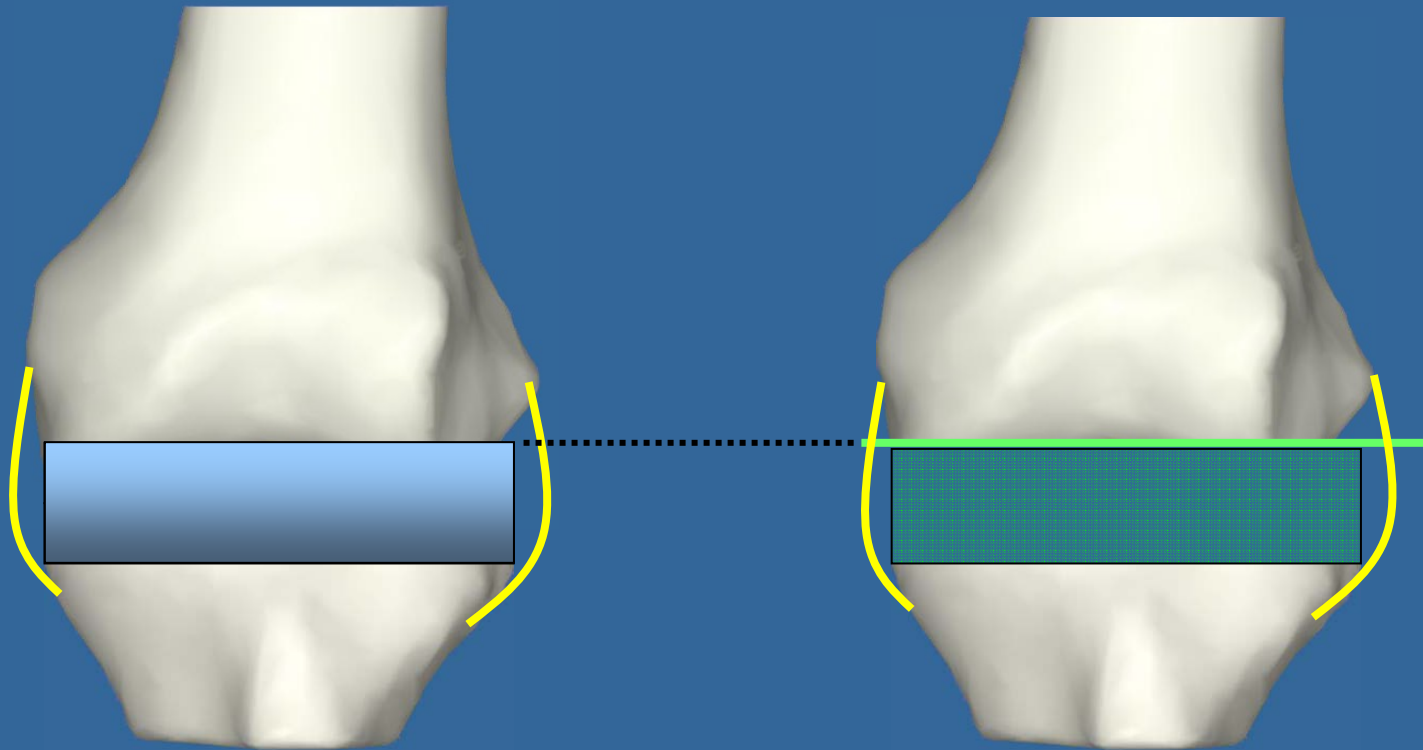


| Computer Assisted Orthopaedic Surgery |

- Functional challenge
- Ligament balancing

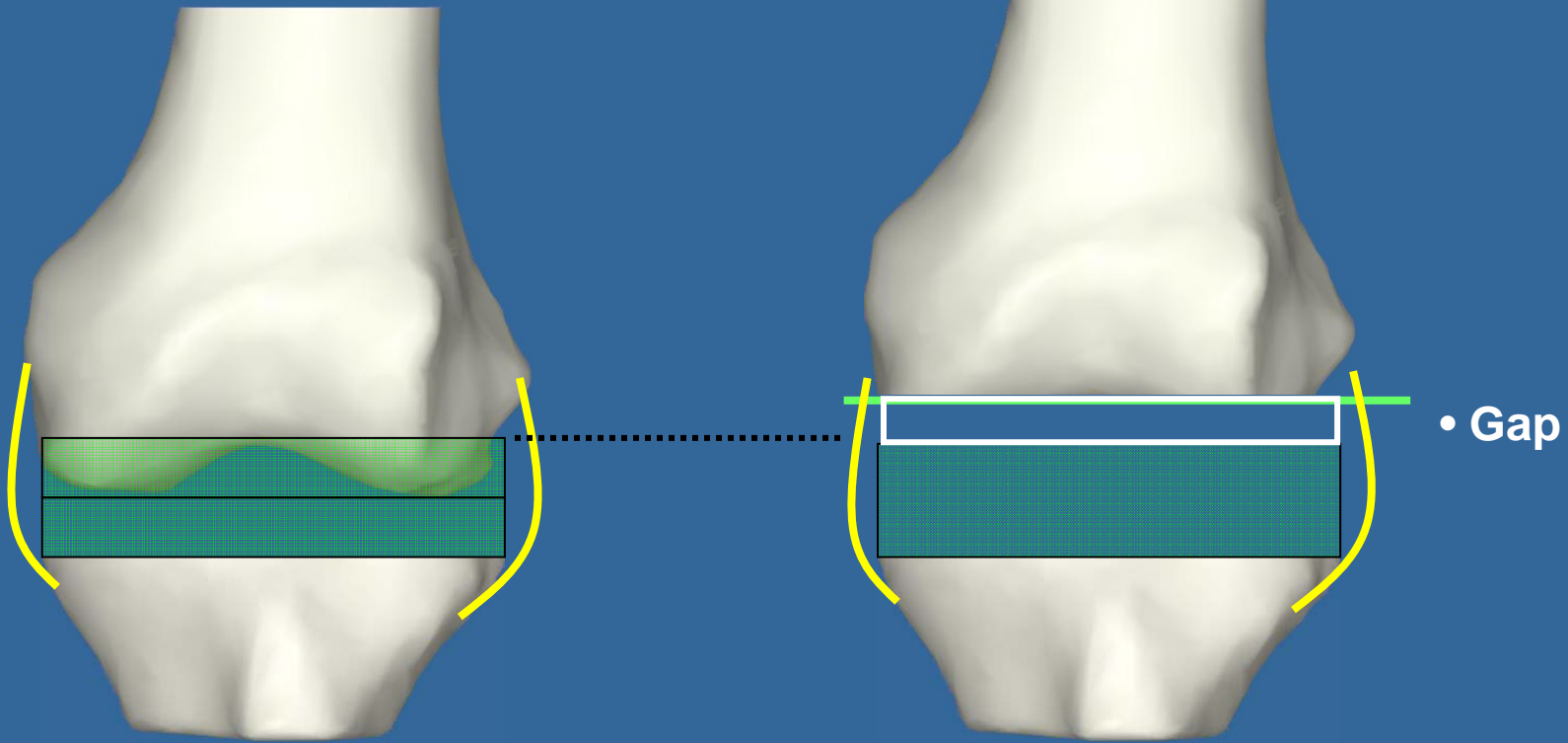
- Well align knee (HKA ~ 180°): Good cuts



