

# | Computer Assisted Orthopaedic Surgery |

Introduction

History

Basics

TKA

HTO

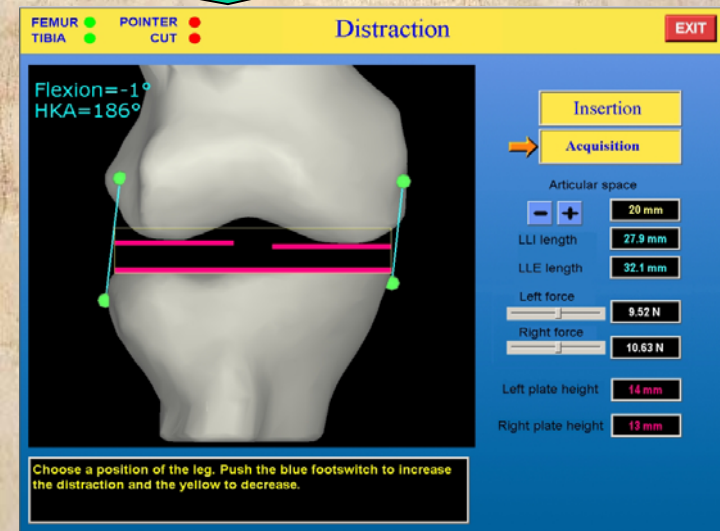
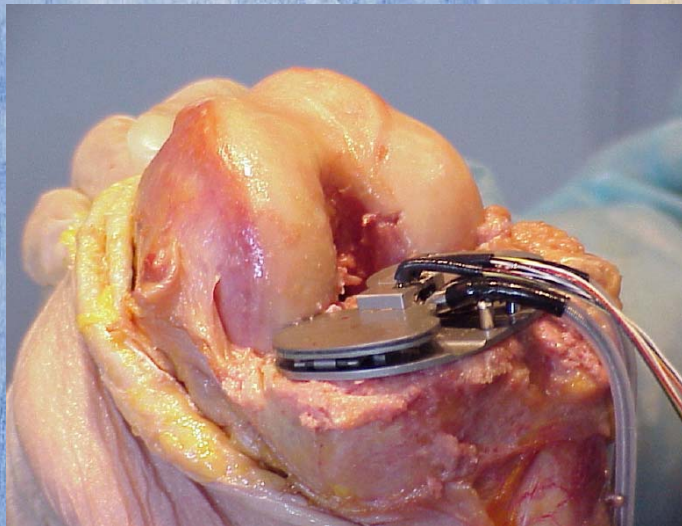
ACL

THA

Conclusion

## Decision

- Level 2 : based on dynamic per-operative data
- Loop until the threshold is reached



• Courtesy of Christophe Marmignon and Philippe Cinquin – TIMC - Grenoble

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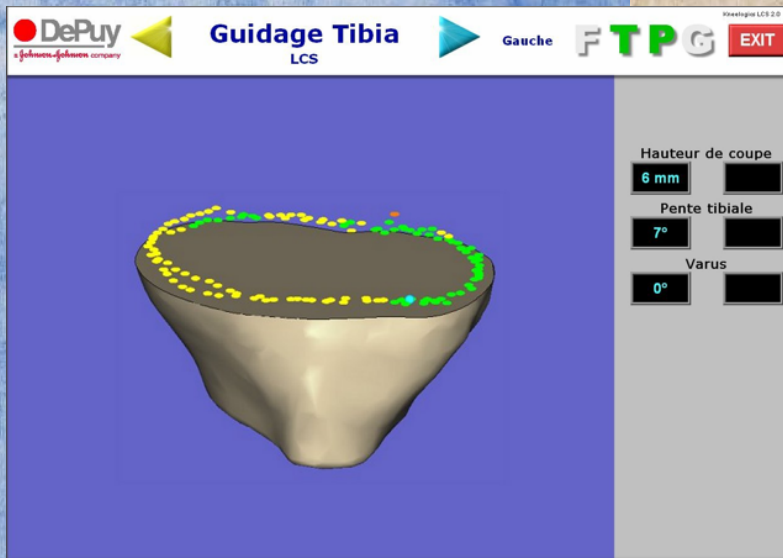
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## Decision

- **Level 3 : Integration of quality control in the decision loop**



DePuy **Guidage Tibia** LCS Gauche FTPG EXIT Stratégie LCS 2.0

Hauteur de coupe  
6 mm

Pente tibiale  
7°

Varus  
0°

Positionner le palpeur sur la coupe tibiale.  
Démarrer l'acquisition avec la pédale bleue et glisser la pointe du palpeur sur le plan tibial coupé



# Computer Assisted Orthopaedic Surgery



## • Femoral planning

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The screenshot shows the DePuy LCS Femur planning software interface. At the top, it displays the DePuy logo, 'LCS Femur planning', and 'YFTPG' with an 'EXIT' button. Below this, the software shows a 3D model of a knee joint with a femoral implant planned. The interface includes several data points: 'Int. laxity 0.4 mm', 'Ext. laxity 0.9 mm', 'Int. laxity 0.1 mm', and 'Ext. laxity 0.5 mm'. It also shows 'Int. difference 0.0 mm' and 'Ext. difference -0.0 mm'. The 'HKpA' is set to 179°. The interface is divided into 'internal' and 'external' views. On the right, there are controls for 'Implant size' (Std), 'Insert' (10), 'Flexum/Recurvatum' (4° REC), 'Medial/Lateral' (0 mm), 'Anterior/Posterior' (0 mm), 'Femoral rotation' (0°), 'Varus/Valgus' (0°), and 'Height shift' (0 mm). At the bottom, there are buttons for 'Planning femur', 'Repeat cut/r/n/tibial', 'Patella', and 'Laxities' (selected), and 'Cut heights'. A 'Planning optimization' button is also present.

Verify the proposed planning, possibly adjust the position and orientation of the implant

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## Non image based



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Active system : robots



Passive system : navigation

- Freehand
- Tools are localized in the 3D space in real time with respect to the bones

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- Robotized cutting guides



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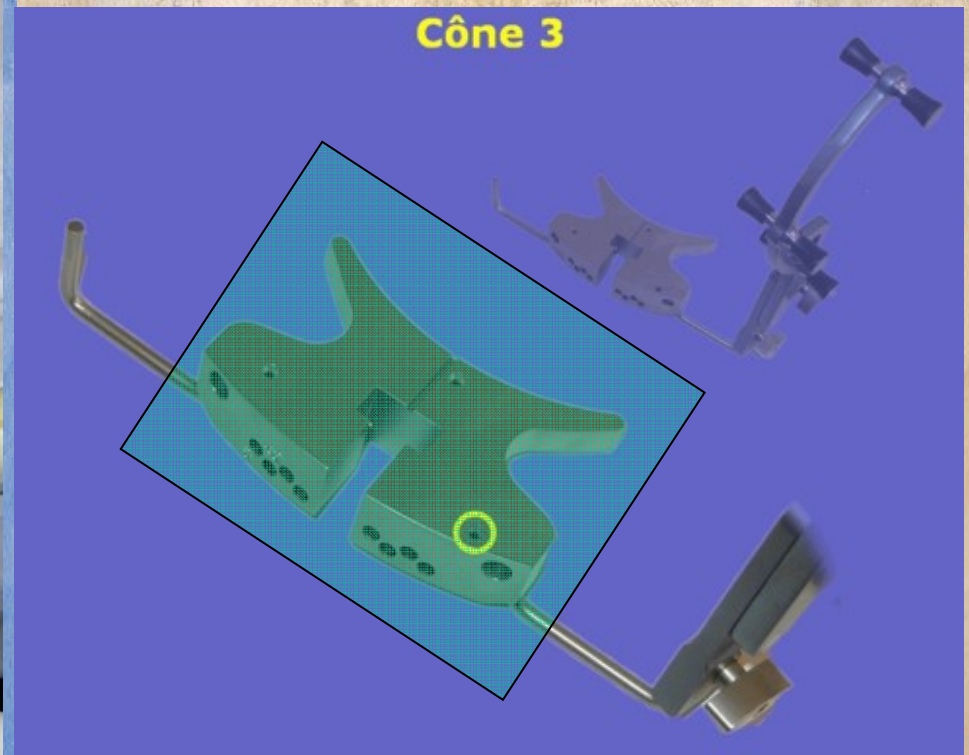
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## Navigation of cutting guides





# | Computer Assisted Orthopaedic Surgery |



## Navigation of cutting guides

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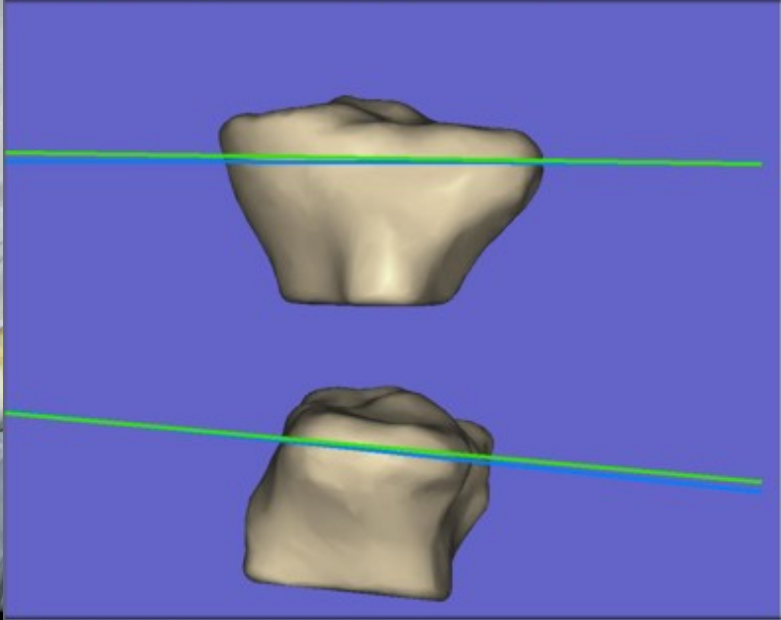
DePuy  **Guidage Tibia**  
LCS  Gauche **FTPG** 

Hauteur de coupe  
**8 mm** **7 mm**

Pente tibiale  
**7°** **6°**

Varus  
**0°** **-1°**

Aligner le guide de coupe tibial

A 3D computer-generated model of a knee joint. A green line represents the cutting plane. The model is shown from two perspectives: a top-down view and a side view. The side view shows the tibia and femur with the cutting guide positioned over the tibia.

