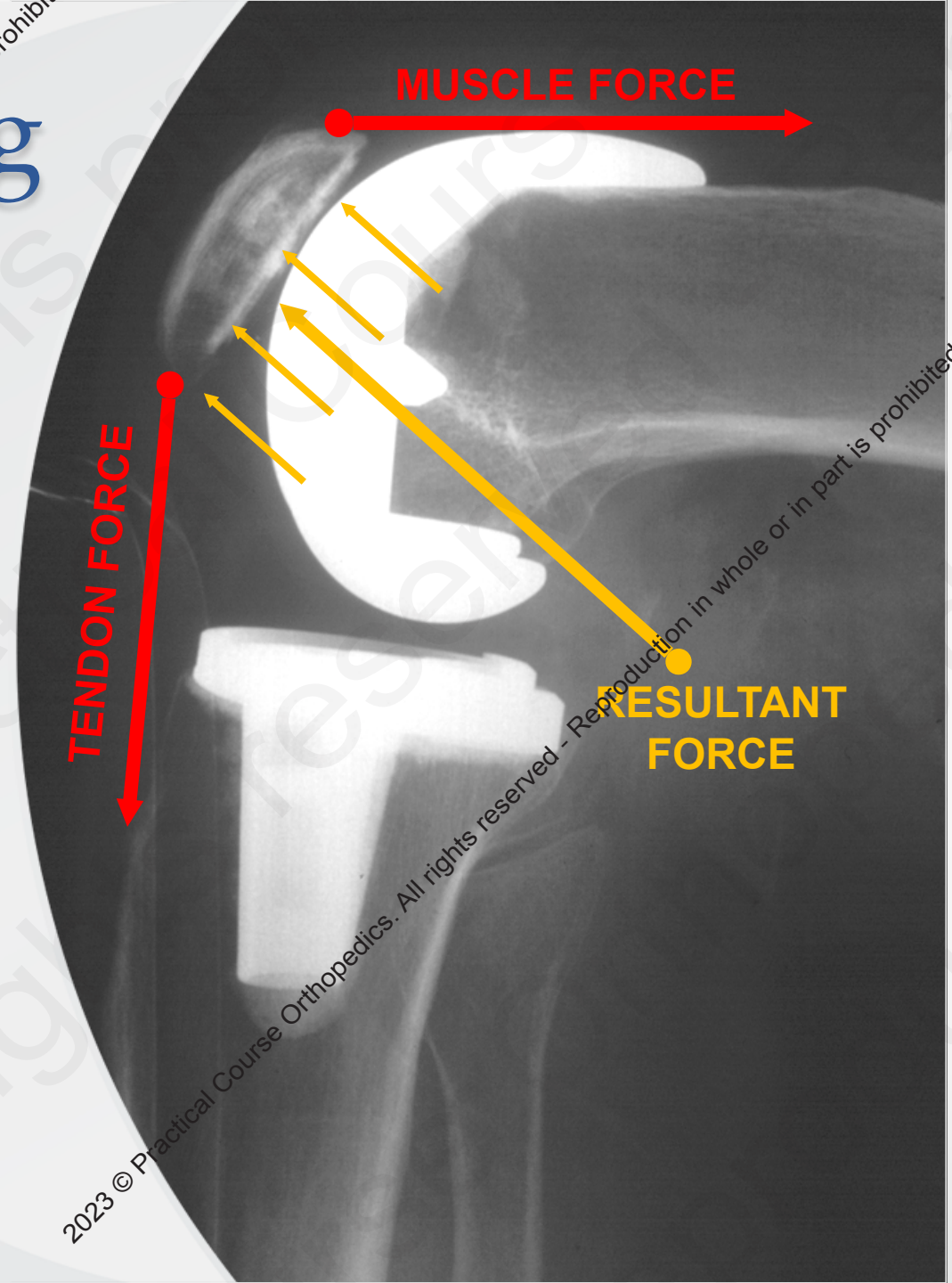
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# Tendofemoral Sharing & Patella Loading