| Computer Assisted Orthopaedic Surgery |

- Functional challenge
- Ligament balancing

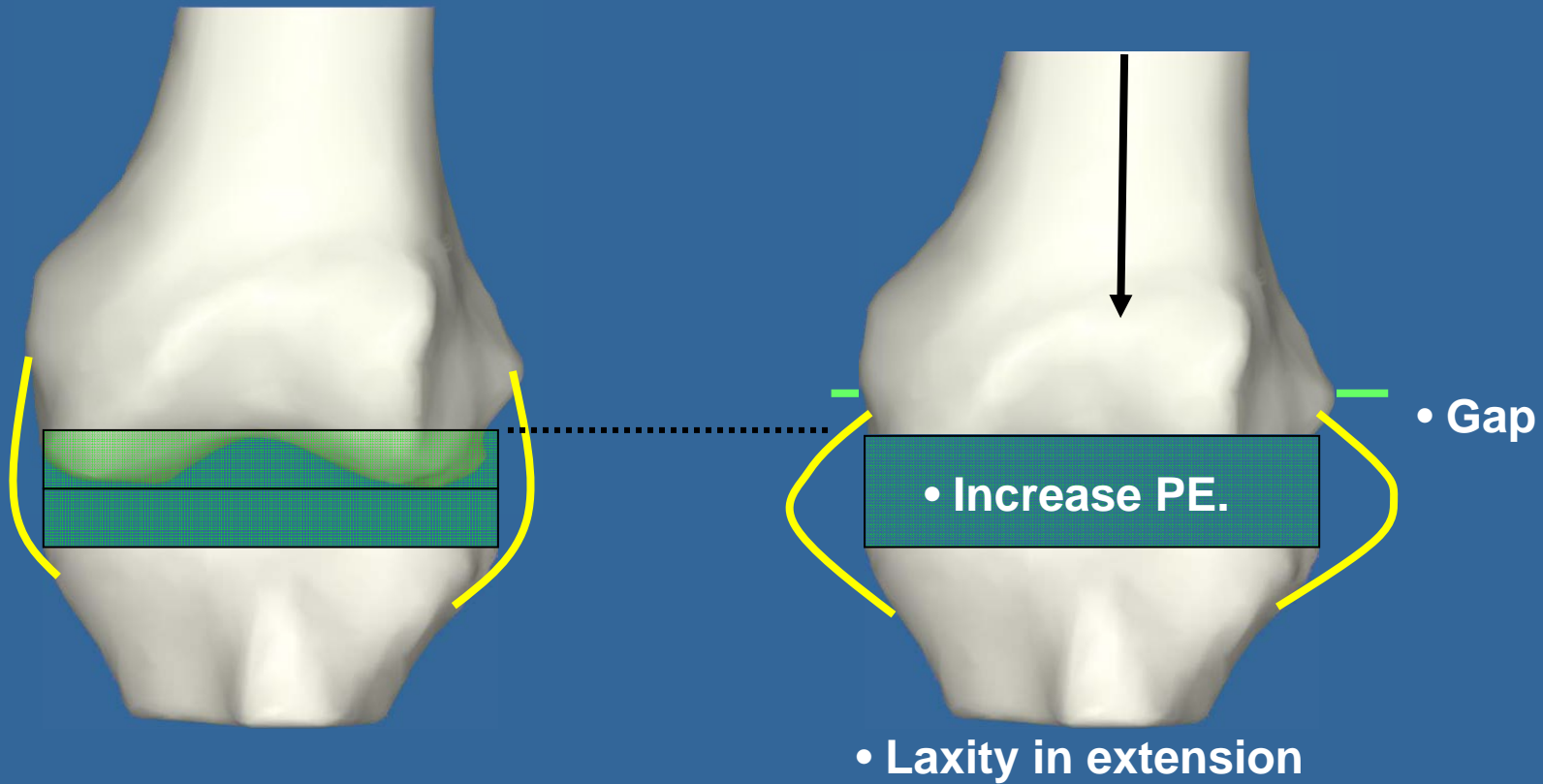
• Well align knee (HKA ~ 180°): Excessive cuts



| Computer Assisted Orthopaedic Surgery |

- Functional challenge
- Ligament balancing

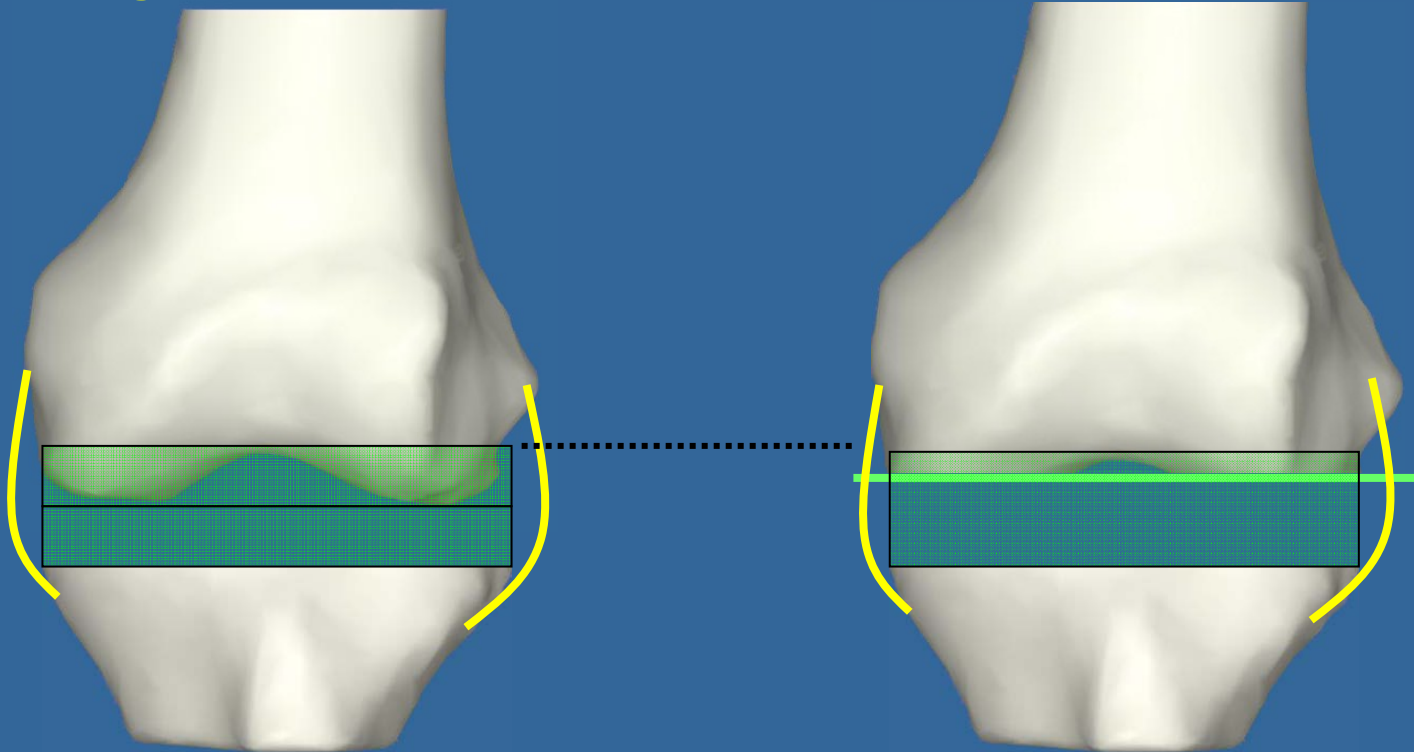
• Well align knee (HKA ~ 180°): Excessive cuts