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## Application : HTO

**7 000 cases / Year / France**

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• **Integration of bricks**

**-Hip center : Same brick**

**-Knee center : Specific solution**

**-Ankle center : Same brick**

**-3D Planning**

**Computer Assisted Surgical Protocol - CASP**

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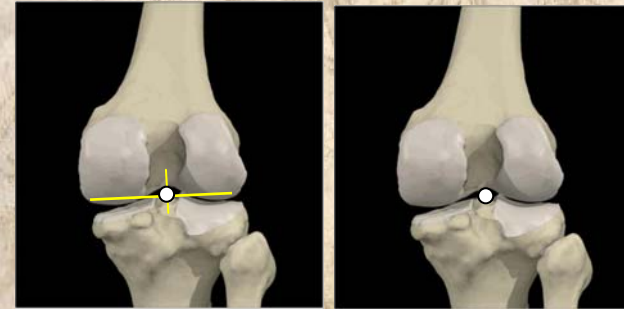
Conclusion

- **Knee center**

- **No access to the joint**

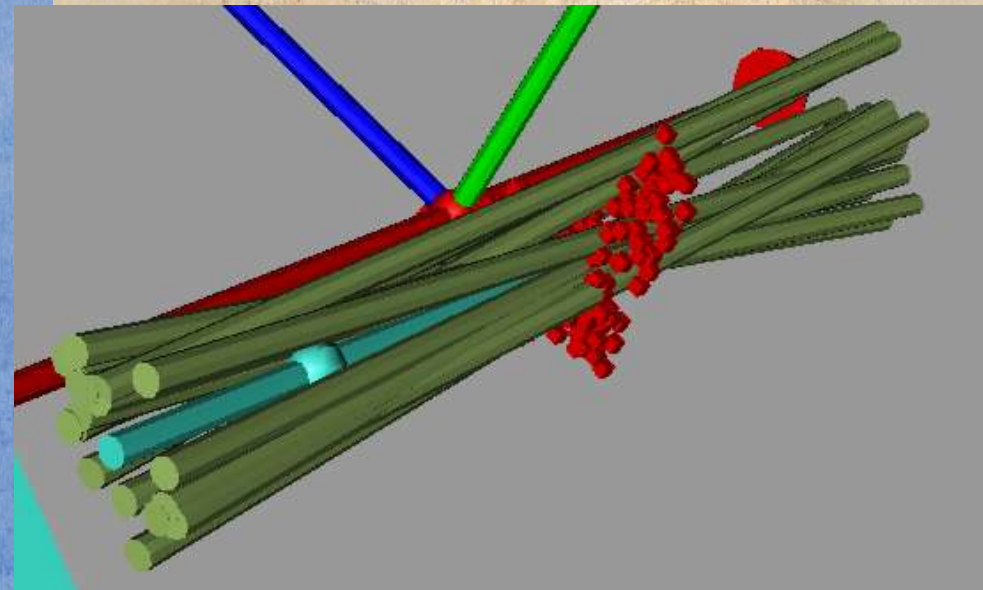
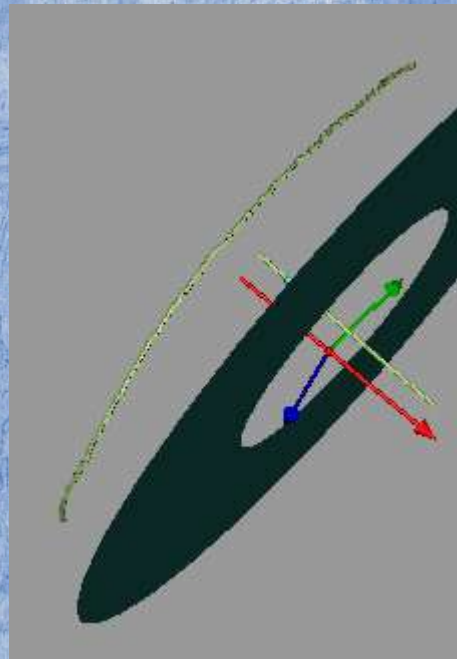
- **Mixed approach**

- **Man / Machine synergy**



*SOMMER, H.J., Determination of first and second order instant screw parameters from landmark trajectories.*

*Mechanical Design, 1990: p. 141-142.*

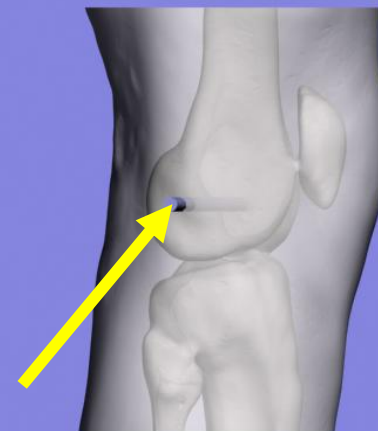
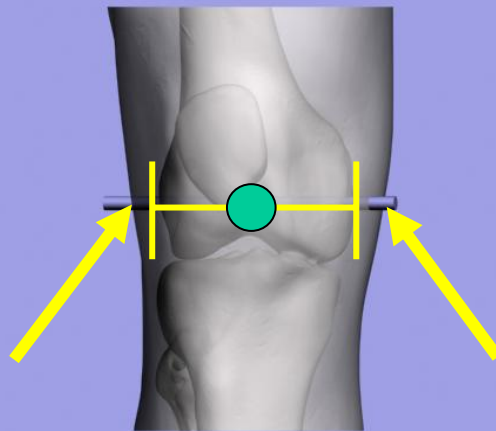
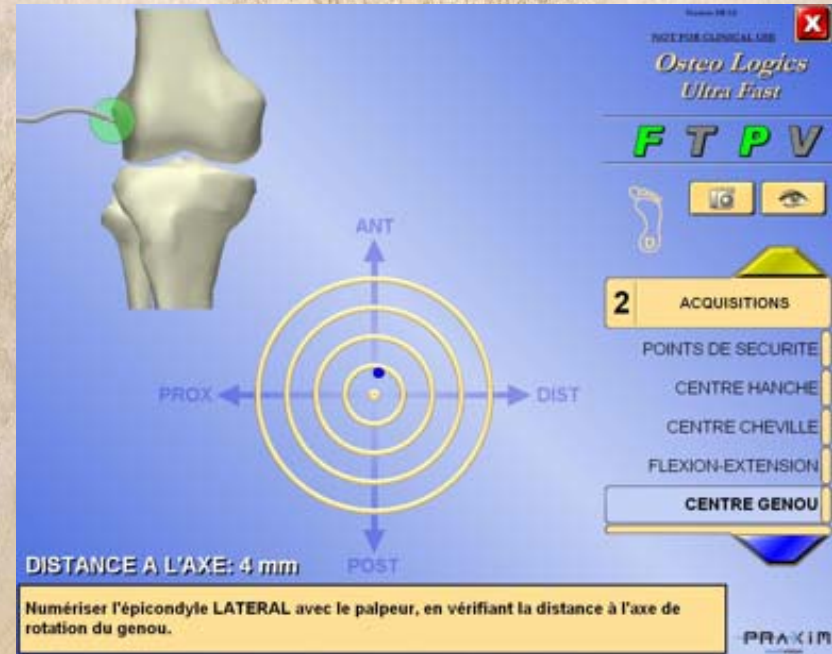


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- HTO**
- ACL
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- Conclusion

• **Knee center**

- **No access to the joint**
- **Mixed approach**
- **Man / Machine synergy**



**Expert steering**

# Computer Assisted Orthopaedic Surgery

## • Planning of the cuts: UGI

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**LOTIM** ◀ **Planification** ▶ **F T P G** **EXIT**

