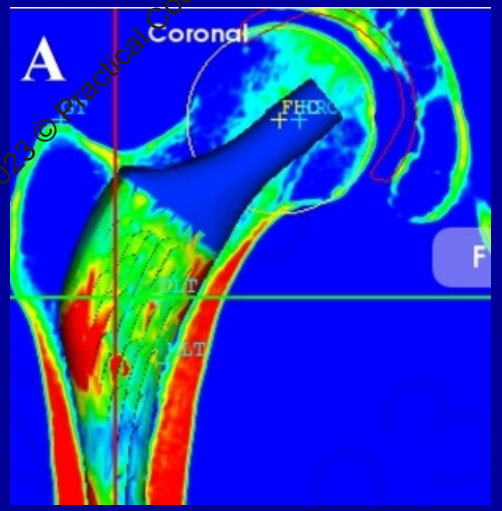
The scope and accuracy of HIP-PLAN Software in the reconstruction of the young adult hip

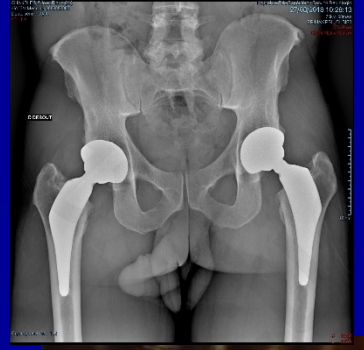
Low dose calibrated CT-scan Based 3D planning