| Computer Assisted Orthopaedic Surgery |

- Functional challenge
- Ligament balancing

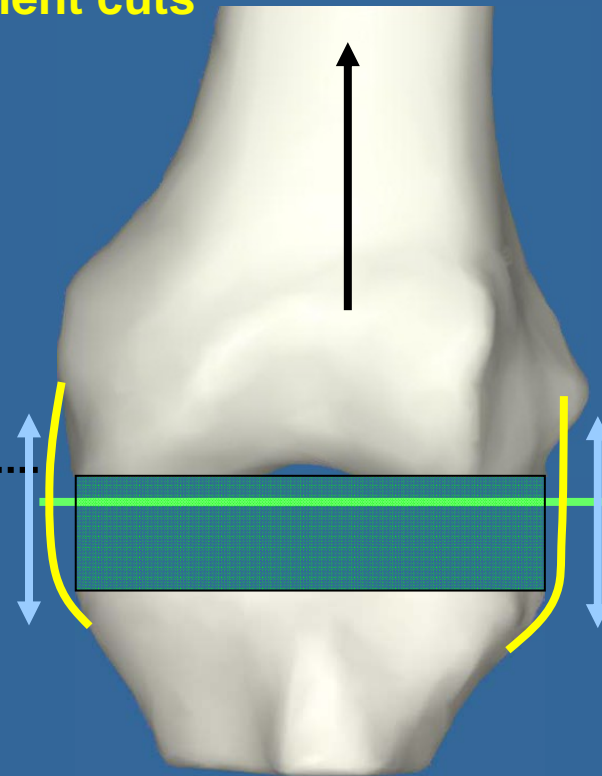
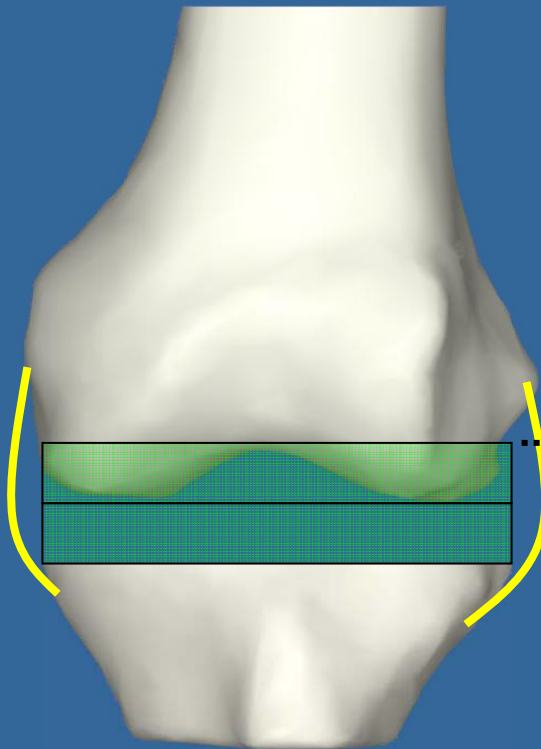
- Well align knee (HKA ~ 180°): Insufficient cuts



| Computer Assisted Orthopaedic Surgery |

- Functional challenge
- Ligament balancing

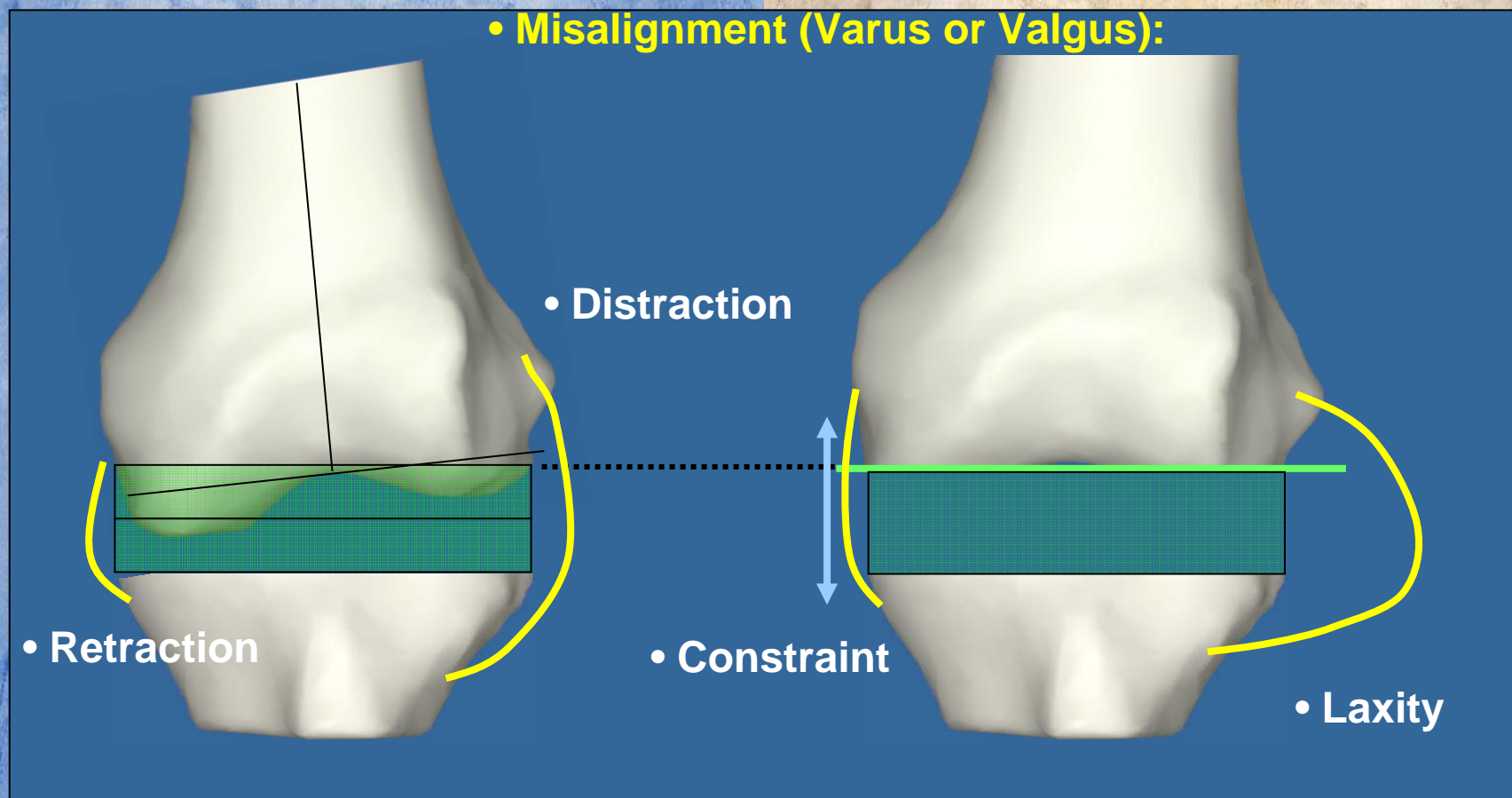
• Well align knee (HKA ~ 180°): Insufficient cuts