**Frontal View**      **Sagittal View**

**Simulation**

**PARAMETRES**

Hauteur de la coupe: **15 mm**

Angle frontal plateau tibial: **90°**

Correction frontale: **10°**

Angle sagittal plateau tibial: **90°**

Correction sagittal: **0°**

HKA frontal: **186°**      HKA sagittal: **186°**

**Views**

1 2 3  
+ - \* /  
% = ^ \$

Vérifier la proposition de planning, éventuellement ajuster la position et

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**Application : ACL**

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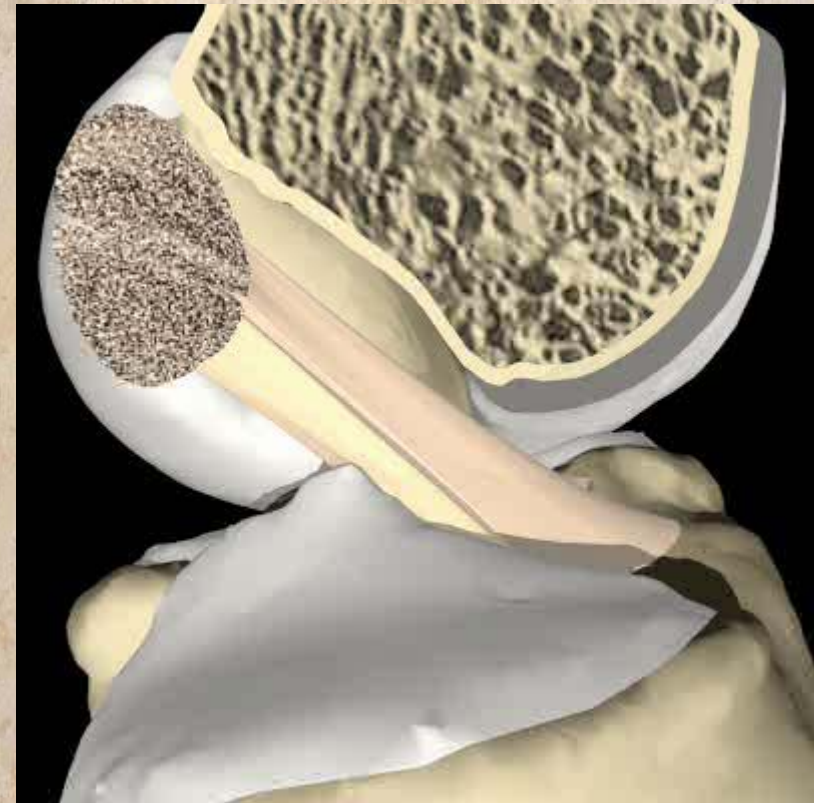
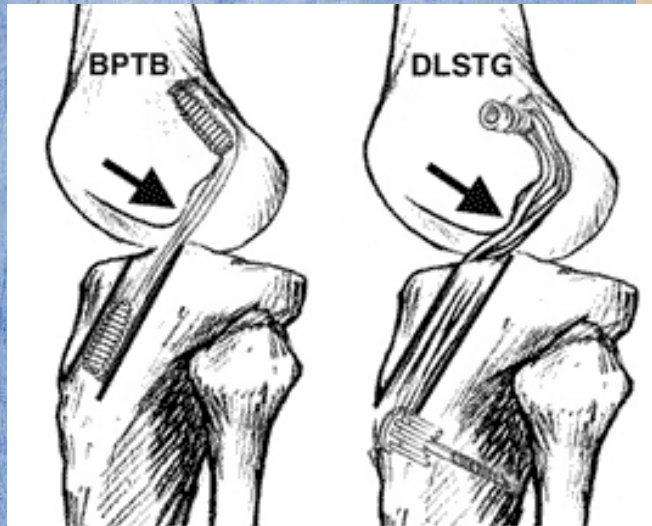
THA

Conclusion

## • Anterior Cruciate Ligament Replacement

### • The challenges

- Isometry
- Avoid impingement





# Computer Assisted Orthopaedic Surgery

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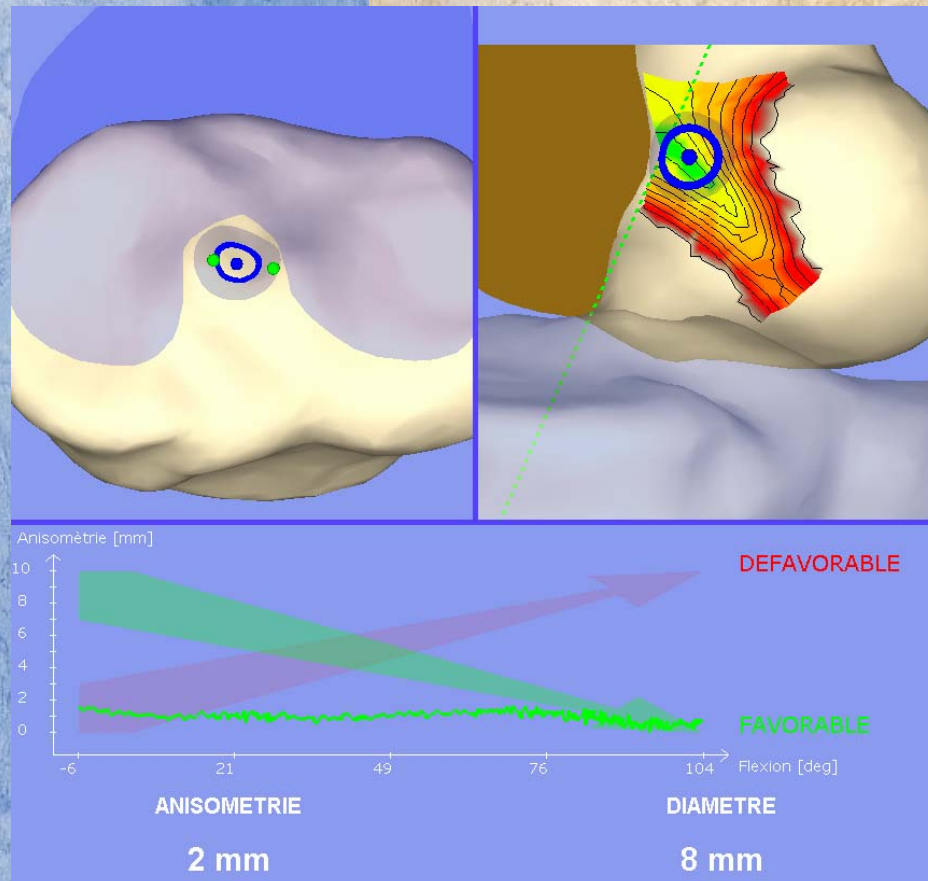
THA

Conclusion

## • Anterior Cruciate Ligament Replacement

### • Planning

- Projection of the tibial point / Femoral notch projection
- Compute the anisometry map



- For a specific tibial point choose the best location of the femoral point

# Computer Assisted Orthopaedic Surgery

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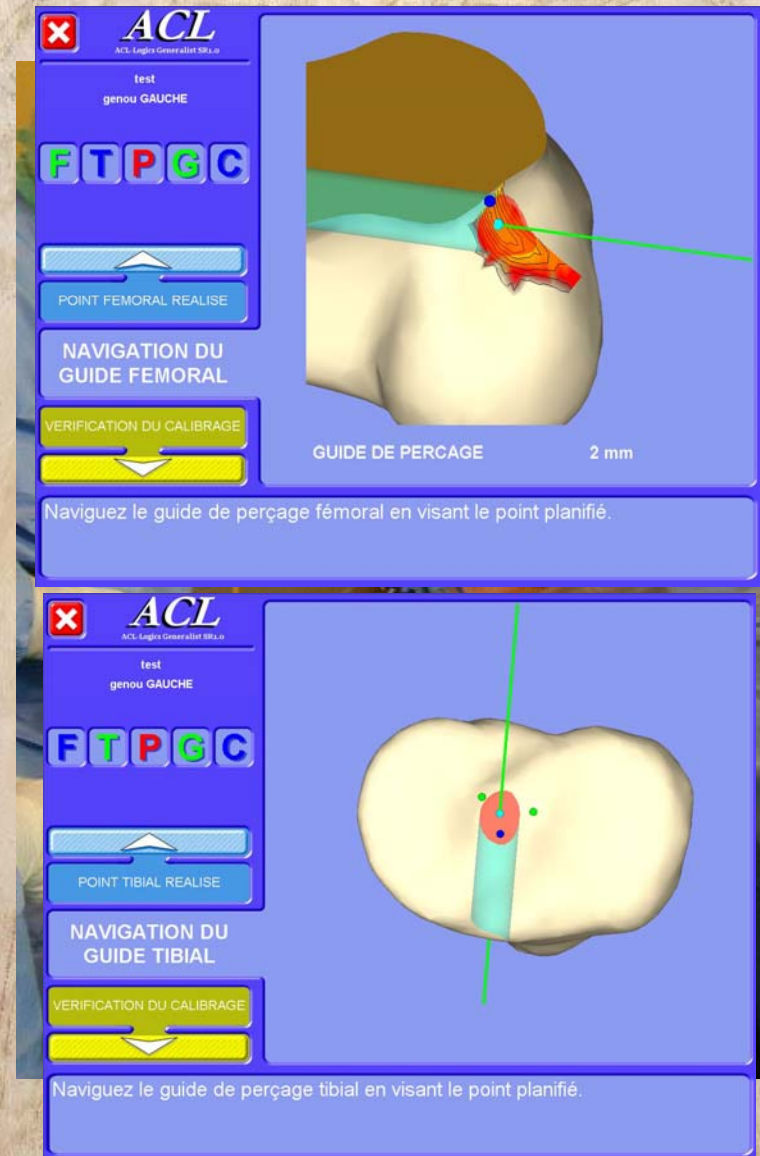
THA

Conclusion

## • Anterior Cruciate Ligament Replacement

### • Action

- Take the usual guide
- Attache a rigid body
- Perform the calibration
- Drill the tunnels with the help of the GUI