Professor SARIALI

La Pitié Teaching Hospital

Paris, France

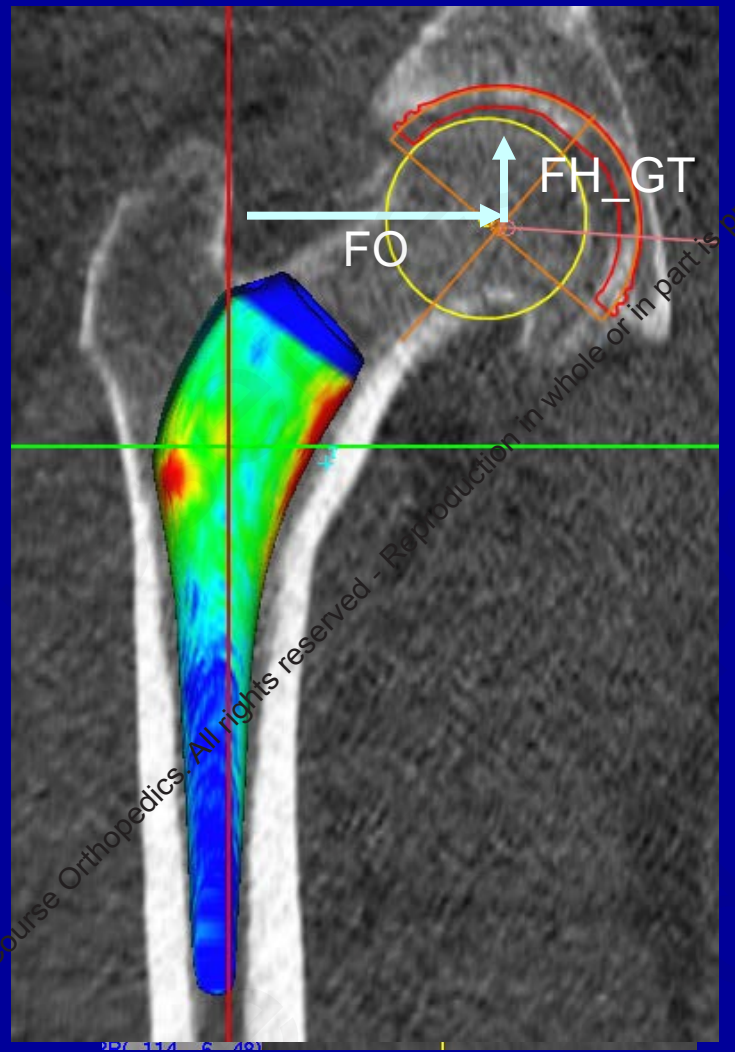


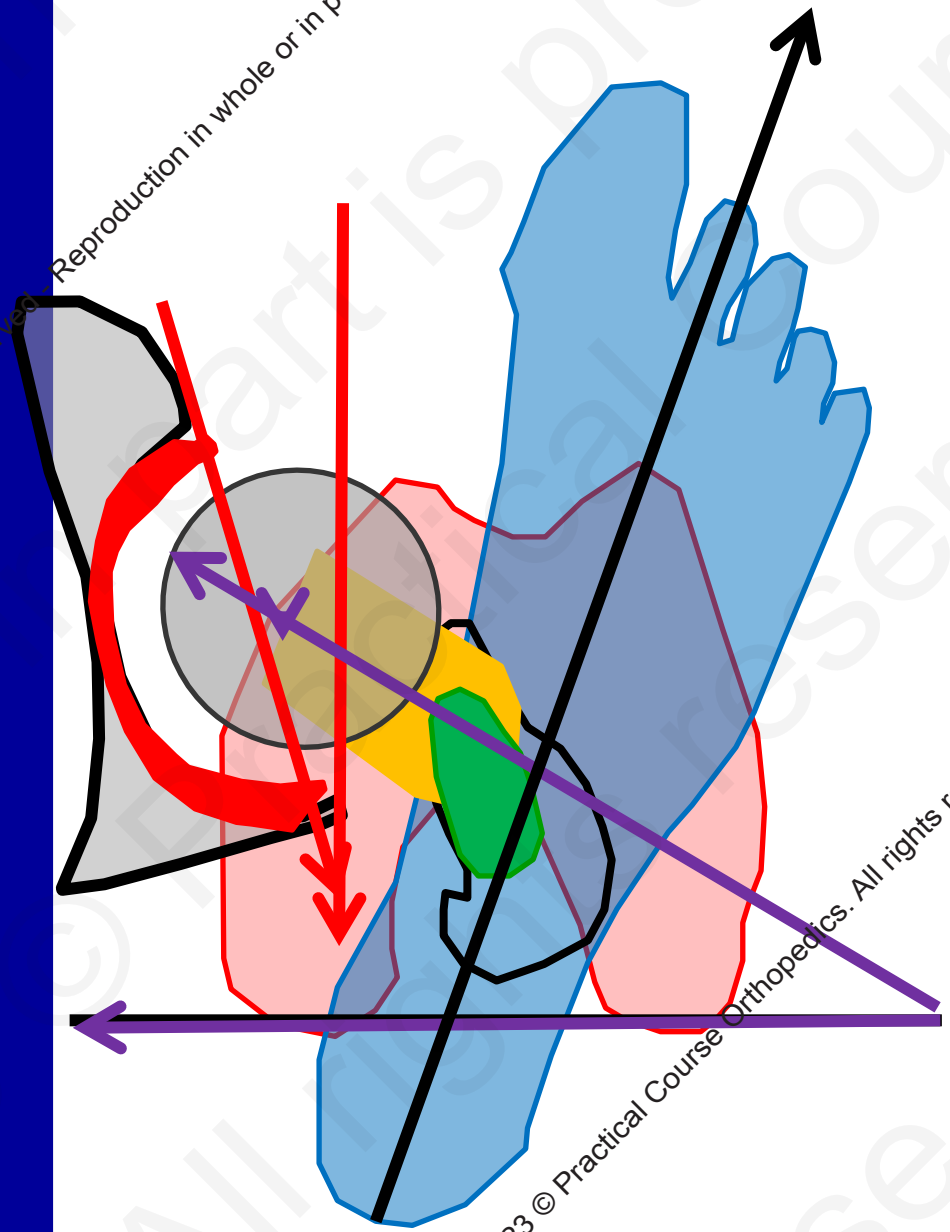
Goals

- Restore hip function
- Restore biomcanics as close as possible :normal
- Accurate 3D Planning
  - Analyse 3D hip anatomy
  - Anticipate difficulties