• Excessive constraint

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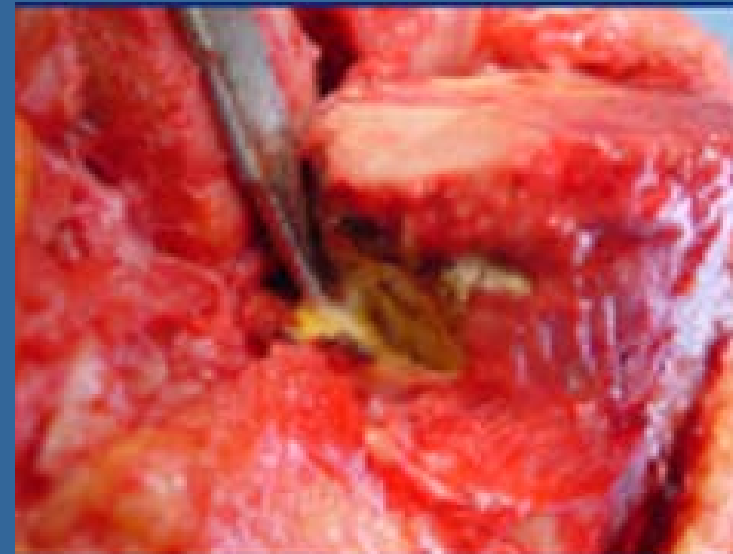
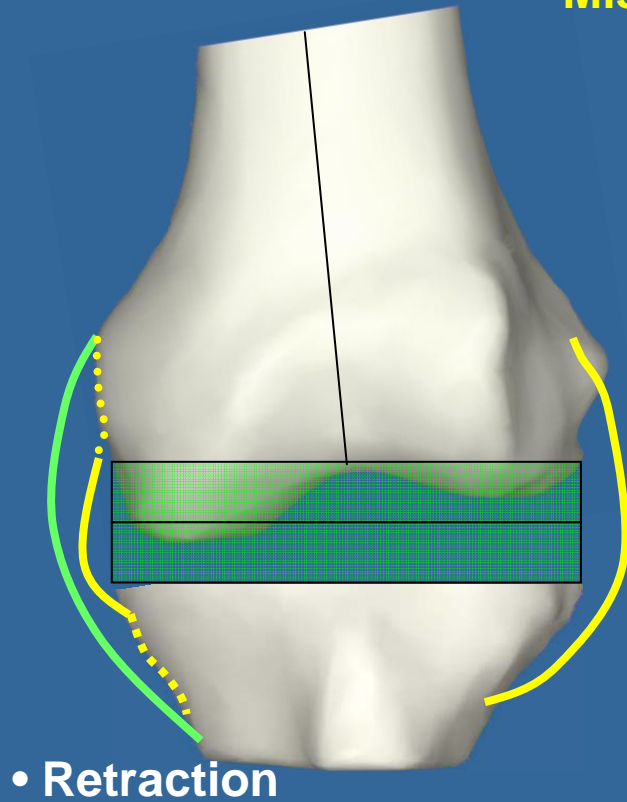
- Functional challenge
- Ligament balancing



| Computer Assisted Orthopaedic Surgery |

- Functional challenge
- Ligament balancing

• Misalignment (Varus or Valgus):



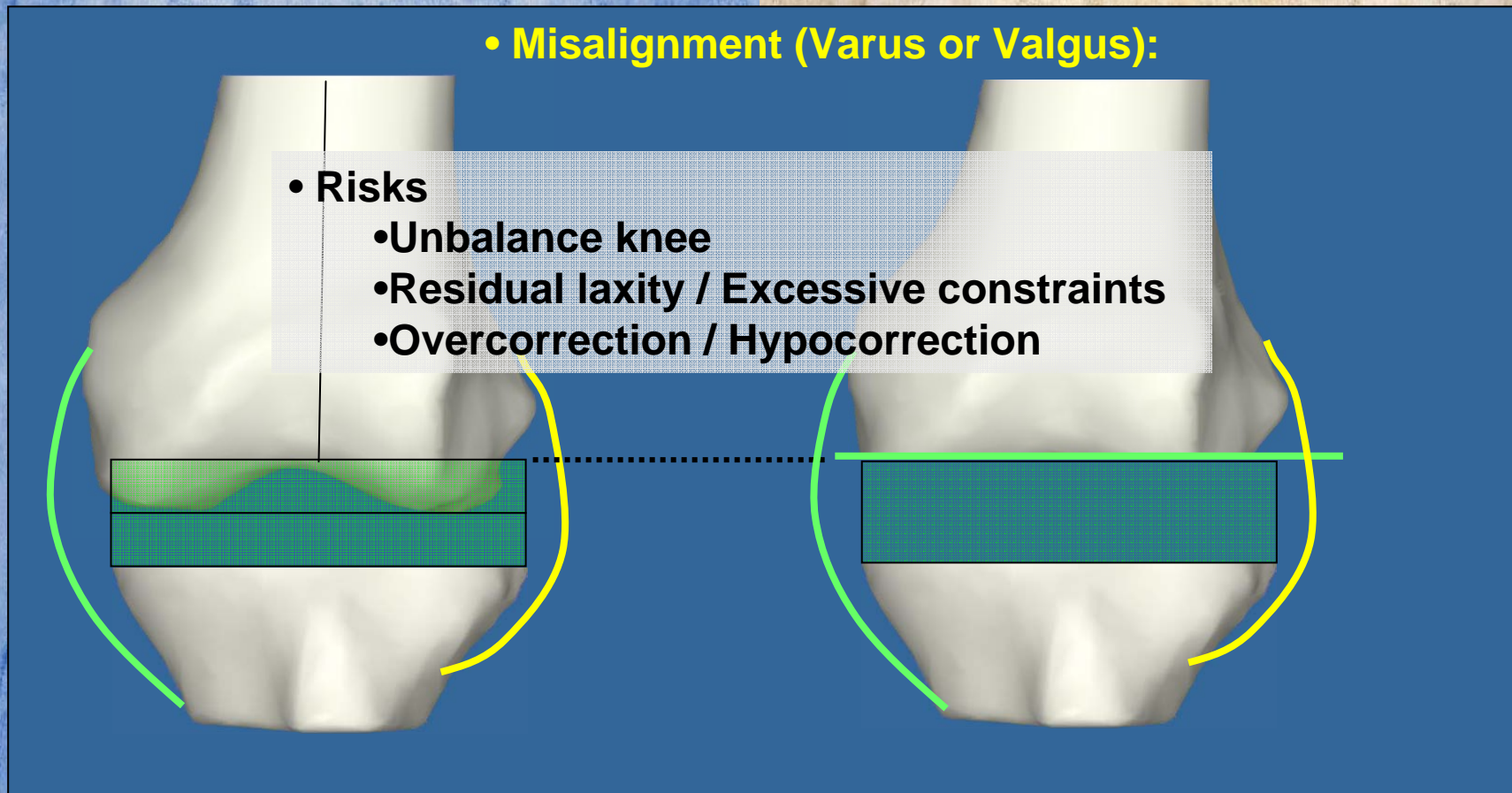
| Computer Assisted Orthopaedic Surgery |

- Functional challenge
- Ligament balancing

• Misalignment (Varus or Valgus):

• Risks

- Unbalance knee
- Residual laxity / Excessive constraints
- Overcorrection / Hypocorrection



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Application : TKA

The solutions

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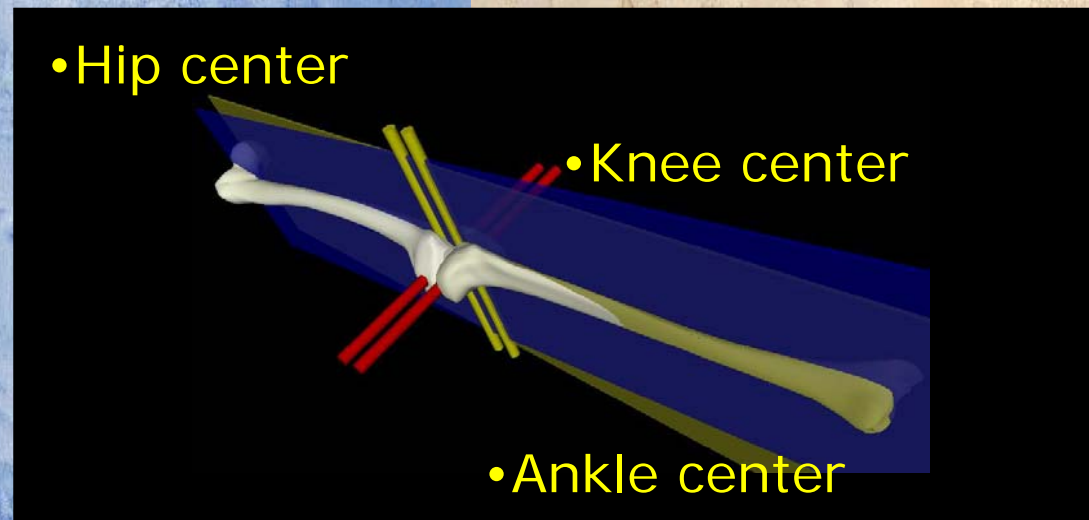
THA

Conclusion

The solutions

Build a **SPECIFIC** model of the patient under surgery

- Build the specific **GEOMETRY** of this patient
- Align the prosthesis with respect to the patient axes