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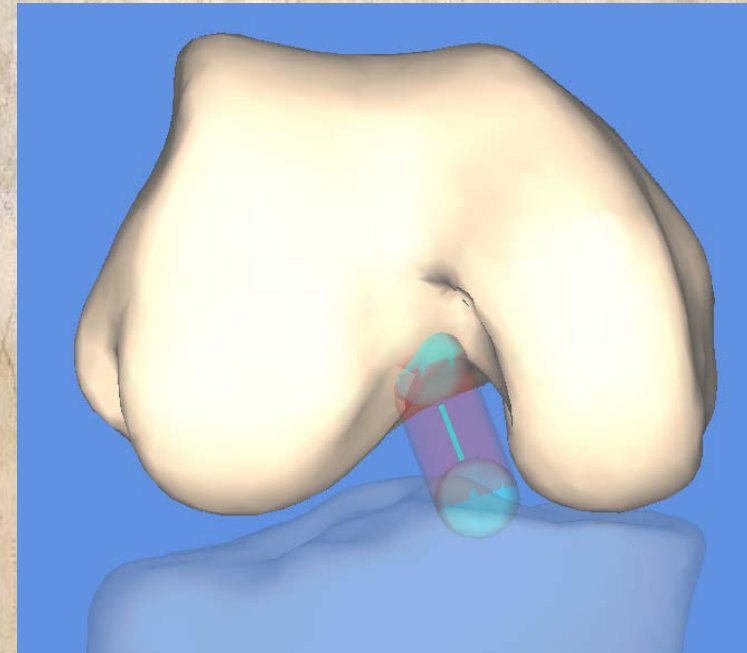
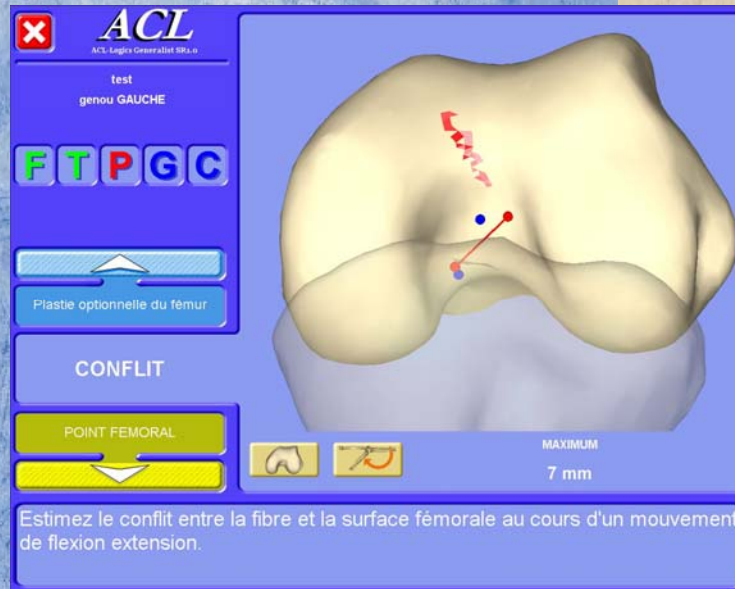
ACL

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Conclusion

## • Anterior Cruciate Ligament Replacement

### • Impingement



- Digitized the anterior fiber of the graft

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## Application : **THA**

**100 000 cases / Year / France**

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## • Total Hip Arthroplasty

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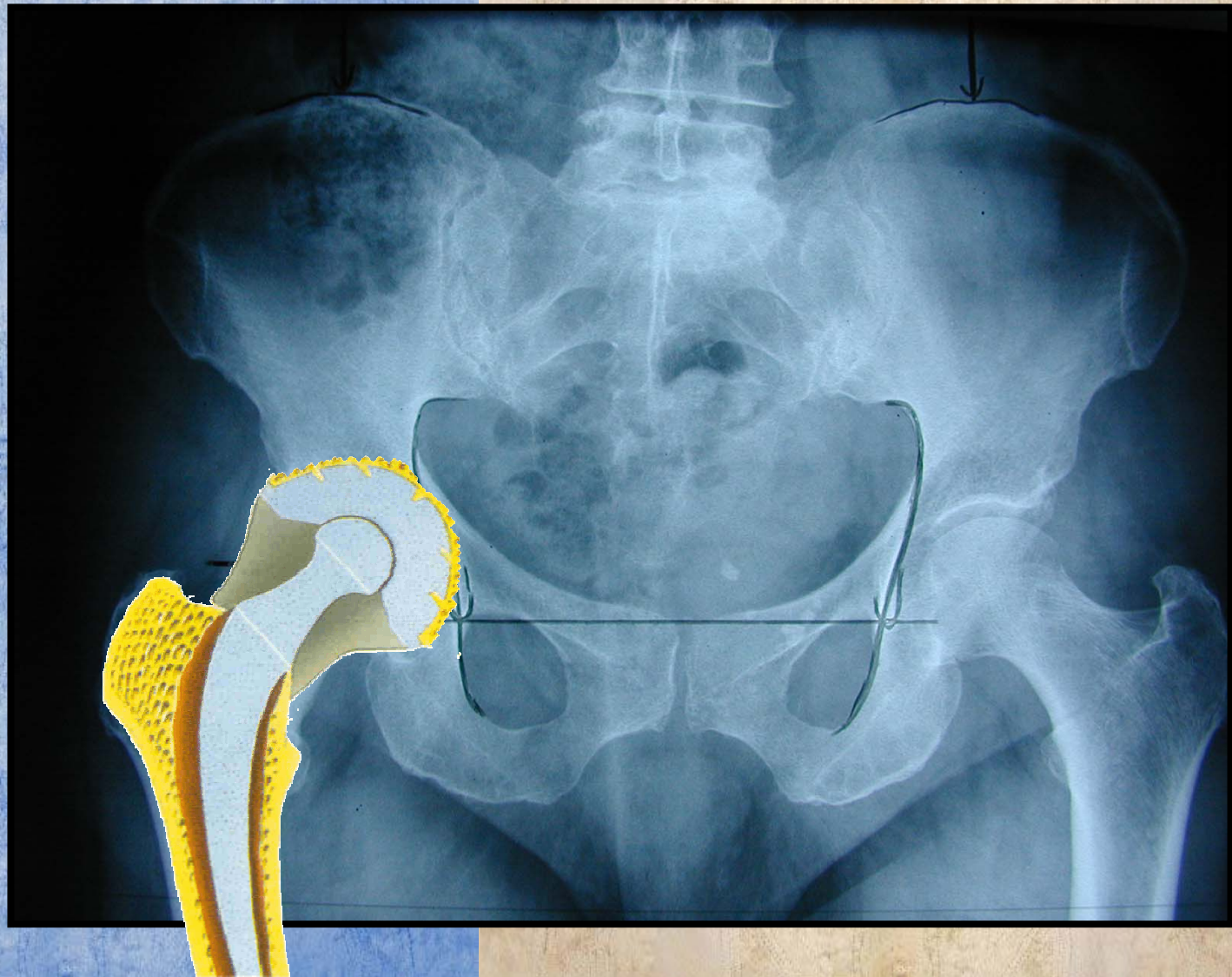
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# | Computer Assisted Orthopaedic Surgery |

## • Total Hip Arthroplasty

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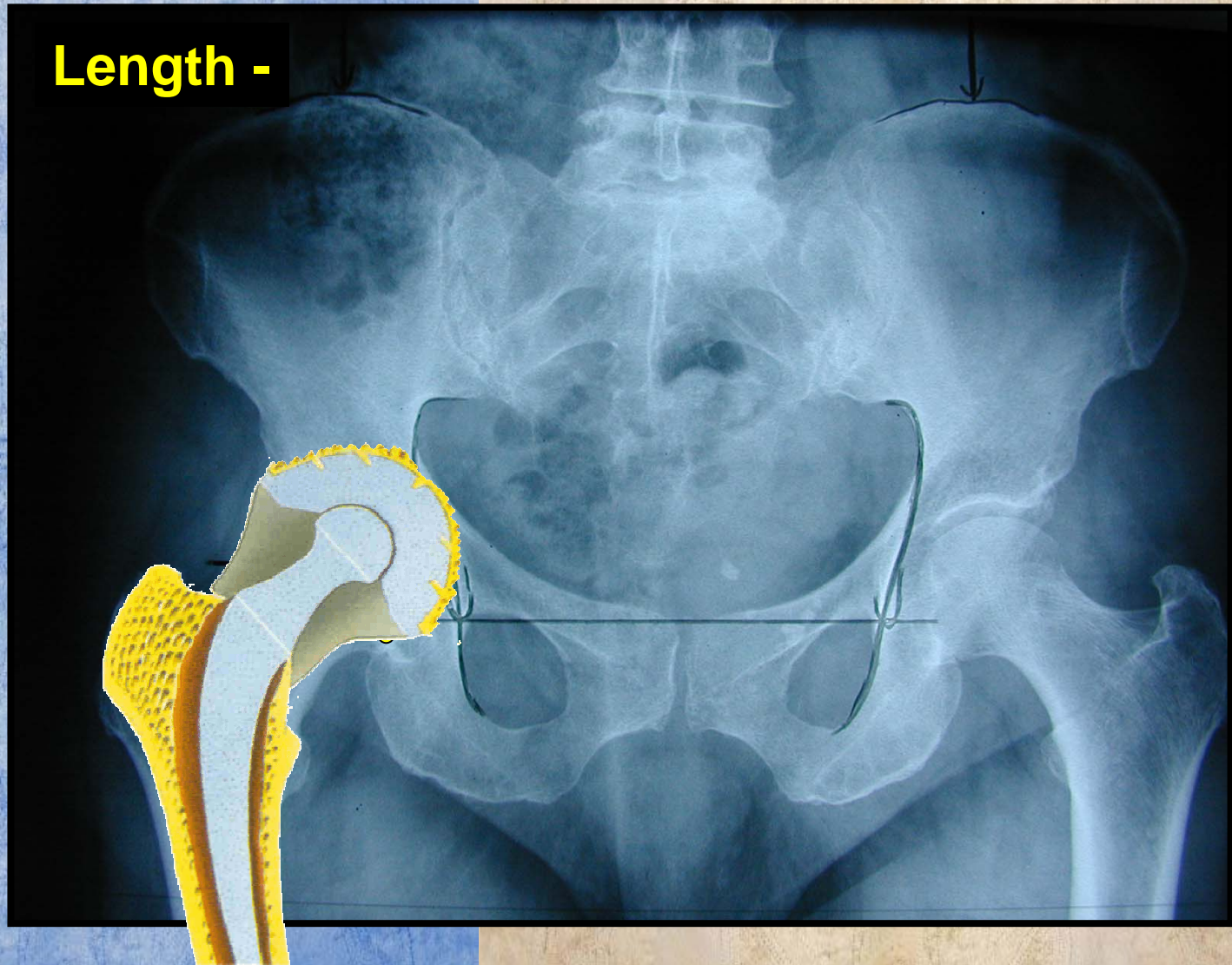
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**Length -**