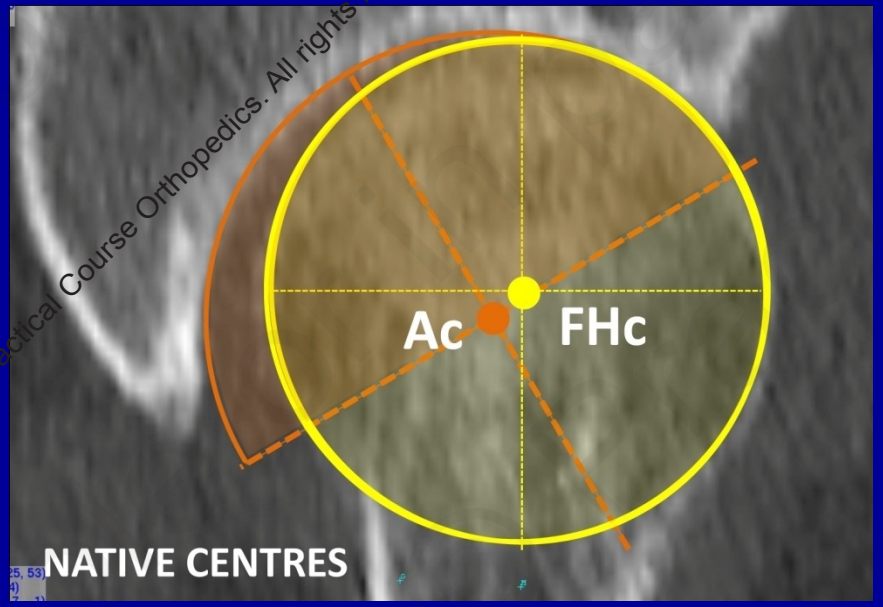
What are the anatomic parameters influencing the hip biomechanics?

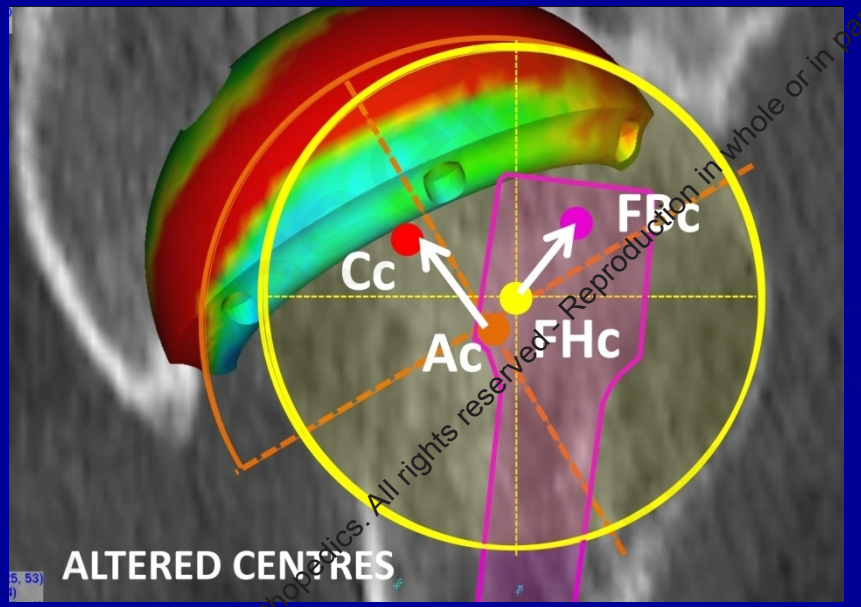
- Hip Rotation Centre
  - Medial lateral position
  - Cranio-caudal: 10 mm
- Head femoral Centre
  - Leg length: LLD 10mm: Legal Action
    - Asymmetric increase in muscle group activity
    - Lateral imbalance
  - Femoral Offset
    - Decrease 12%: decrease in abd muscle strength
    - 20%: Limping
- Acetabular/ Femoral anteversion
  - Alteration of the global anteversion →
  - dislocation