- Localize **in 3D** the joint centers
- Build reference planes

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The solutions

Build a **SPECIFIC** model of the patient under surgery

- Build the specific MORPHOLOGY of this patient

Local adjustment to the bones

Ligament balance can only be made with local data



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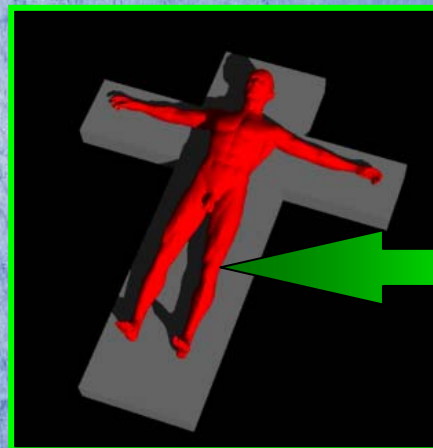
THA

Conclusion

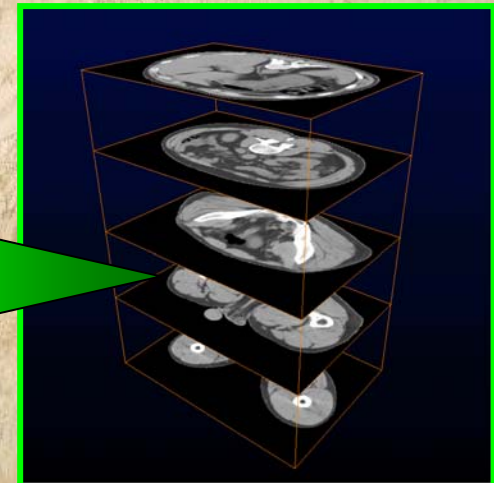
The solutions

Pros and Cons

- CT based approach
 - Pre-operative planning
 - Cost – Radio protection issues
 - Archiving and communication of images : PACS
 - No increasing time for acquisition and planning
- CT including Hip – Knee - Ankle
- Setup time
- Intra-operative registration (time consuming/accuracy issues)



Registration



Computer Assisted Orthopaedic Surgery

The solutions

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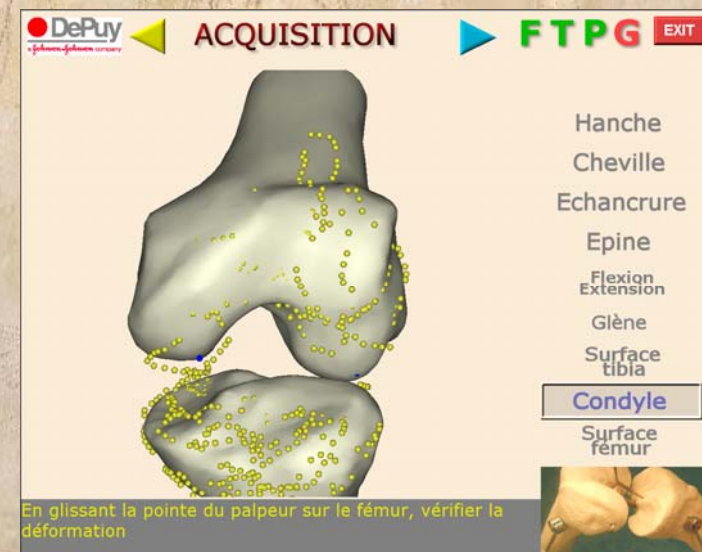
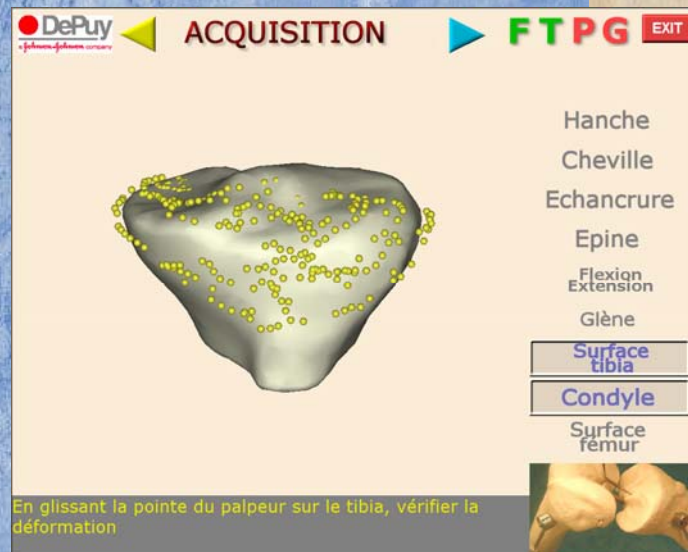
THA

Conclusion

Pros and Cons

• Non image based system

- Simple
 - Low cost – No radiation
 - Integration of intra-operative data
 - No registration issue
-
- Increase the operative time



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Non image based



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Perception

- **No pre-operative images**
- Build a specific model of the patient : Acquisition



- Geometric data
 - Axes
 - Hip center
 - Knee center
 - Ankle center
- Morphologic data
 - Bone surfaces

- **Digitization of points with a 3D probe**

| Computer Assisted Orthopaedic Surgery |

Perception

Hip center

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Conclusion

- **None image based approach**



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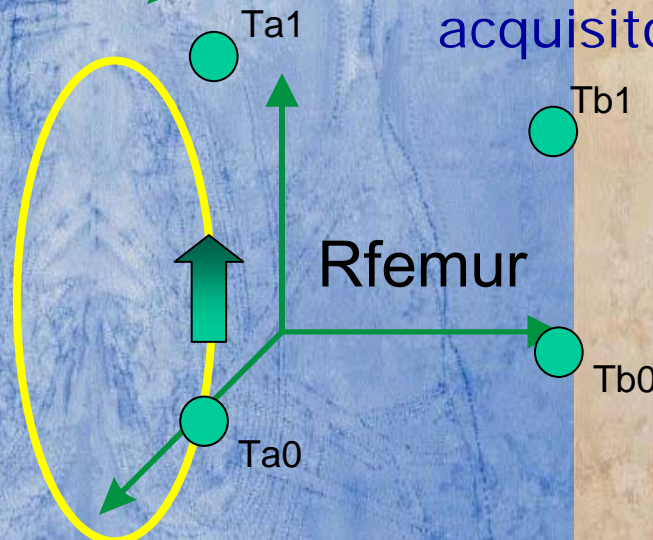


$R_{polaris}$

• None image based approach

-Kinematics approach

• Search of a point C of R_{femur} with the minimum trajectory during the acquisition motion