# | Computer Assisted Orthopaedic Surgery |

## • Total Hip Arthroplasty

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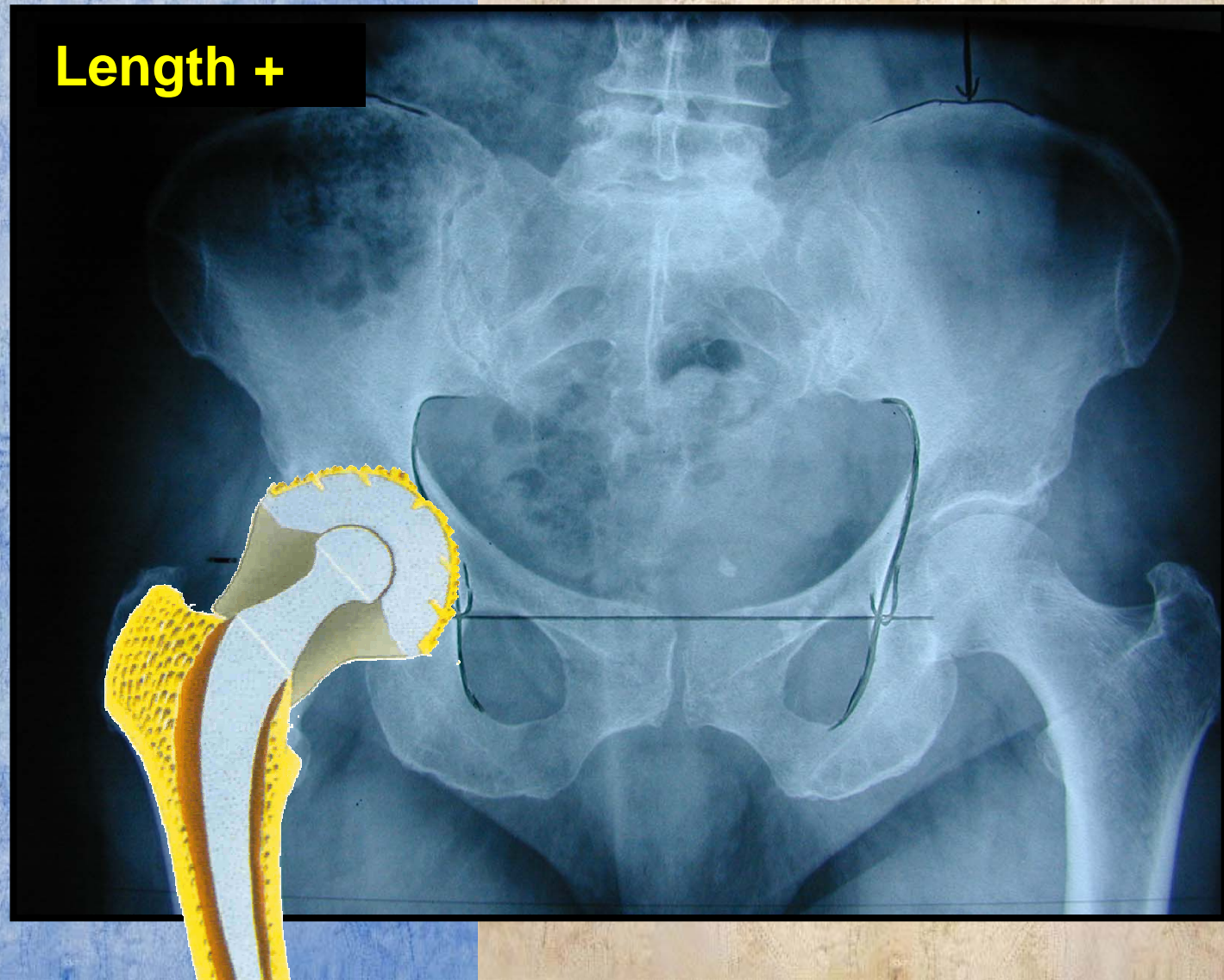
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## • Total Hip Arthroplasty

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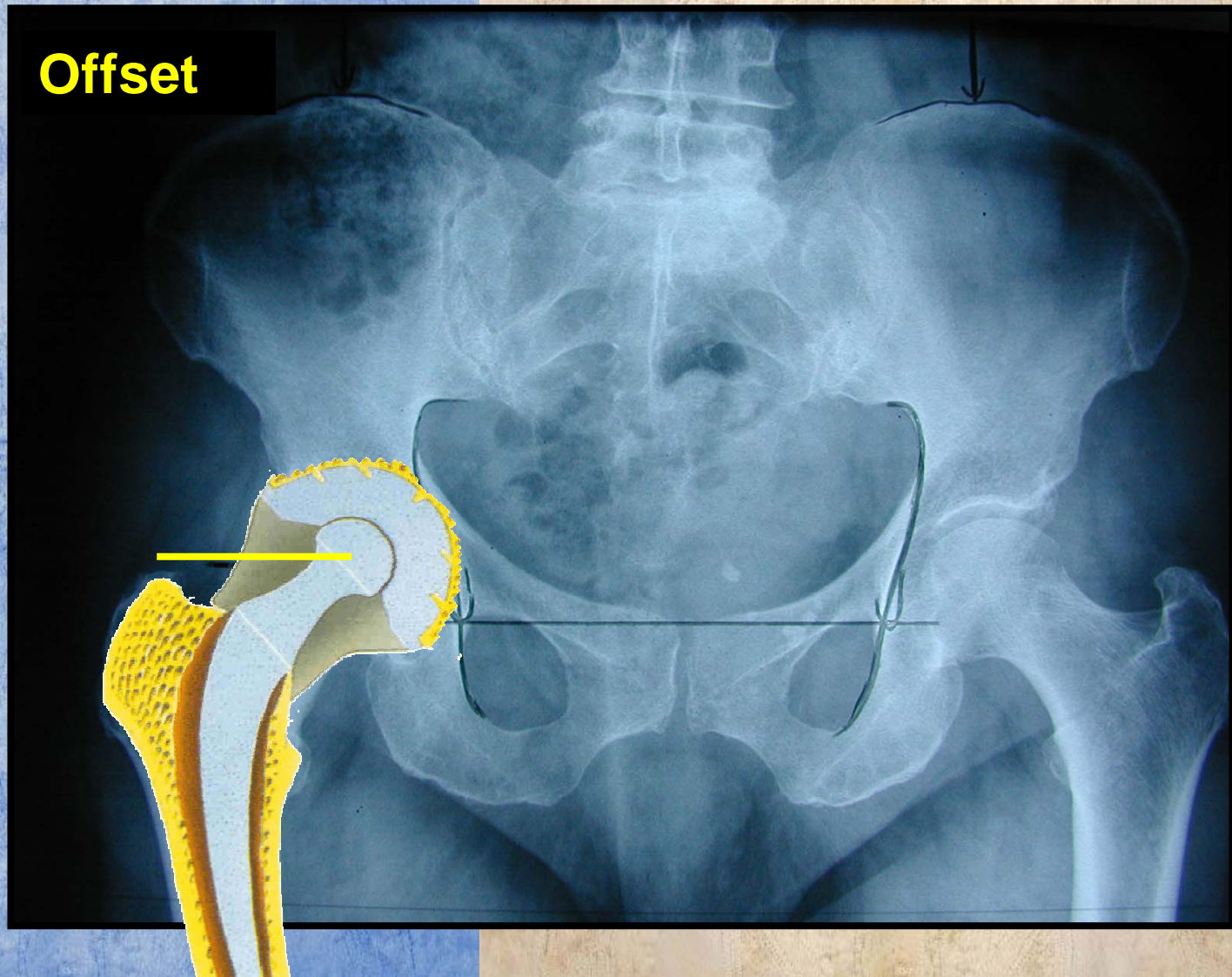
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## • Total Hip Arthroplasty