- Moderate Knee Flexion

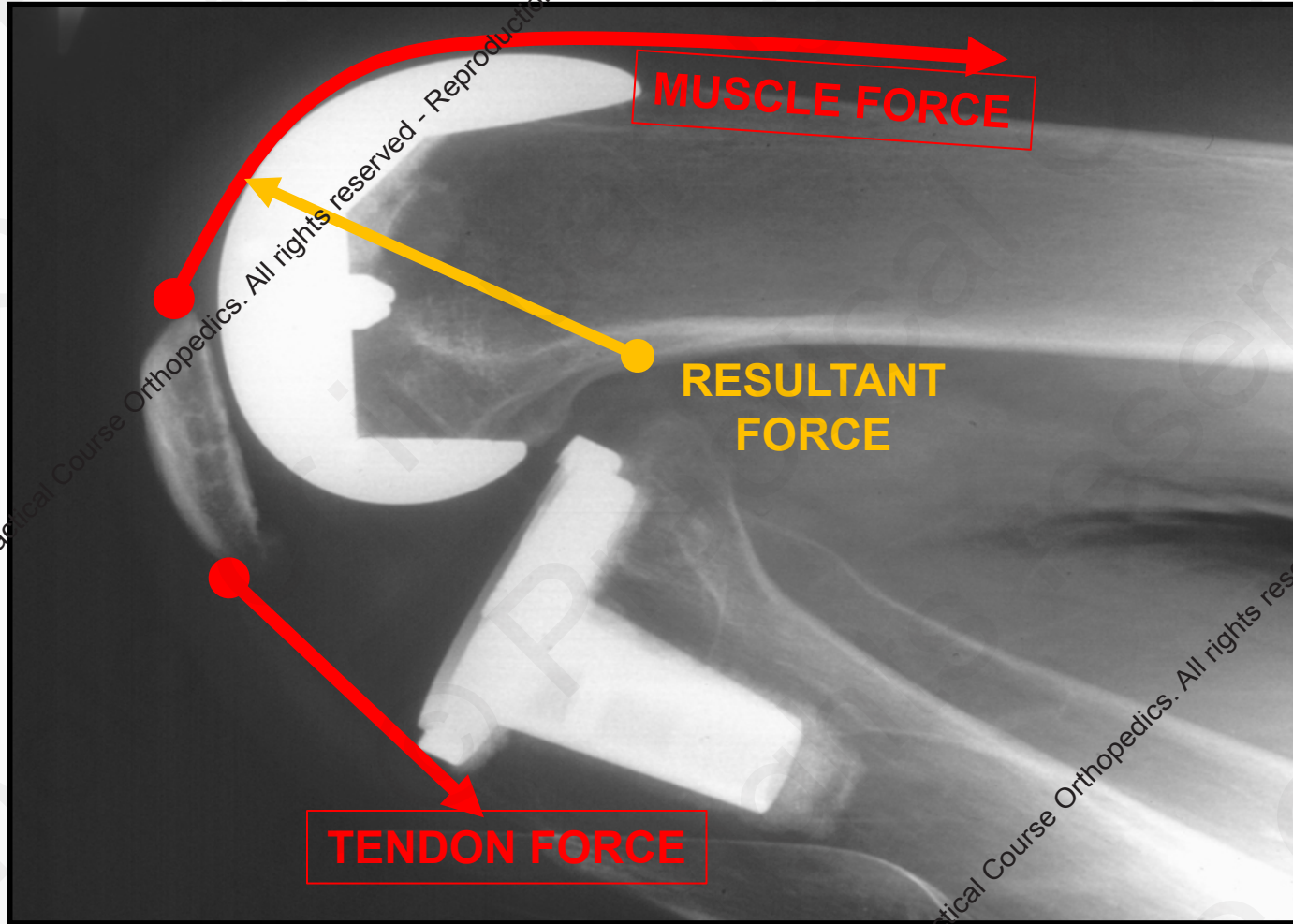


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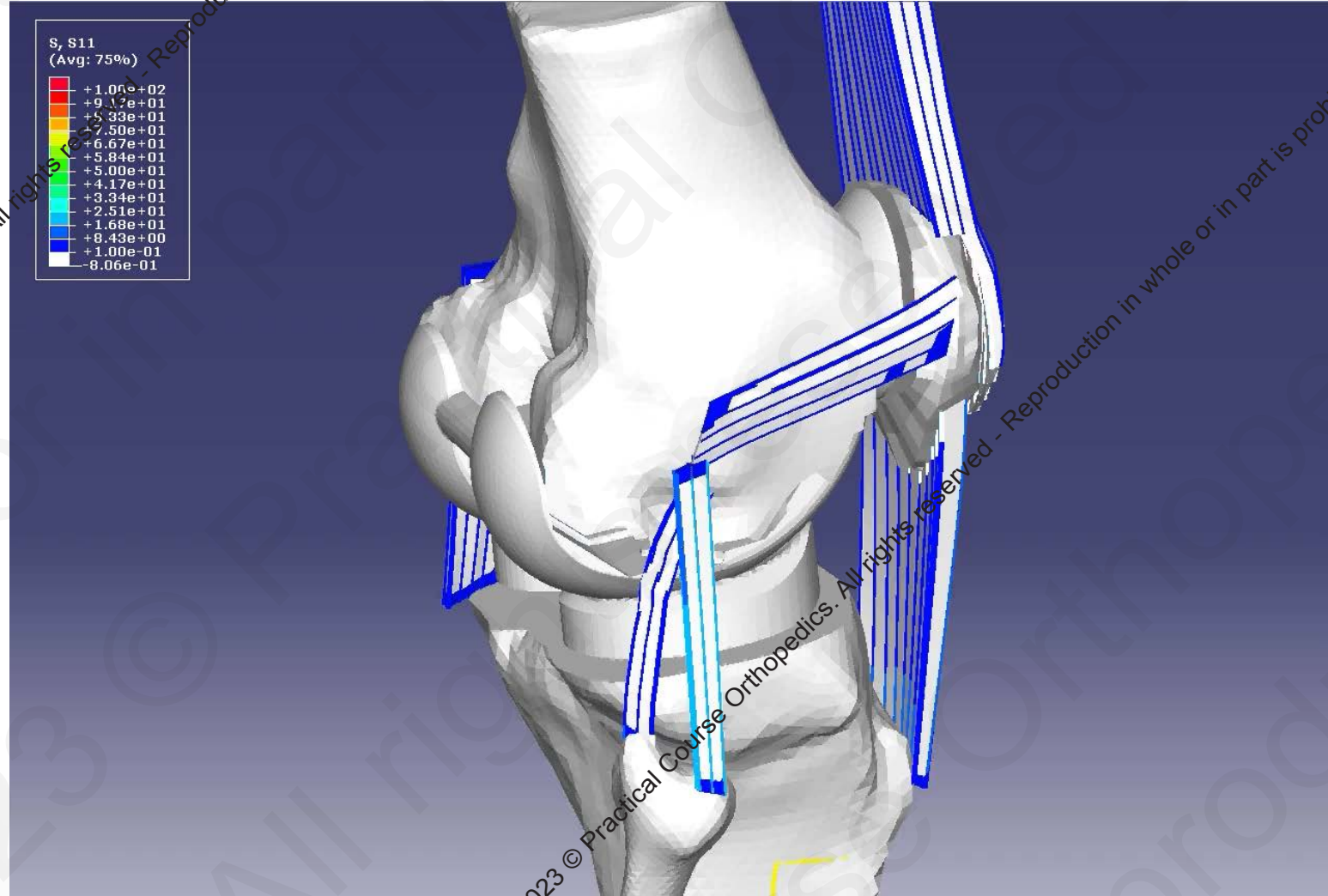


# High Demand Knee



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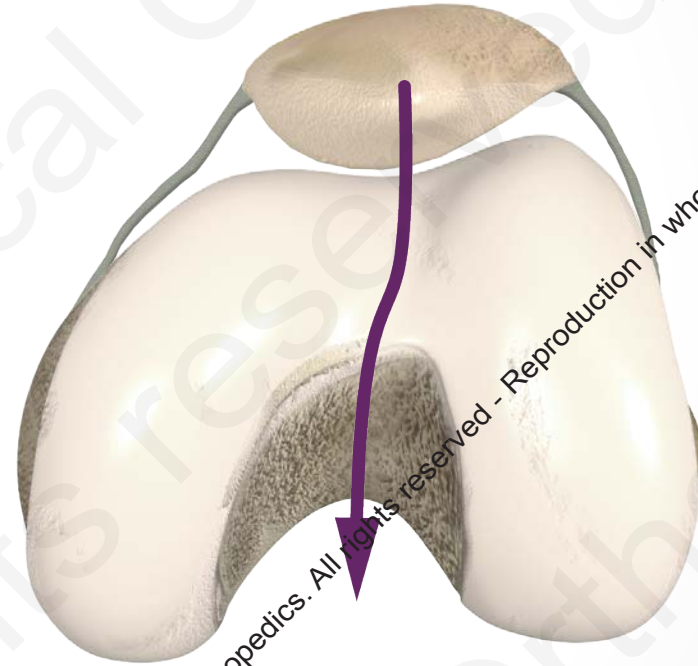
# Predictive model