$Tc1$

$Tc0$

$Td1$

$Td0$

Hip Center

Hip center

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Perception

• None image based approach



Rpolaris



Knee center

-Morphologic approach



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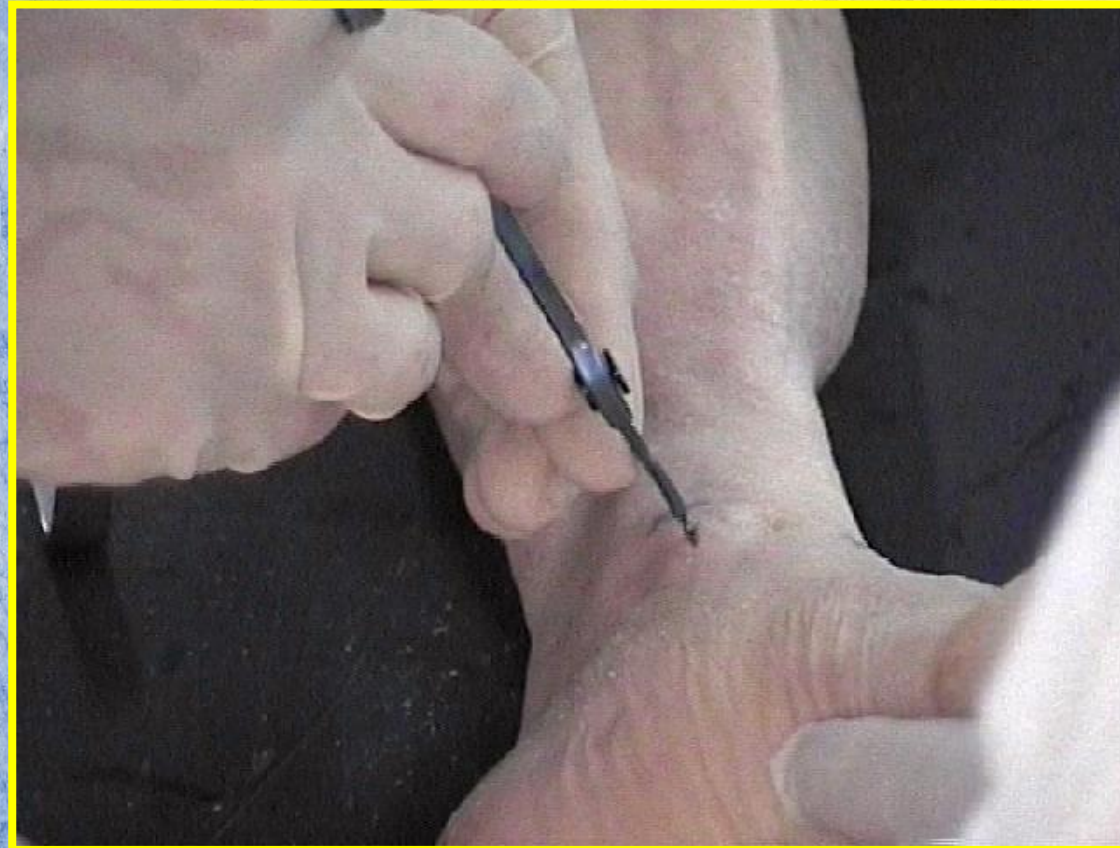
Conclusion

Perception

- **None image based approach**
- Percutaneous digitization of points

Ankle center

-Geometric approach



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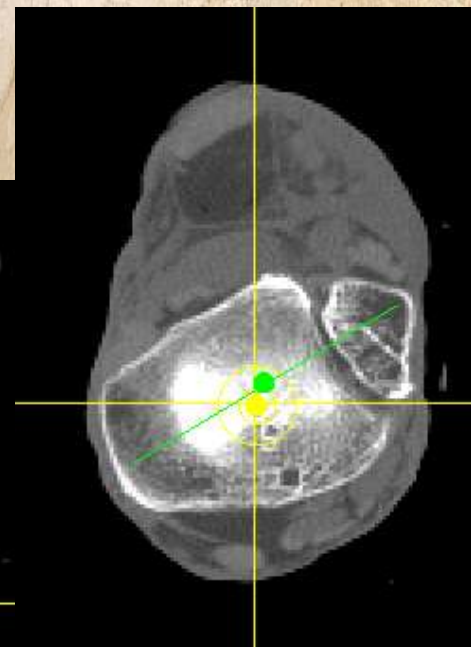
Conclusion

Perception

- None image based approach

Ankle center

-Geometric approach



- Error
- Slope
- Varus
- Valgus

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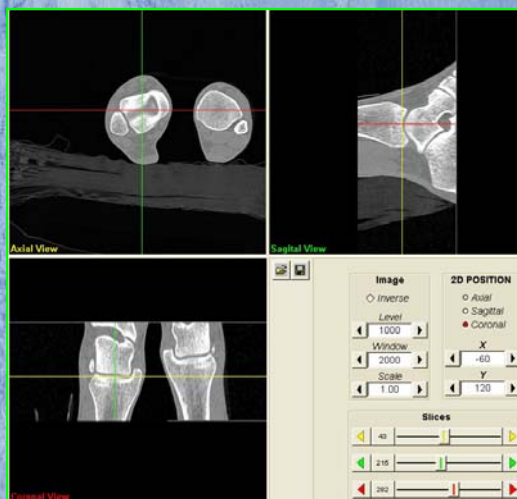
ACL

THA

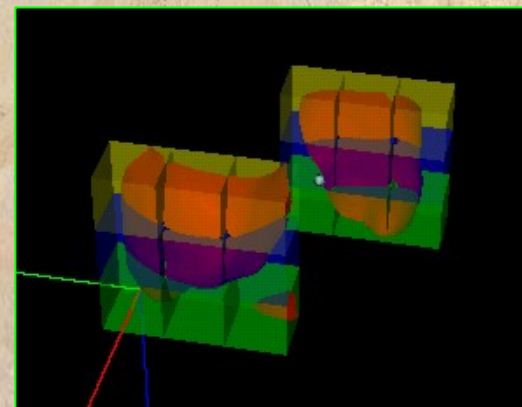
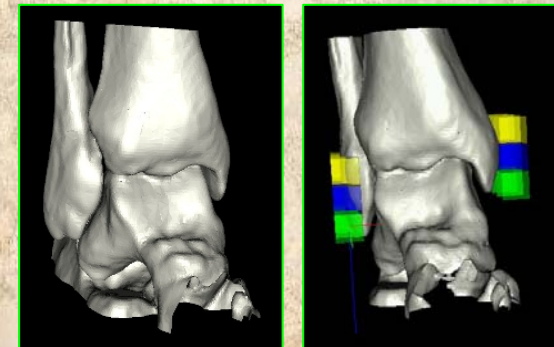
Conclusion



-Geometric approach



Ankle center



E. STINDEL, et Al., The center of the ankle in ct less based navigation system.

*What is really important to detect?
CAOS Santa fee 19-22 Juin 2002.*

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Perception

Ankle center

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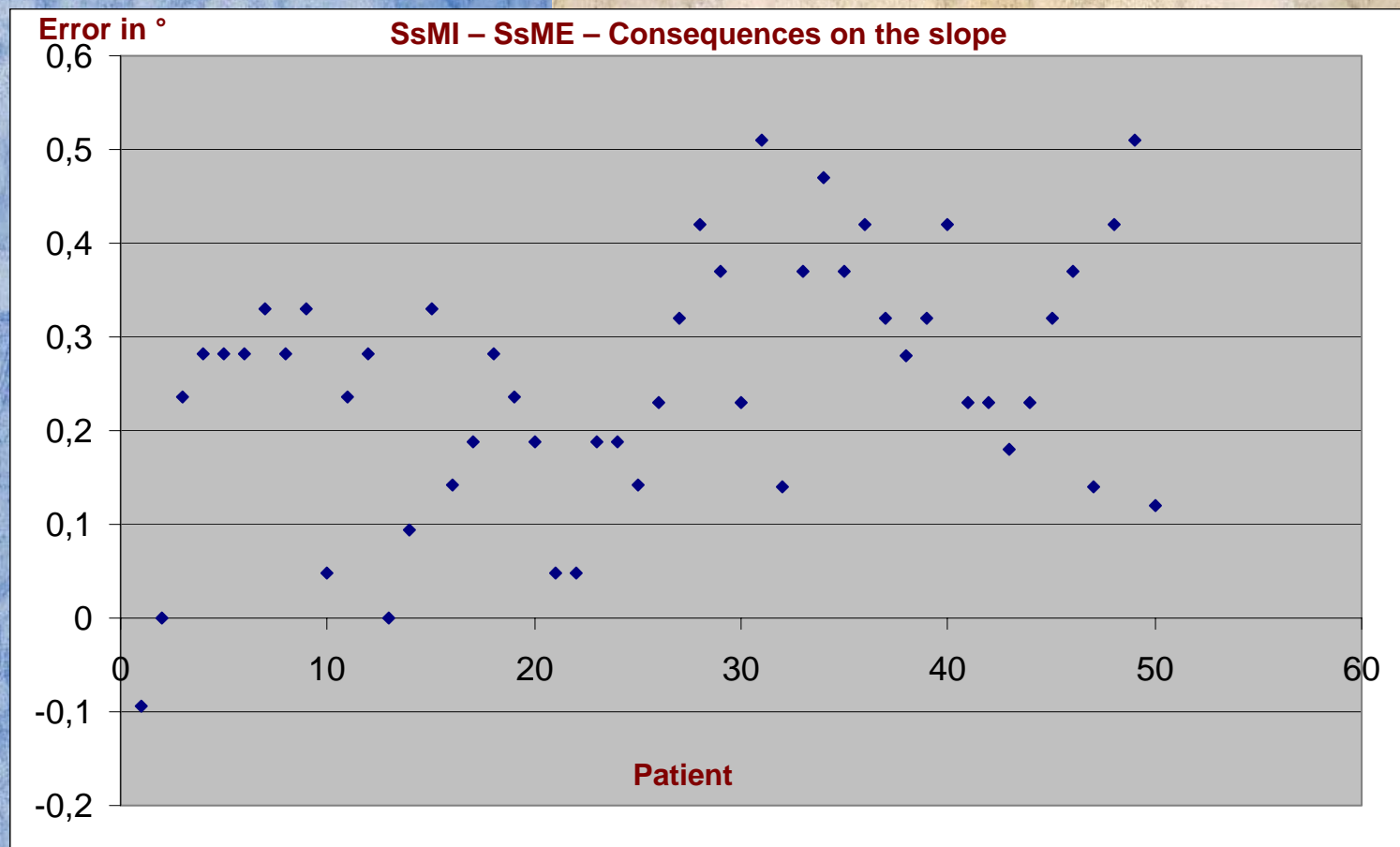
HTO