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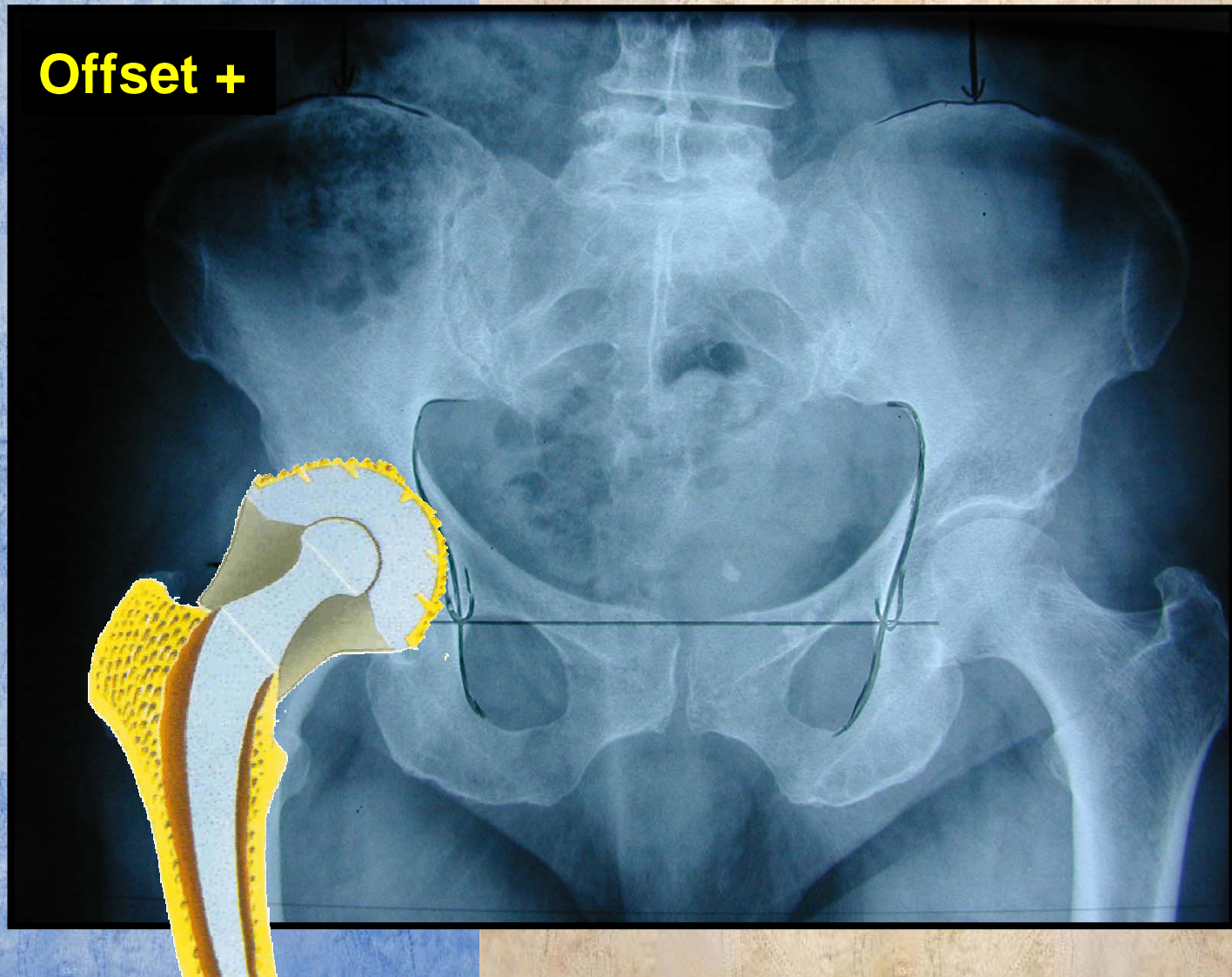
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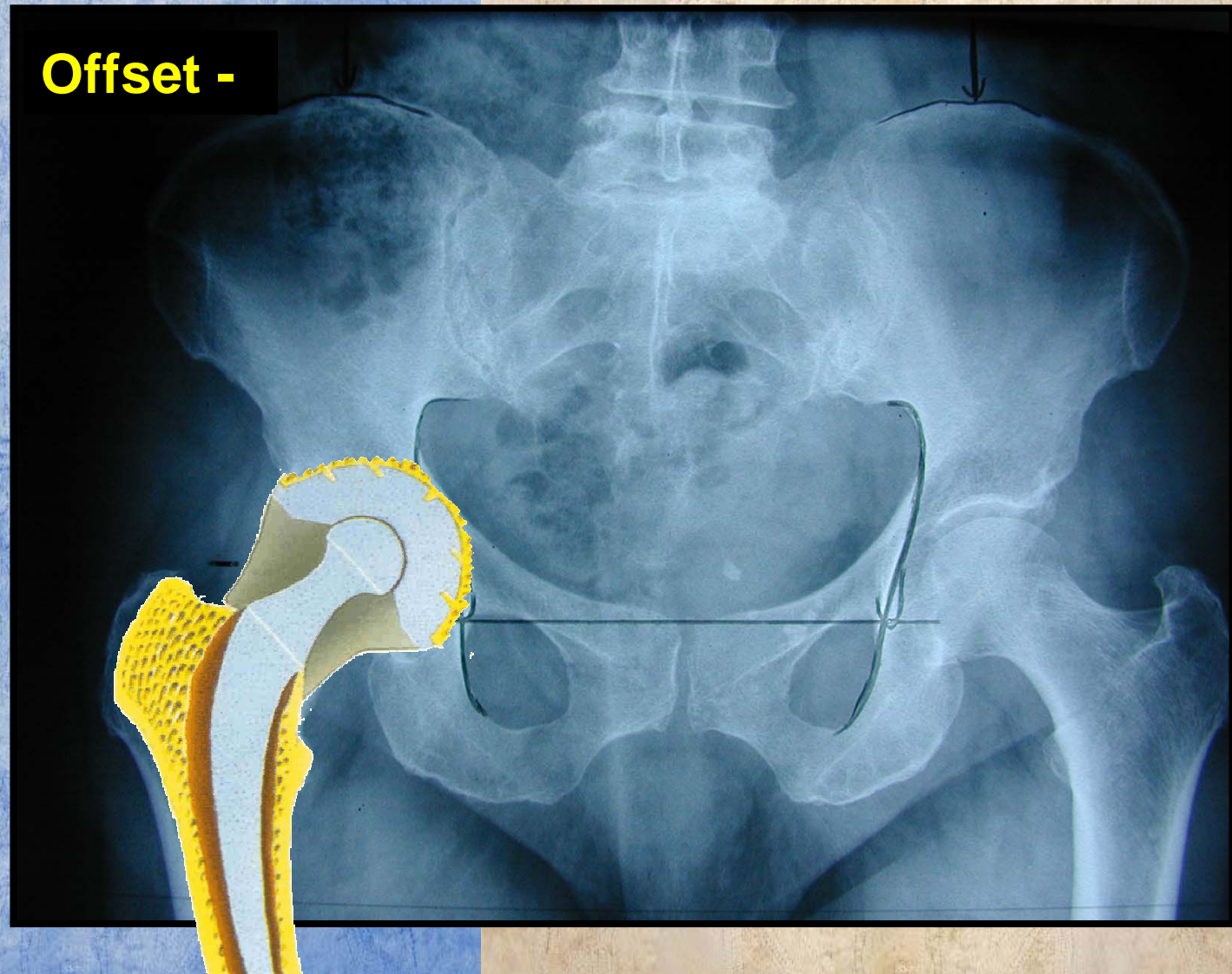
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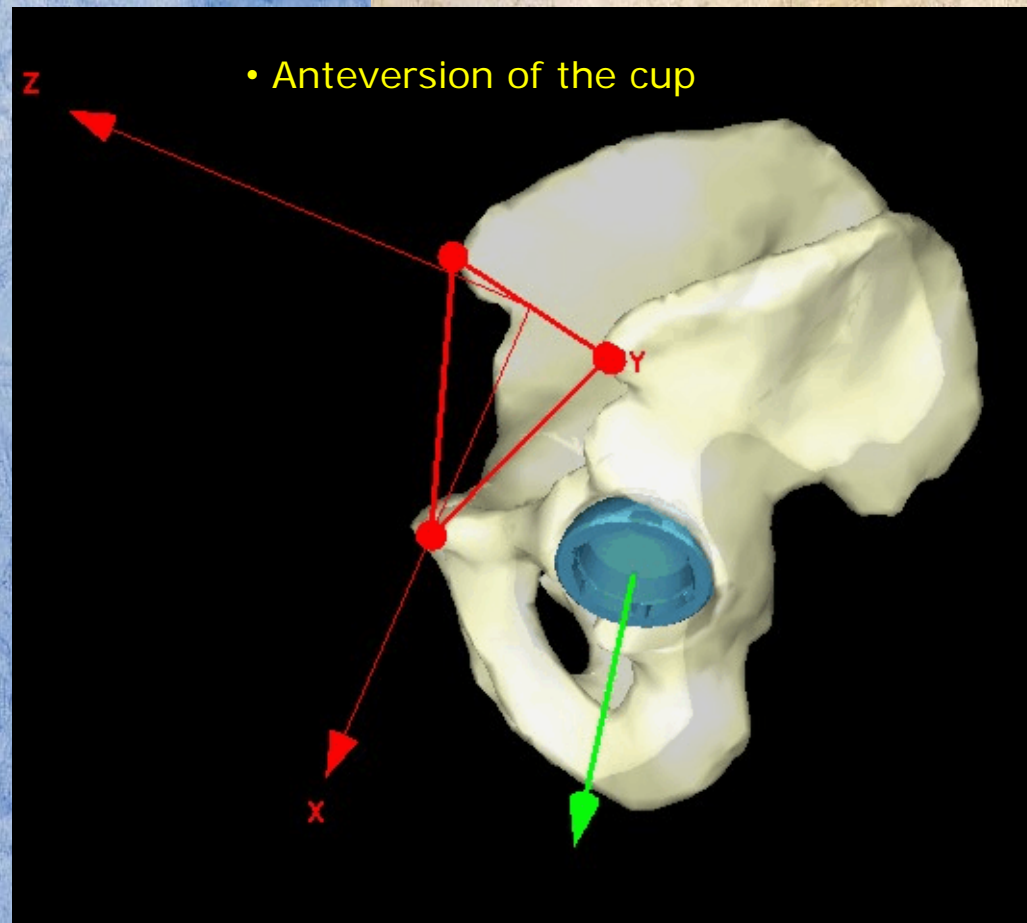
## • Total Hip Arthroplasty