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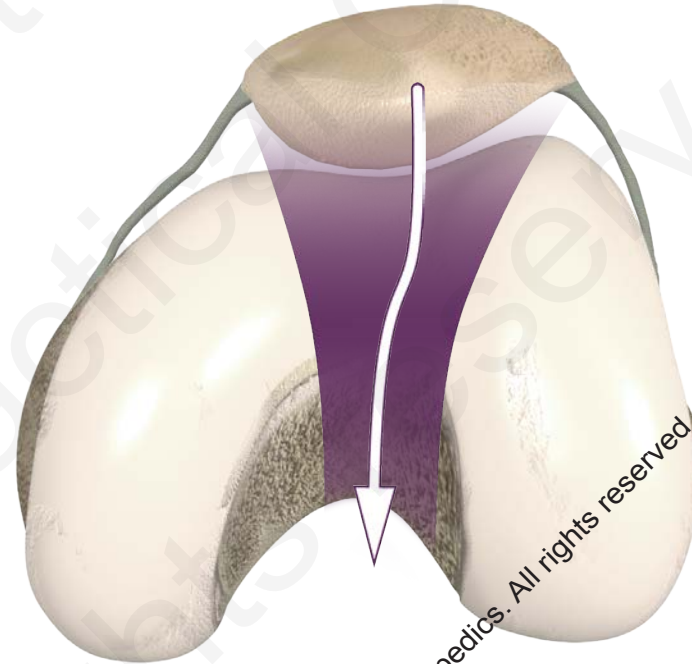
# Patello-femoral mechanics - the changing character

- Key angle 0-30 degrees
- Movement variable on surface of flat area of trochlea (unconstrained)
- Retinacular fibres guide until 30 degrees
- Patella commits to groove, becomes anatomically stable. (constrained) Retinacular fibres loose



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# Patella Tracking:



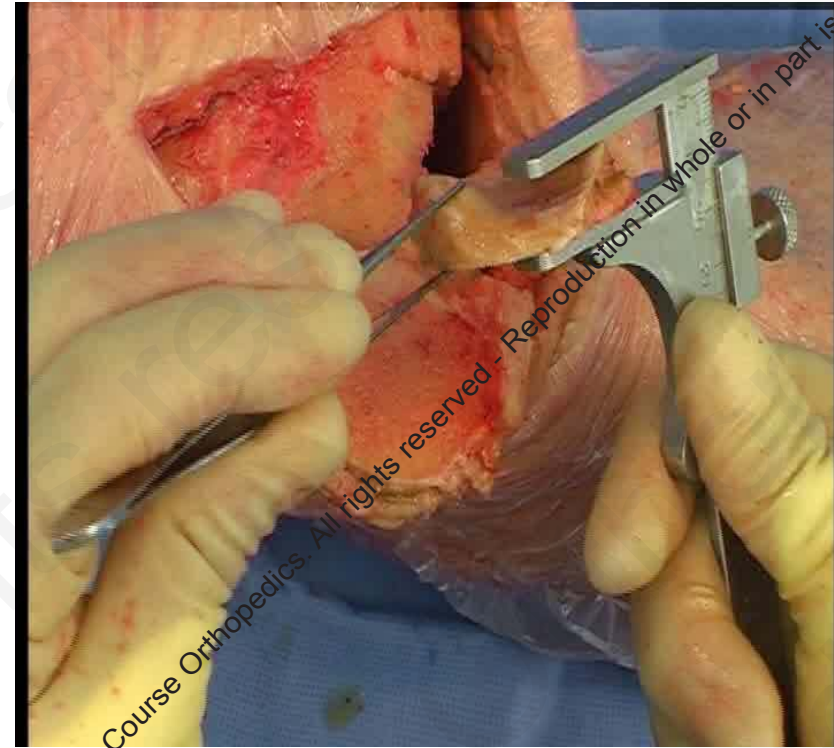
Funnel Effect

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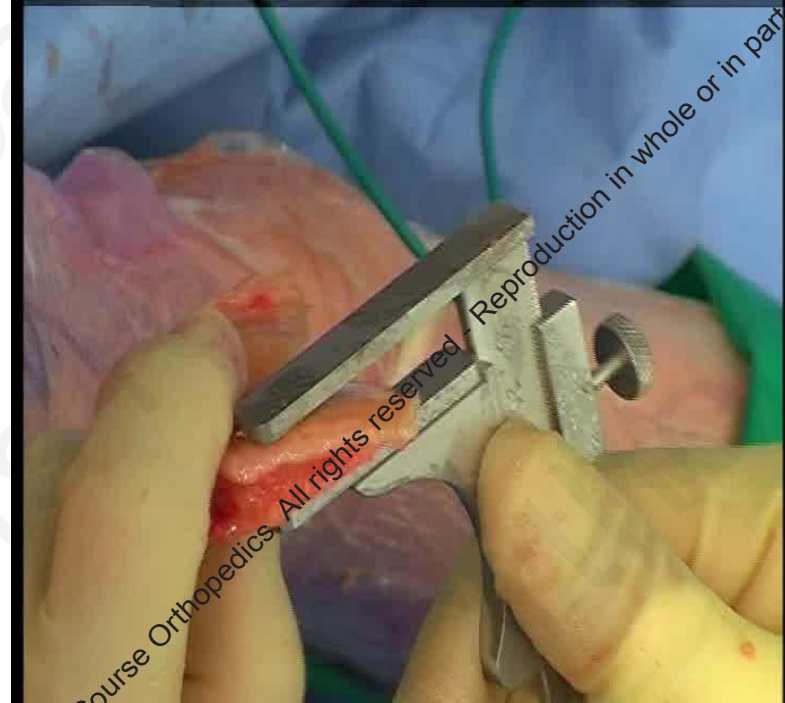
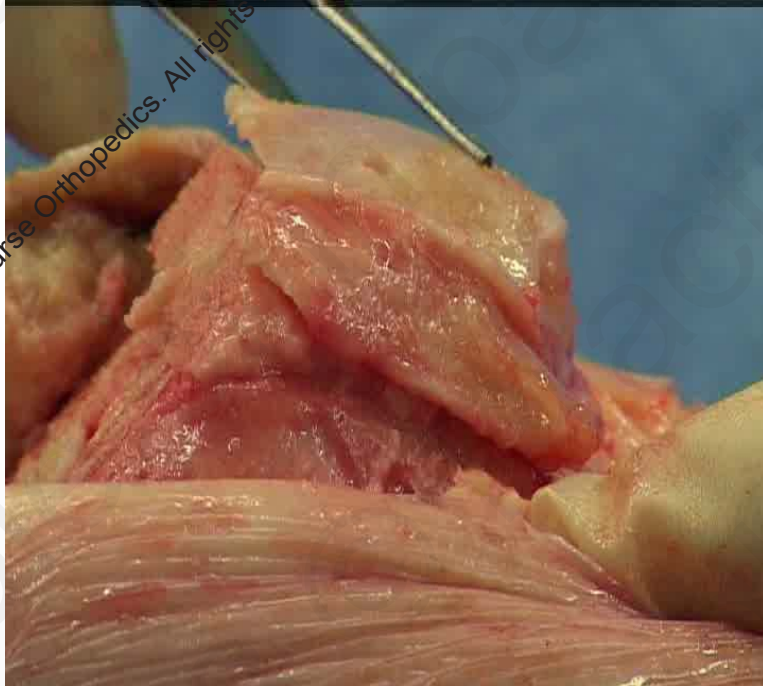
# Patella resection