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- None image based approach



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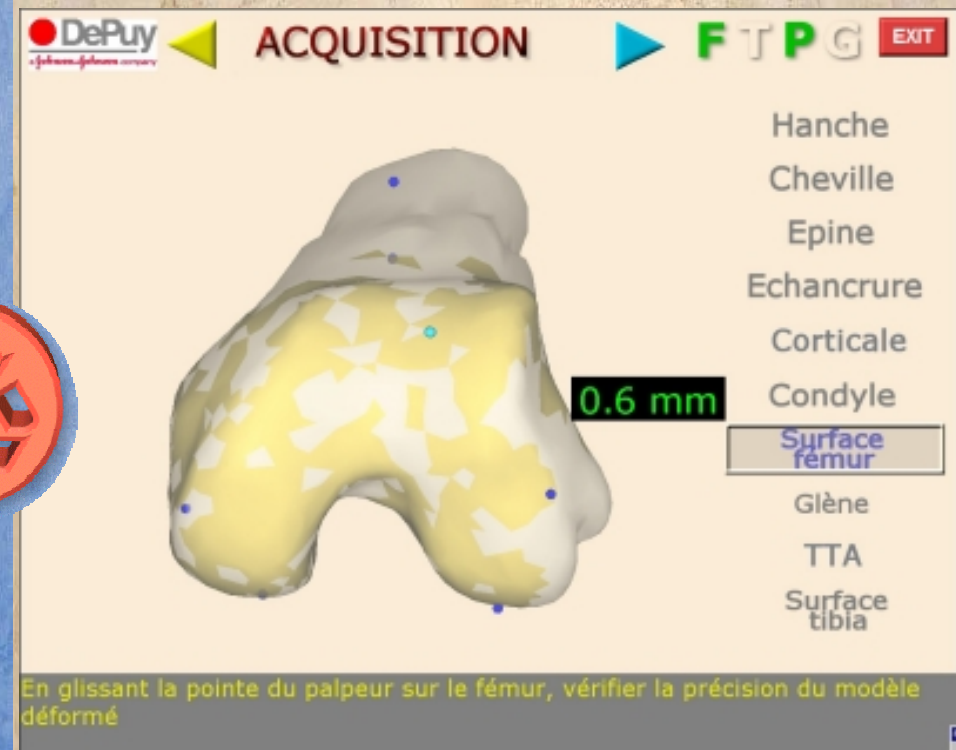
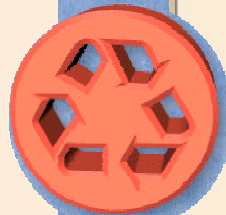
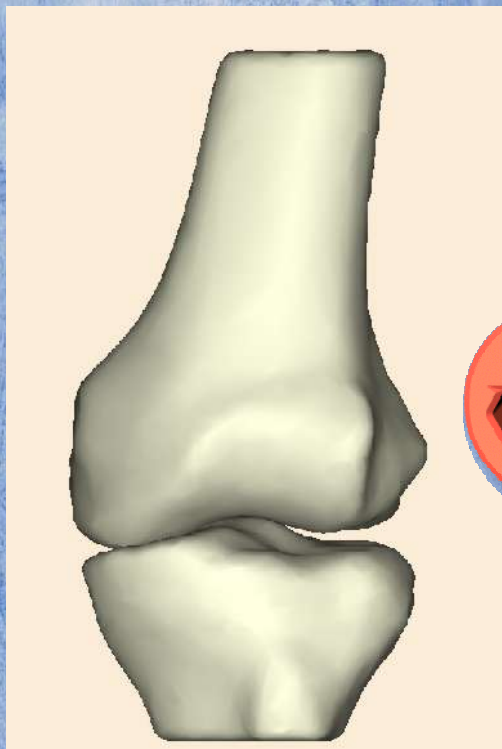
THA

Conclusion

Perception

- Femoral and tibial shape : Bone morphing
- Use of statistical deformable models

Morphology



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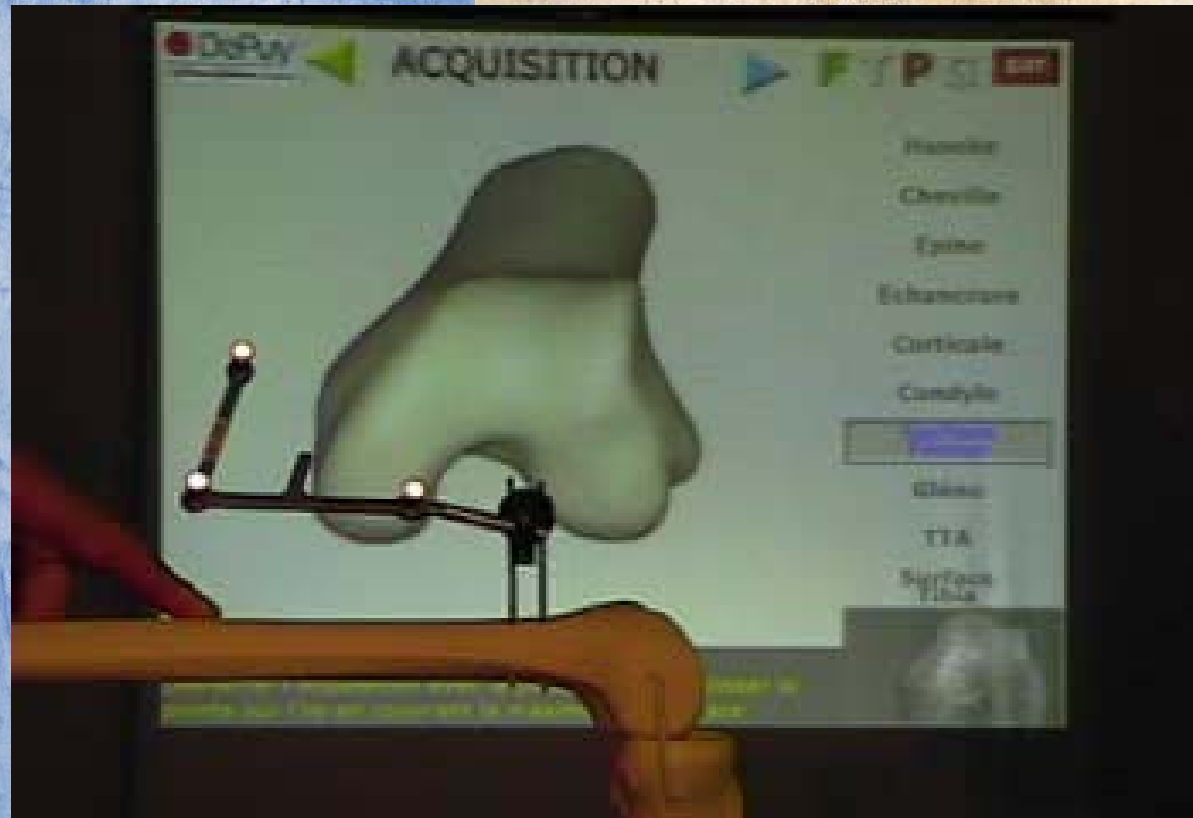
THA