-Length

-Centre of rotation

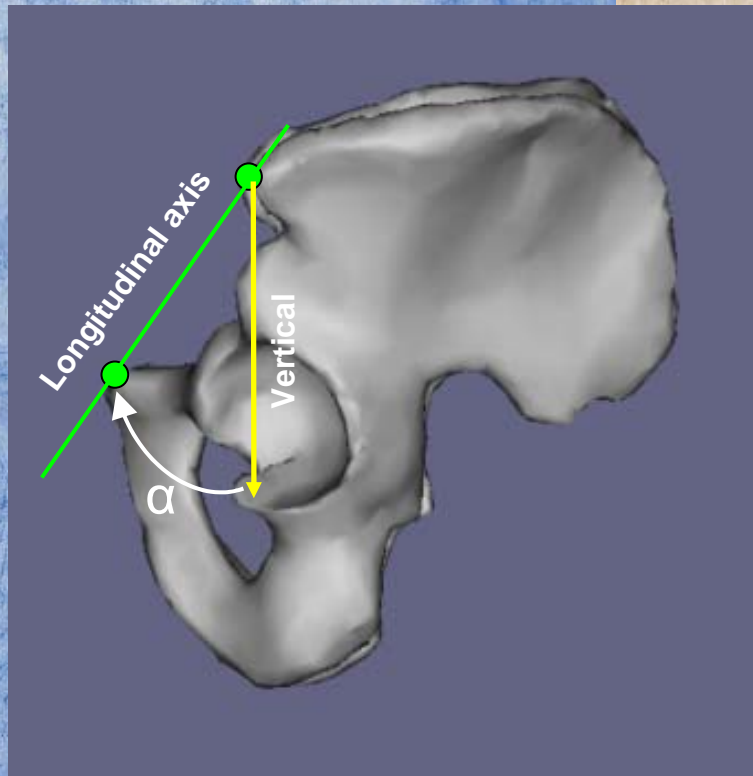
-Offset

**-Stability**



## • Total Hip Arthroplasty

### -Reference plane



- Not an absolute reference
- Can be define on an X-Ray
- Change in supine position
- Influence anteversion values

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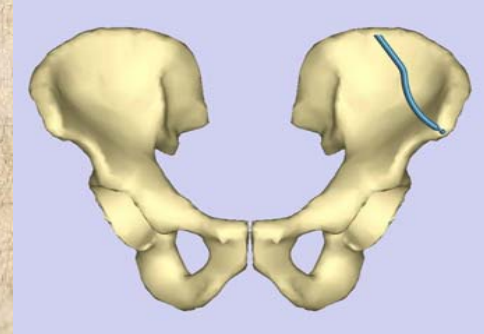
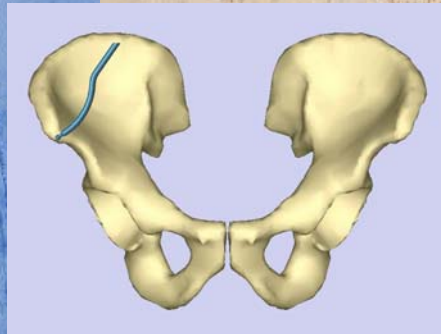
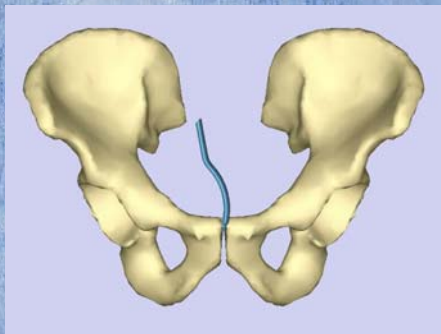
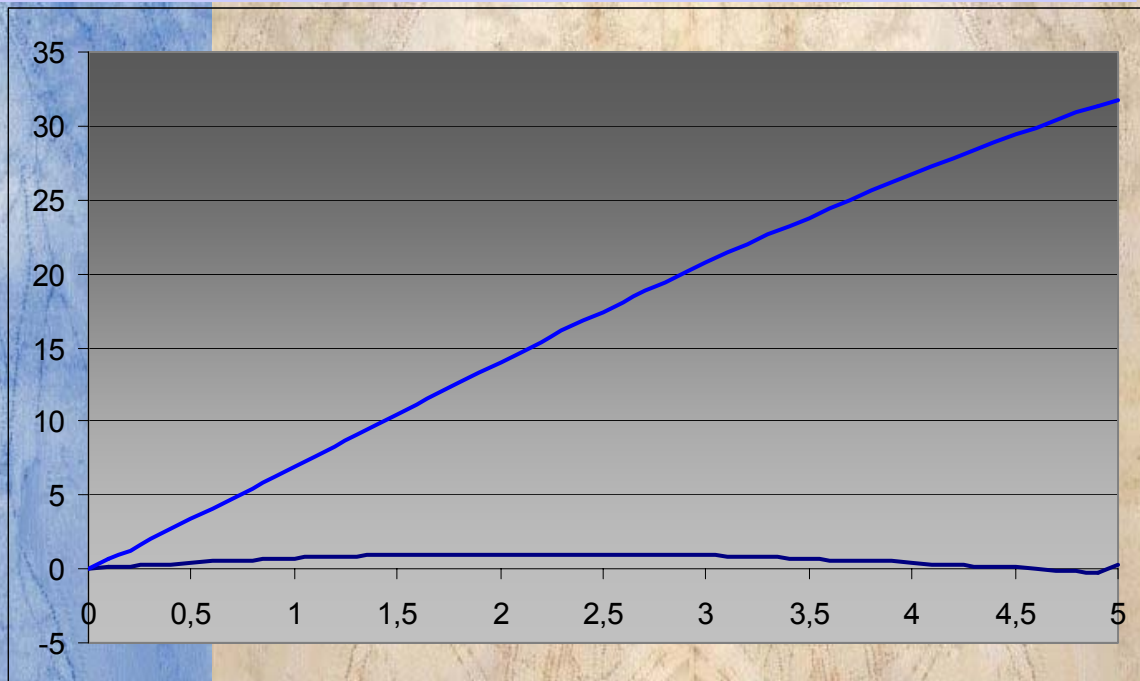
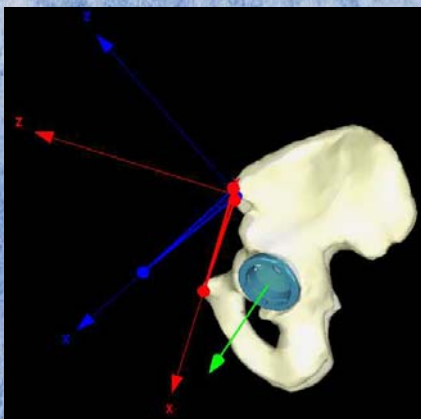
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**-Reference plane**



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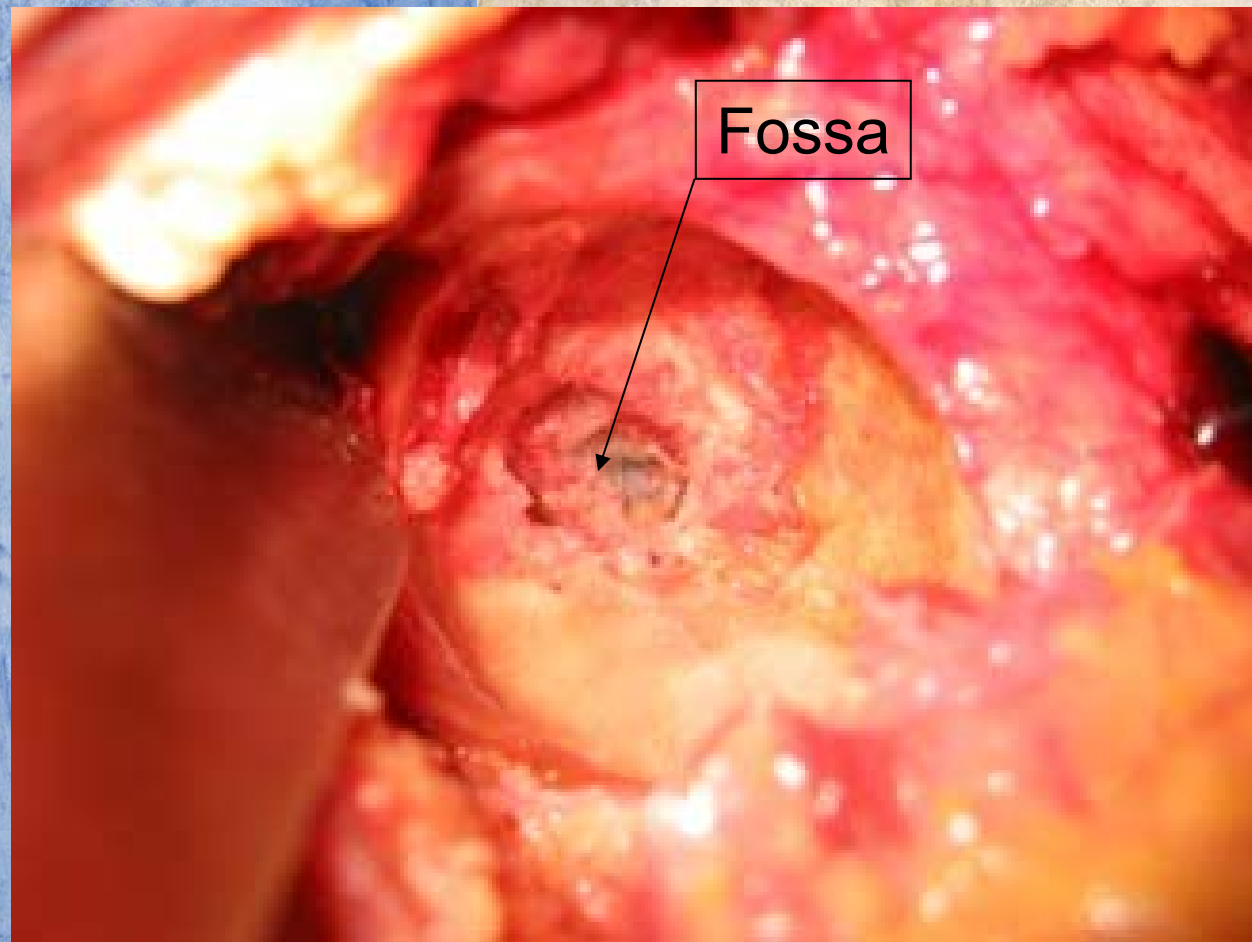
**THA**