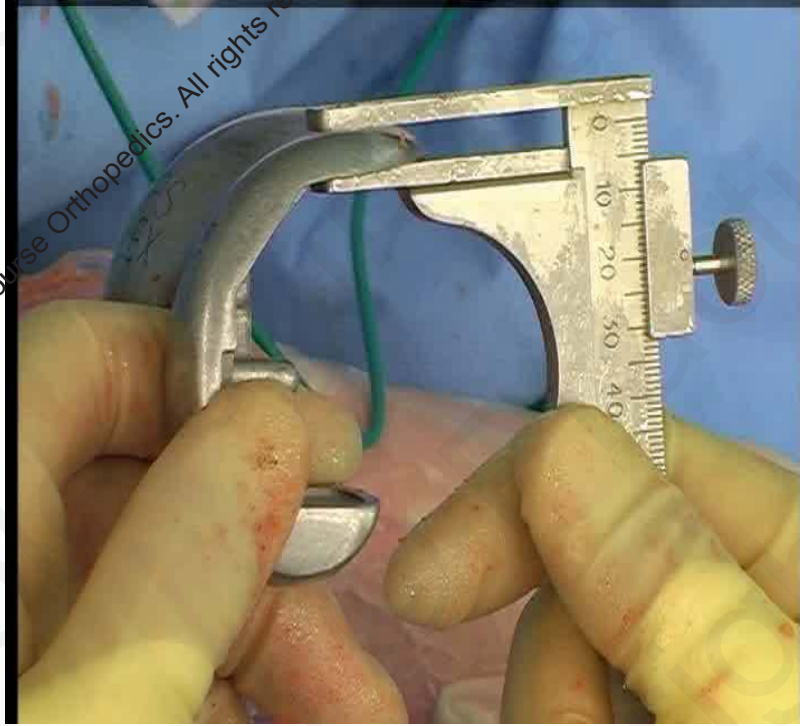
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# Balance pat/fem joint?



# Balance?



*10mm replaced by 6mm = -4mm*

*Would you accept 4mm mismatch  
in flexion/extension gap  
balancing?*

*2mm replaced by 6mm = +4mm*



# Overstuffing the joint space

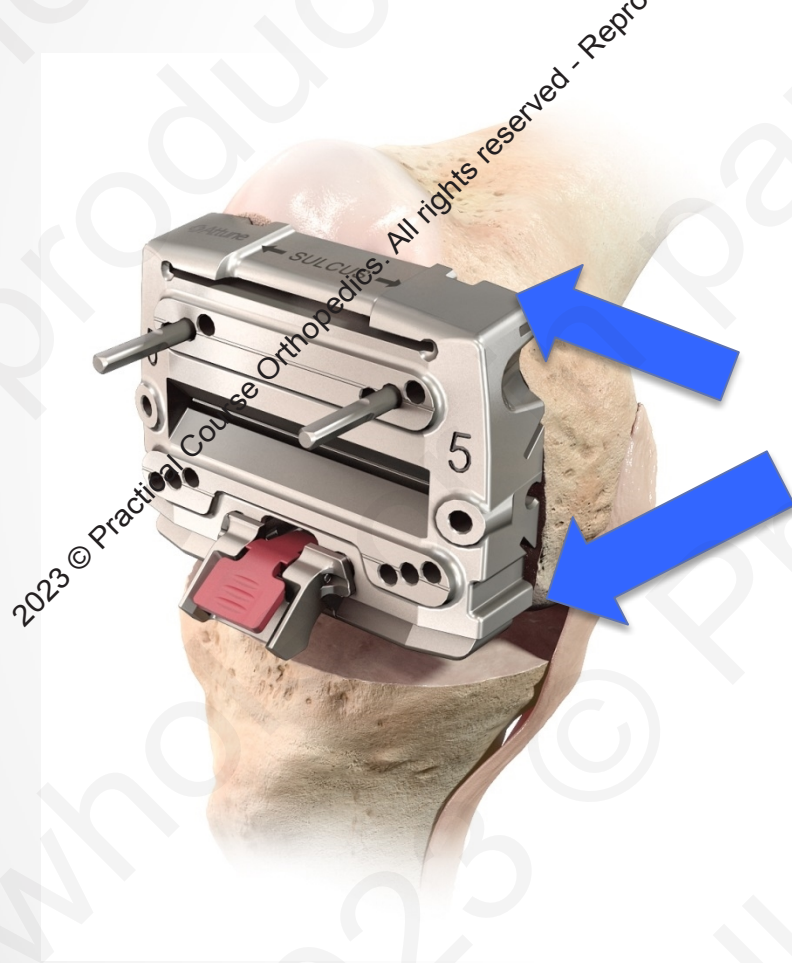
8mm farther quadrants interaction, works as 2 quadrants for pressure