Conclusion

Perception

Morphology

- Femoral shape : Bone morphing
- Acquisition – Deformation – Quality control



Perception

Morphology

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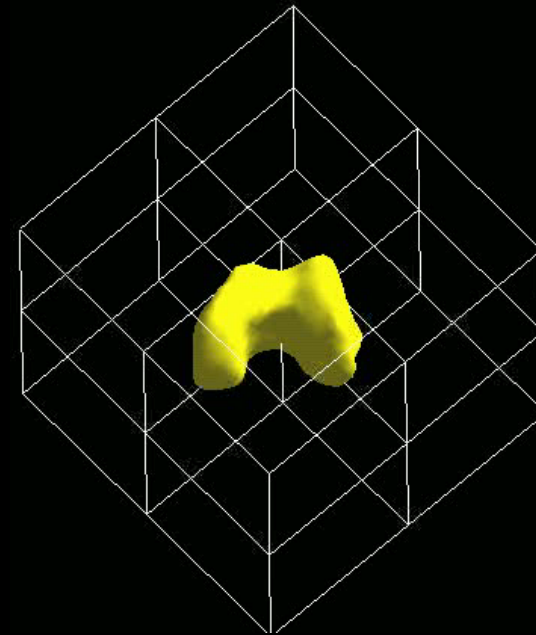
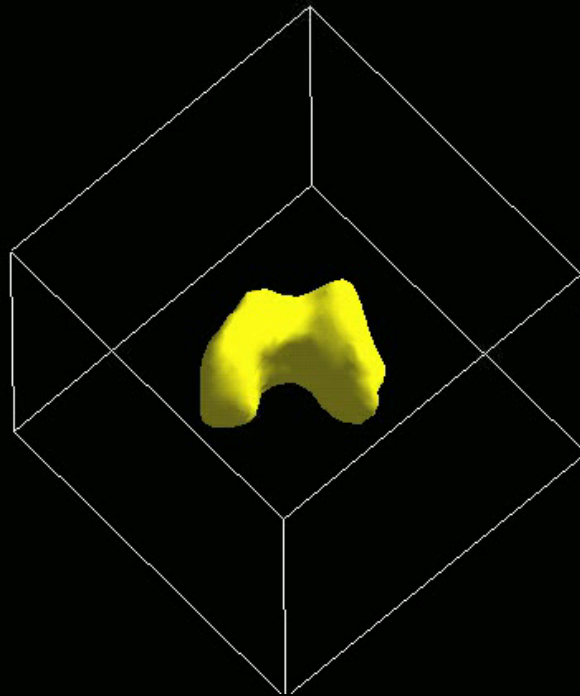
ACL

THA

Conclusion

- **Femoral shape : Bone morphing**

- Quadtree (Lavallée) : hierarchical division of the 3D volume to apply global and local deformation



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Non image based



Computer Assisted Orthopaedic Surgery

Decision

- Level 1 : based on morphologic data

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DePuy a Johnson & Johnson company Planning Tibia LCS Gauche FTPG EXIT

Taille implant: 4
Hauteur de coupe: 6 mm
Pente tibiale: 7°
Varus: 0°
Latéral: 0 mm
Antéro / Postérieur: 0 mm
Rotation axiale: 0°

Optimiser le planning

Vérifier la proposition de planning, éventuellement ajuster la position et l'orientation de l'implant

ML
Tibia=78.4 mm
(3.5, -2.2)
Fémur=Std+

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Decision

- Level 2 : based on dynamic per-operative data

Sensor



Software

Spacer



HkPA: 181°

- Alignment

- Quantitative data on GAPS

12.0mm

10.0mm

Valgus
1.0°

Flexion: 5°

Rotation tibia: 2°

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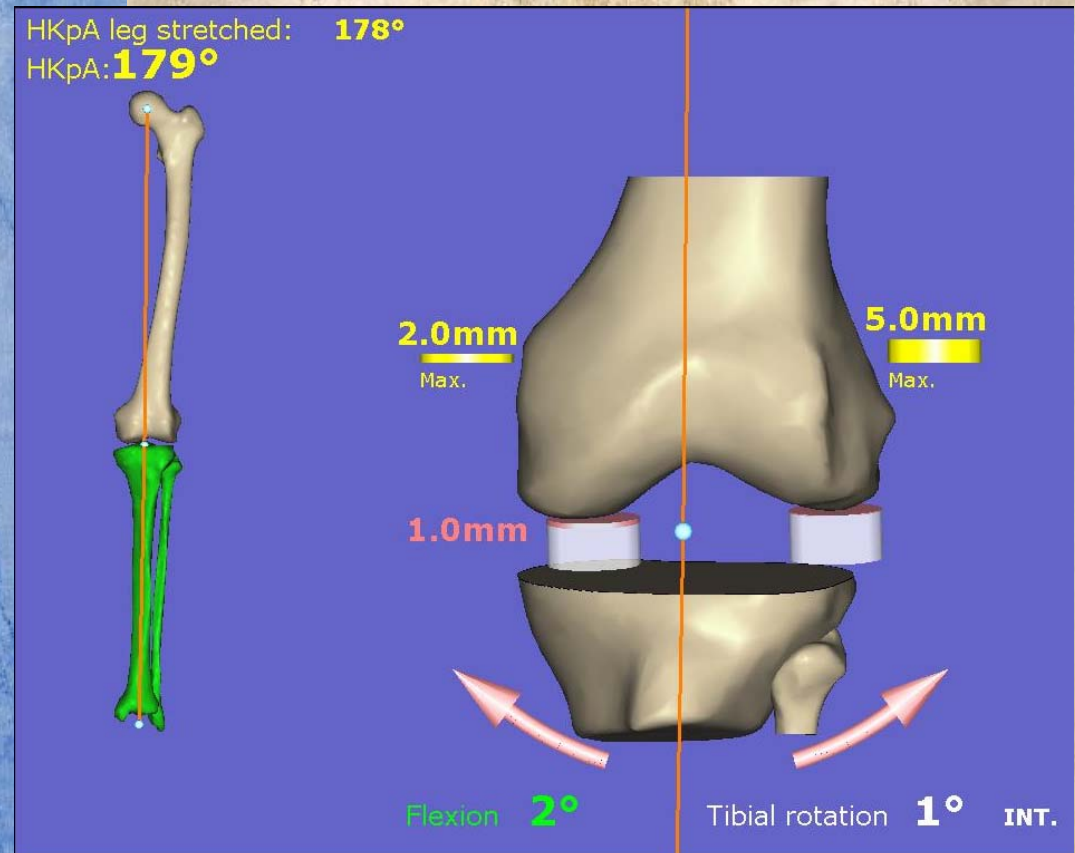
Decision

- **Level 2 : based on dynamic per-operative data**

- **Test residual laxity**

- **Varus Max.**
- **Valgus Max.**

- **If the residual laxity is over a threshold**



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Decision

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