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## • Total Hip Arthroplasty

**-Local bone morphing instead of global**

• View of the acetabulum fossa before reaming



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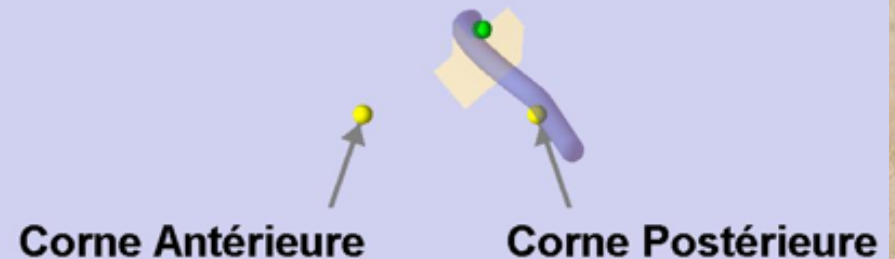
## • Total Hip Arthroplasty

**-Local bone morphing instead of global**



Nombre de points acquis: 108

Distance à la surface osseuse : **0.6 mm**



# | Computer Assisted Orthopaedic Surgery |

## • Total Hip Arthroplasty

-Local bone morphing instead of global

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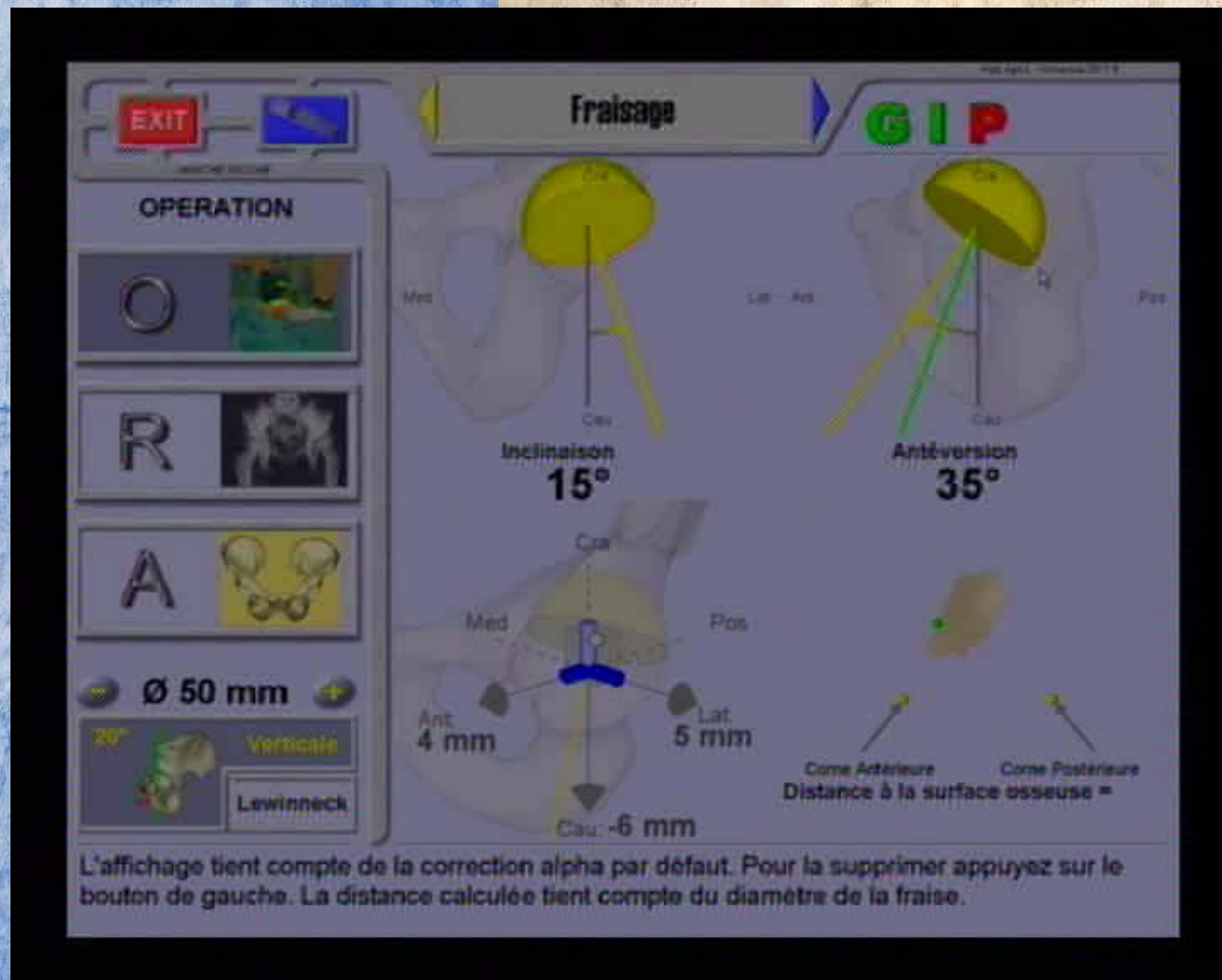
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## • Total Hip Arthroplasty

### -Fine tuning of the implants

- Final hip center location



# Computer Assisted Orthopaedic Surgery

## • Total Hip Arthroplasty

### -Fine tuning of the implants

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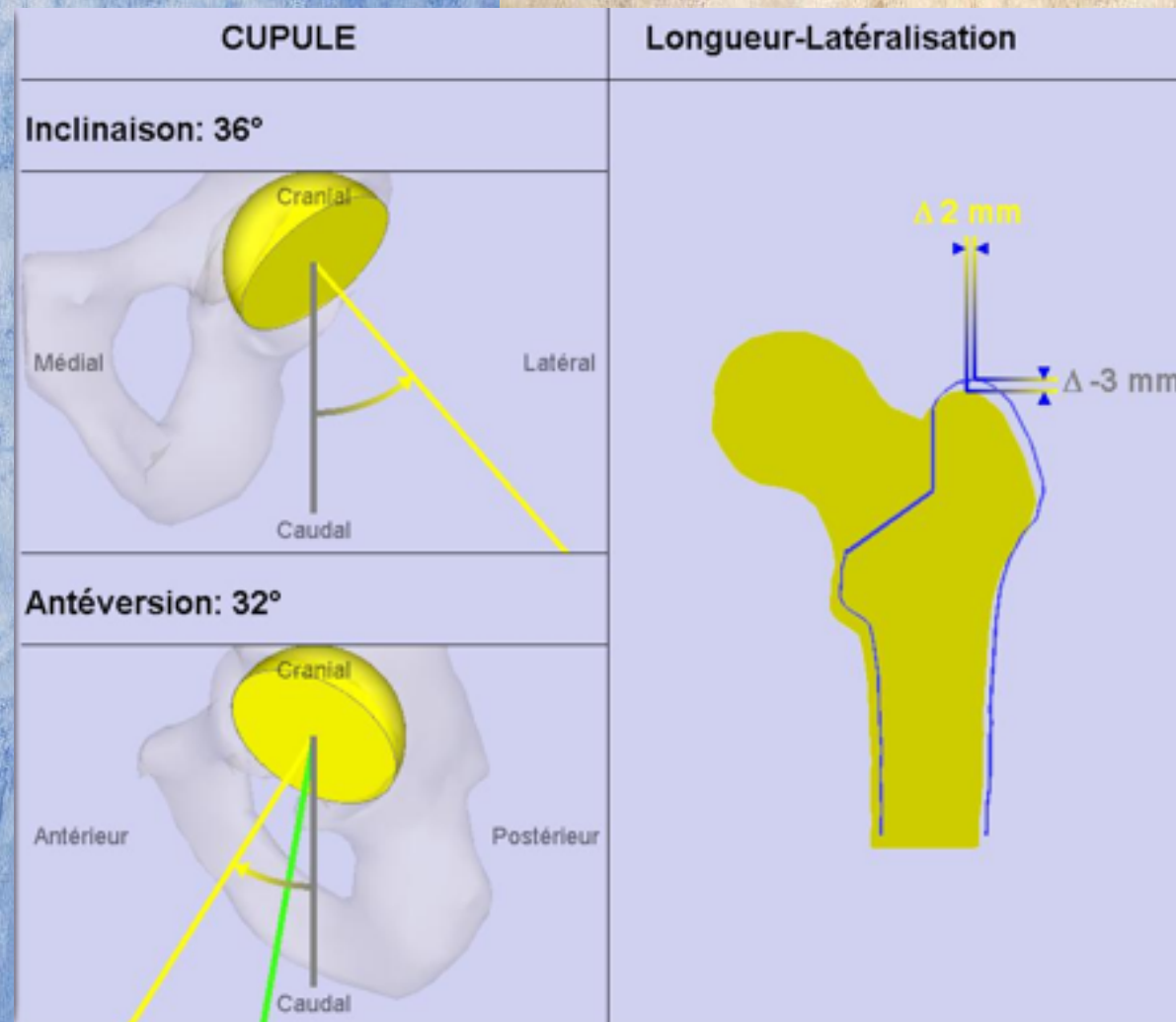
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Blind surgery or quantitative surgery ?