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# FEMORAL PREP

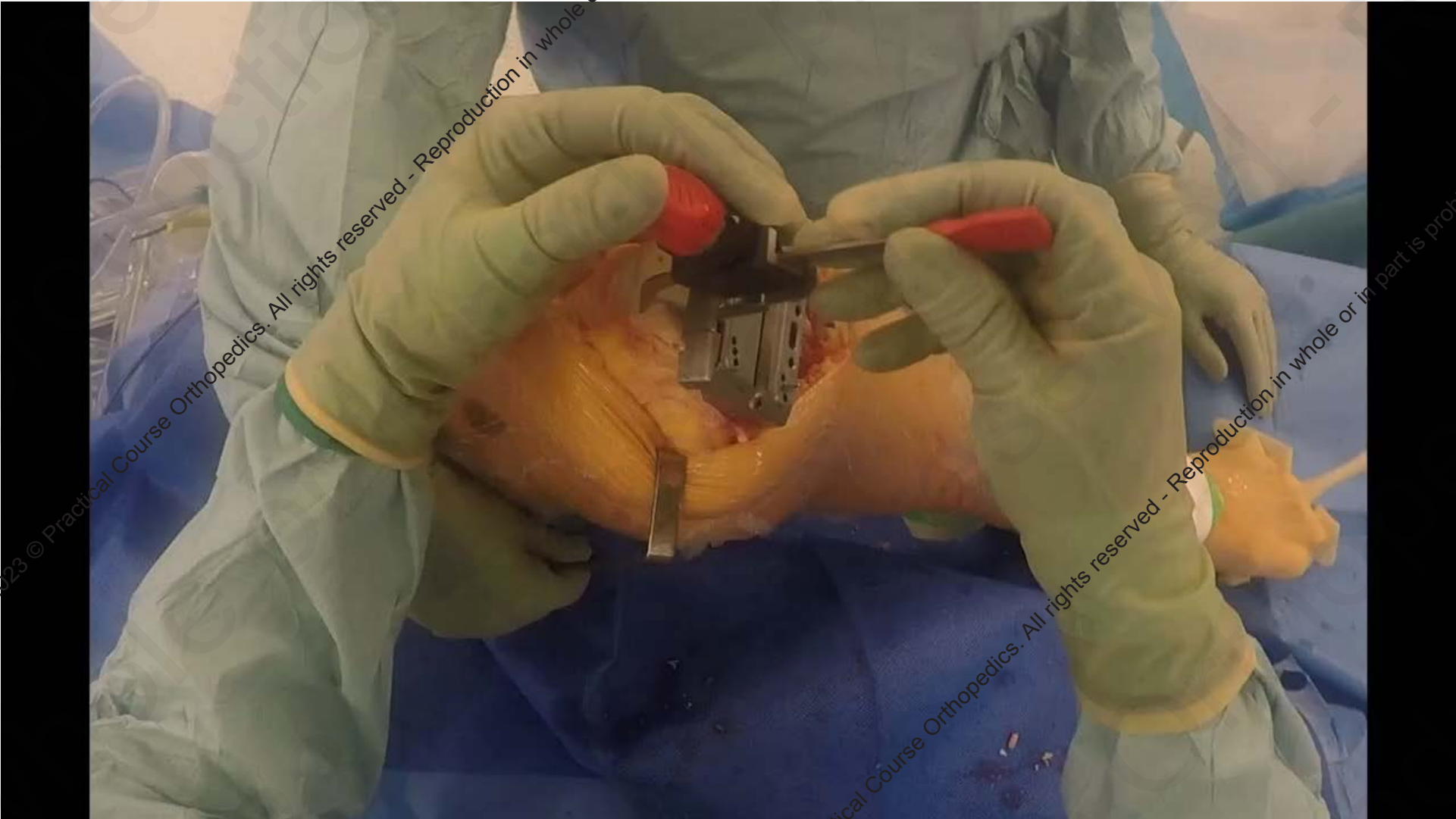


# FINE TUNING of FEMORAL POSITION



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## Summary – so far.....

- Balance the third space/position and size the femur
- Relevant in higher TKR function
- Neglected up till now
- Understand the flexibility and effect of femoral positioning
- Balance flexion/extension gap AND the third gap
- The importance of Pat/fem and Mid flexion instability



# What else are we doing wrong?

- Balancing the third space
- Femoral orientation



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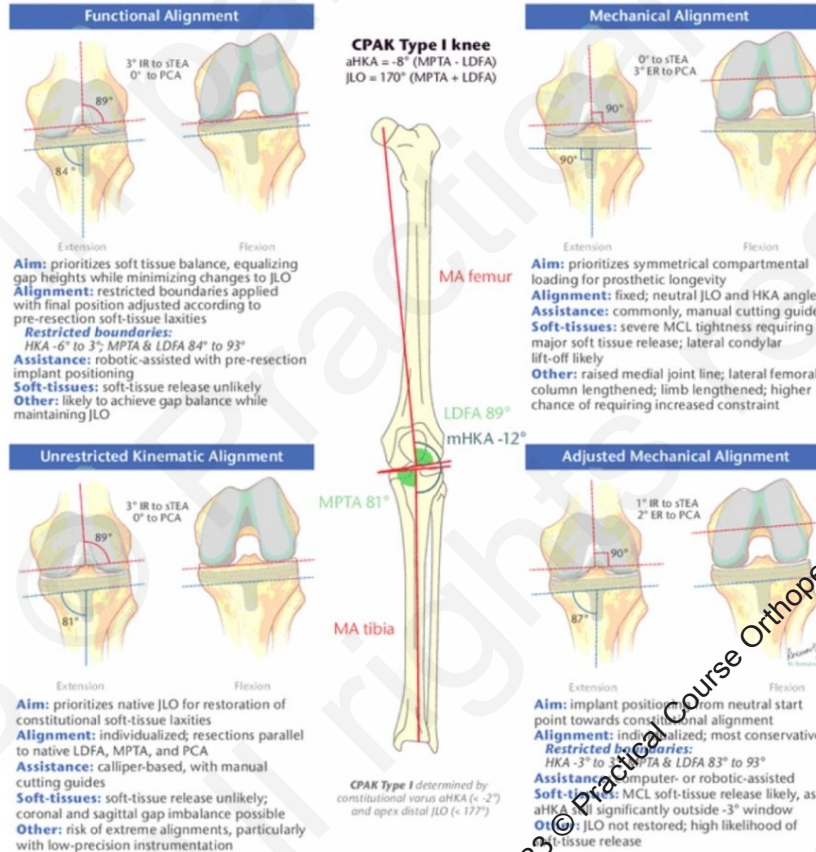
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# Variable axial alignment



**The Language of Knee Alignment**  
 UPDATED DEFINITIONS AND CONSIDERATIONS FOR REPORTING OUTCOMES  
 IN TOTAL KNEE ARTHROPLASTY  
 MacDessi SJ, Oussedik S, Abdel MP et al. *Bone Joint J.* 2023;105-B(2):101

Different alignment strategies in TKA based on a constitutional varus knee phenotype example



Central image shows extreme varus outlier to highlight differences between techniques. Lateral laxity issues have not yet been attenuated in this example. Most cases have smaller absolute differences.

aHKA, arithmetic (native) hip-knee-ankle angle; CPAK, Coronal Plane Alignment of the Knee; ER, external rotation; IR, internal rotation; JLO, joint line obliquity; LDFA, lateral distal femoral angle; MA, mechanical axis; MCL, medial collateral ligament; mHKA, mechanical hip-knee-ankle angle; MPTA, medial proximal tibial angle; PCA, posterior condylar axis; sTEA, surgical transepicondylar axis; TKA, total knee arthroplasty.

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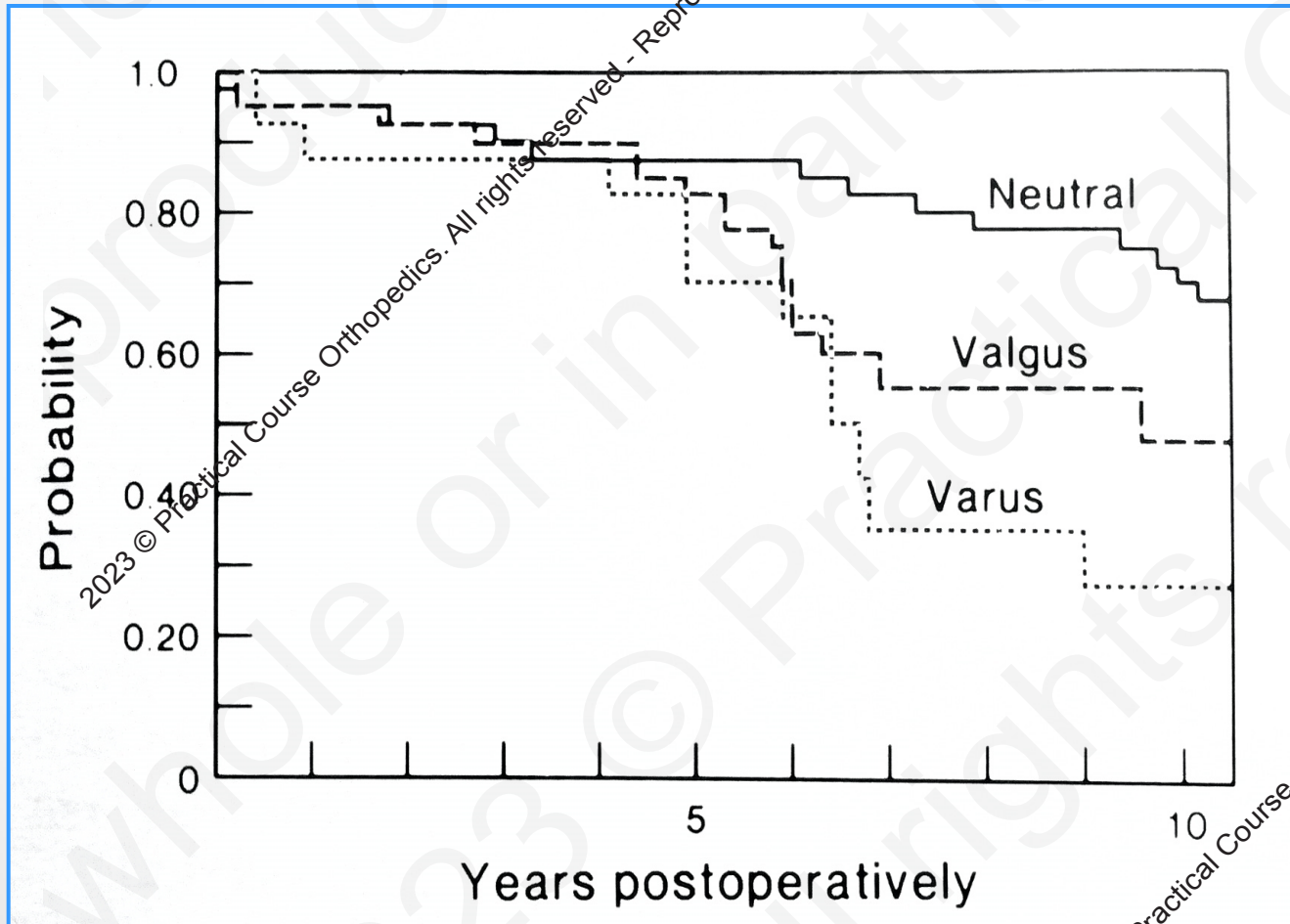
# Why is that suddenly important?

- Recent interest in different alignment last few years
  - [The Chitranjan Ranawat award: is neutral mechanical alignment normal for all patients? The concept of constitutional varus.](#)
    - Bellemans J, Colyn W, Vandenneucker H, Victor J.
      - Clin Orthop Relat Res. 2012 Jan;470(1
- Because it takes so long to develop a TKR, all TKRs today are designed for 0 degrees mechanical axis +/- 3 degrees

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# Limb malalignment & TKA survival



*Lewallen DG*

*JBJS 66A, 1984*

*Post arthroplasty alignment*

*Neutral  $0^{\circ} \pm 4^{\circ}$*

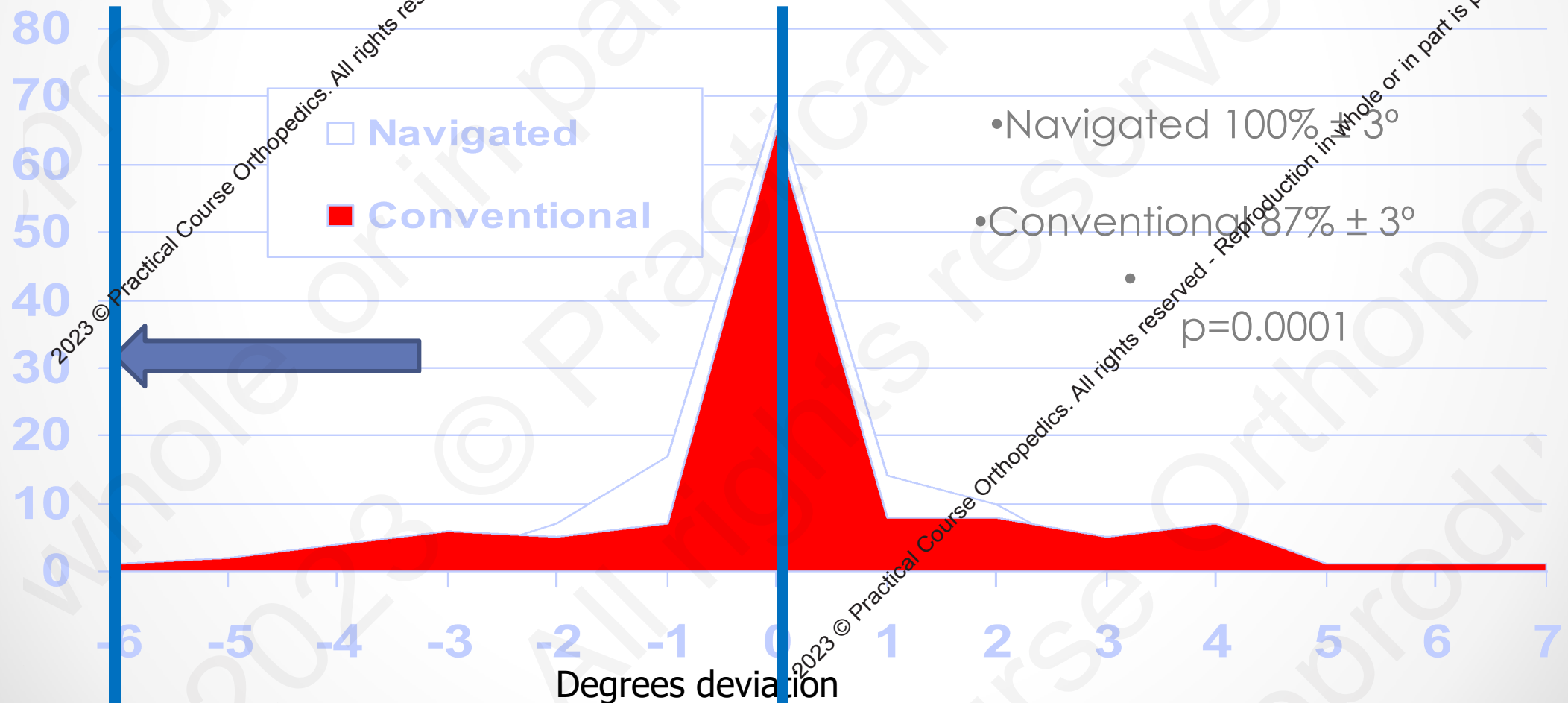
*Valgus knees  $\geq 5^{\circ}$*

*Varus knees  $\geq 5^{\circ}$*



# New Alignment

## Mechanical Axis - Sparmann JBJS 2003



# What affect does altered femoral alignment have on the third space?

Q angle 3 degrees

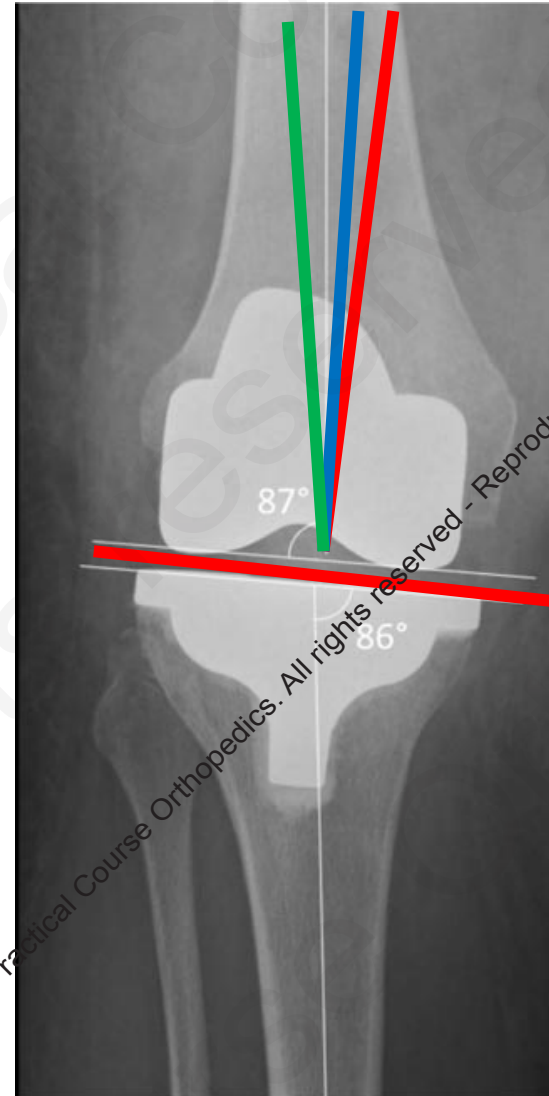
Every single TKR on the market has been designed for 0 degrees mechanical alignment

Tibia at max 6 degrees varus (restricted kinematic)

Resulting Q angle is -3 degrees

Desired Q angle +3 degrees

6 degrees of patella maltracking.....



# Data?

- Alignment philosophy influences trochlea recreation in total knee arthroplasty: a comparative study using image-based robotic technology
- Jobe Shatrov<sup>1,2</sup> · Benoit Coulin<sup>1</sup> · Cécile Batailler<sup>1</sup> · Elvire Servien<sup>1</sup> · Bill Walter<sup>3,4</sup> · Sebastien Lustig<sup>1</sup>
- Received: 19 August 2022
- International Orthopaedics <https://doi.org/10.1007/s00264-022-05570-3>
- Higher proportion of patella complications in those KA knees revised

# Will TKRs perform outside their design envelope?

- Remember, every available TKR designed for 0 degrees  $-/+$  3 degrees
- No new knees released that are designed for KA or restricted KA

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# Probabilistic Analysis



- What if we do this?
- How does it effect the function and movement of the implants?
- What are the probabilities that it will perform?

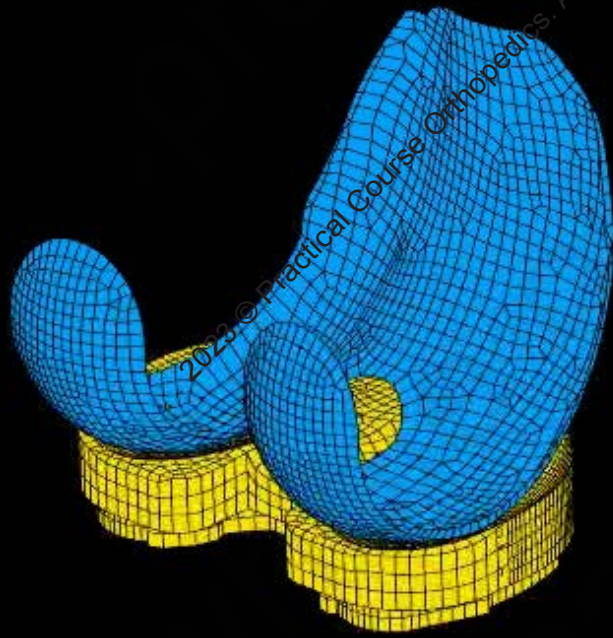


# CR knee

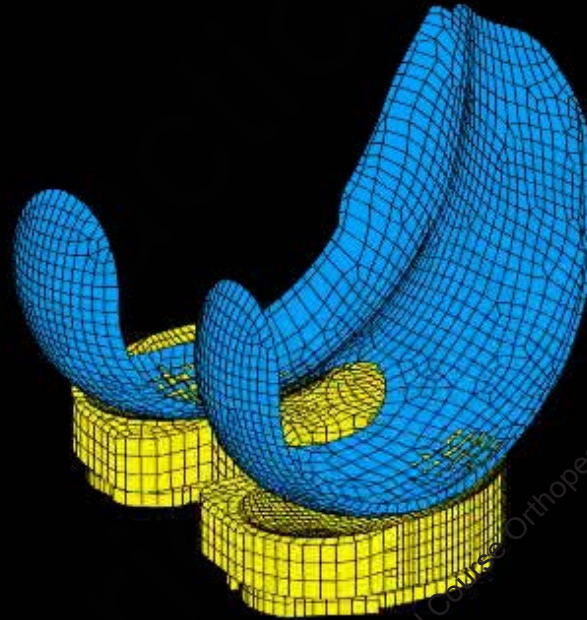
0 degrees

--6 degrees

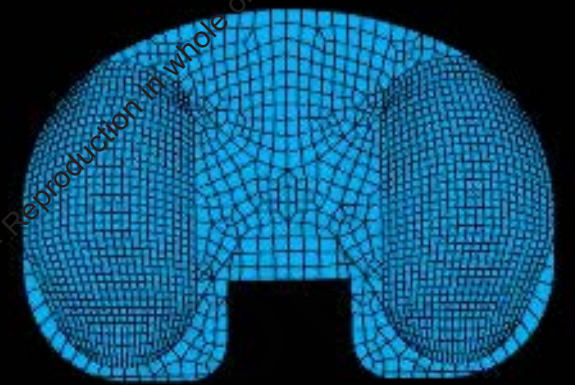
Poly pressure



STATE 1: 0



STATE 4: 30.001

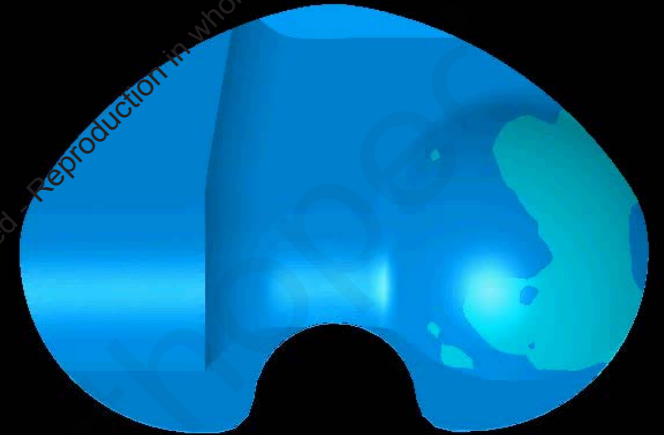
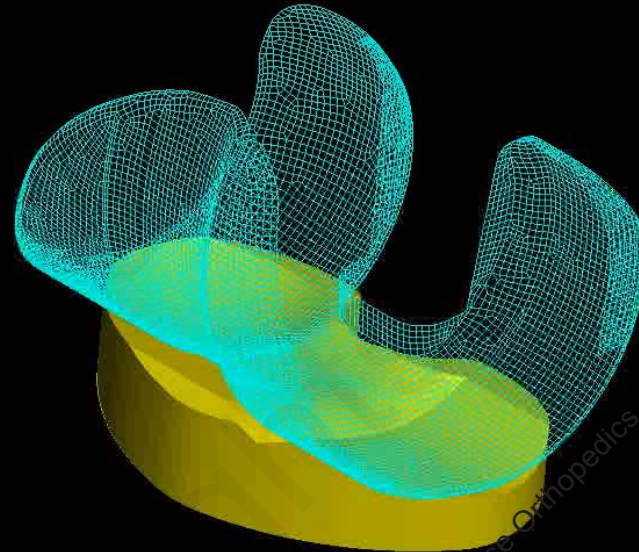
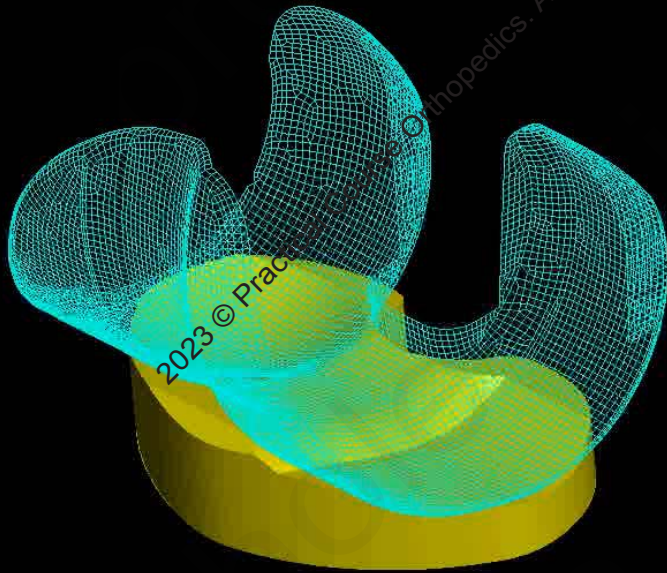


# Medial pivot knee

0 degrees

--6 degrees

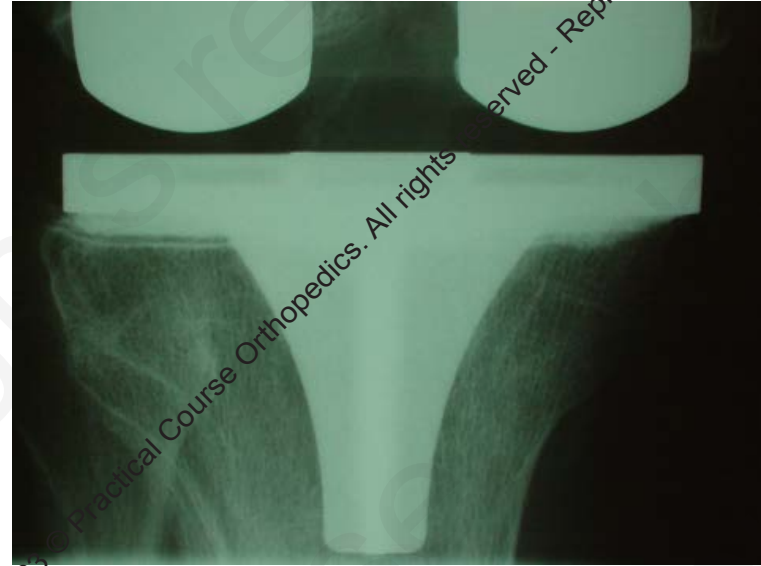
Poly pressure





# Each implant will react differently

- Check with your company before you try the sexy new Alignment!





# Summary

- The third space is functionally important
- We can balance/control the third space
- TKR design has changed to replicate trochlea function (rather than “capture the patella”)
- New alignment techniques will also affect the third space
- Not all TKRs will perform well with new alignment approaches