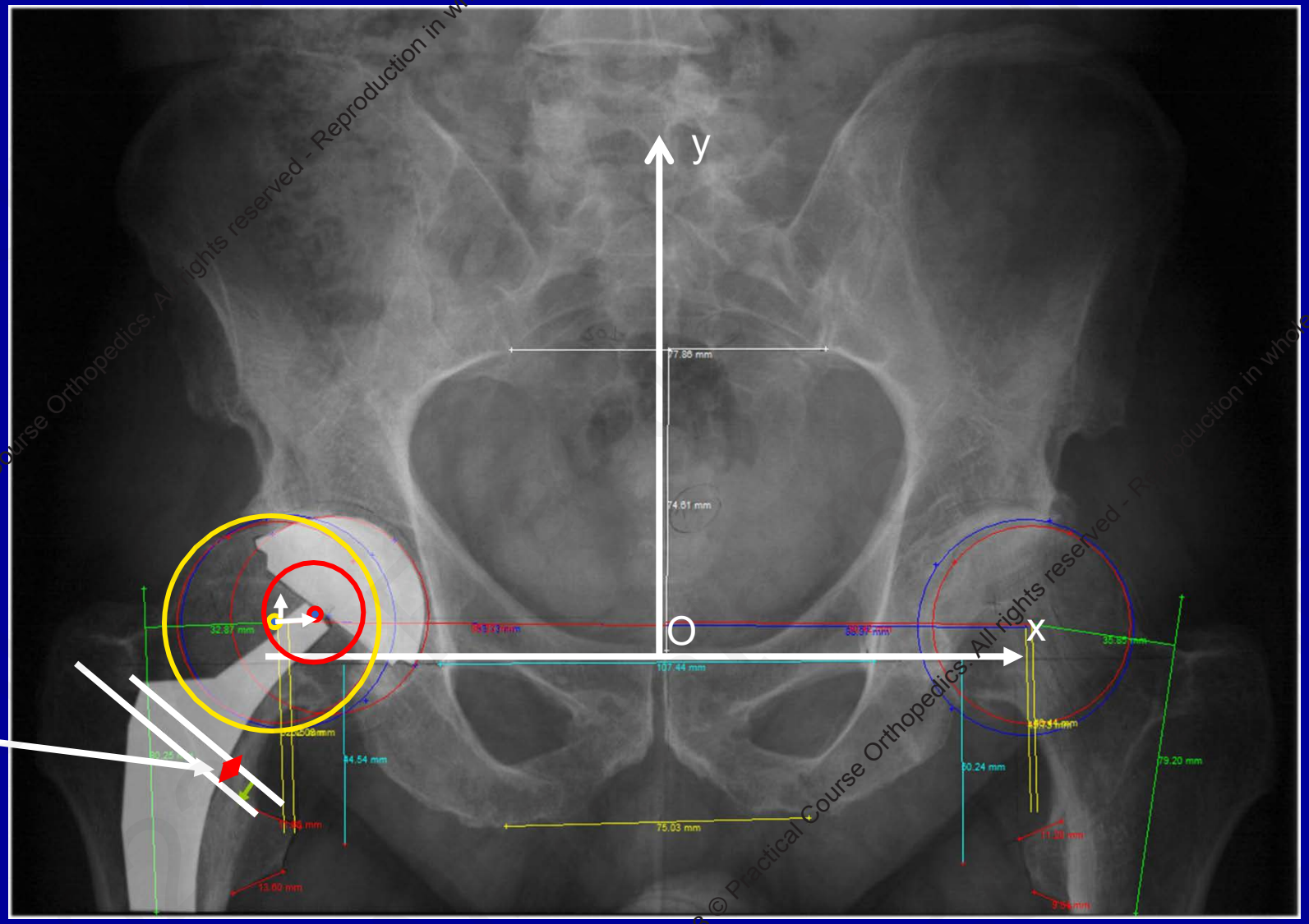


Kinematical Alignment
3D assessment of Biomechanical alteration induced by arthroplasty
Global vectorial ateration =0





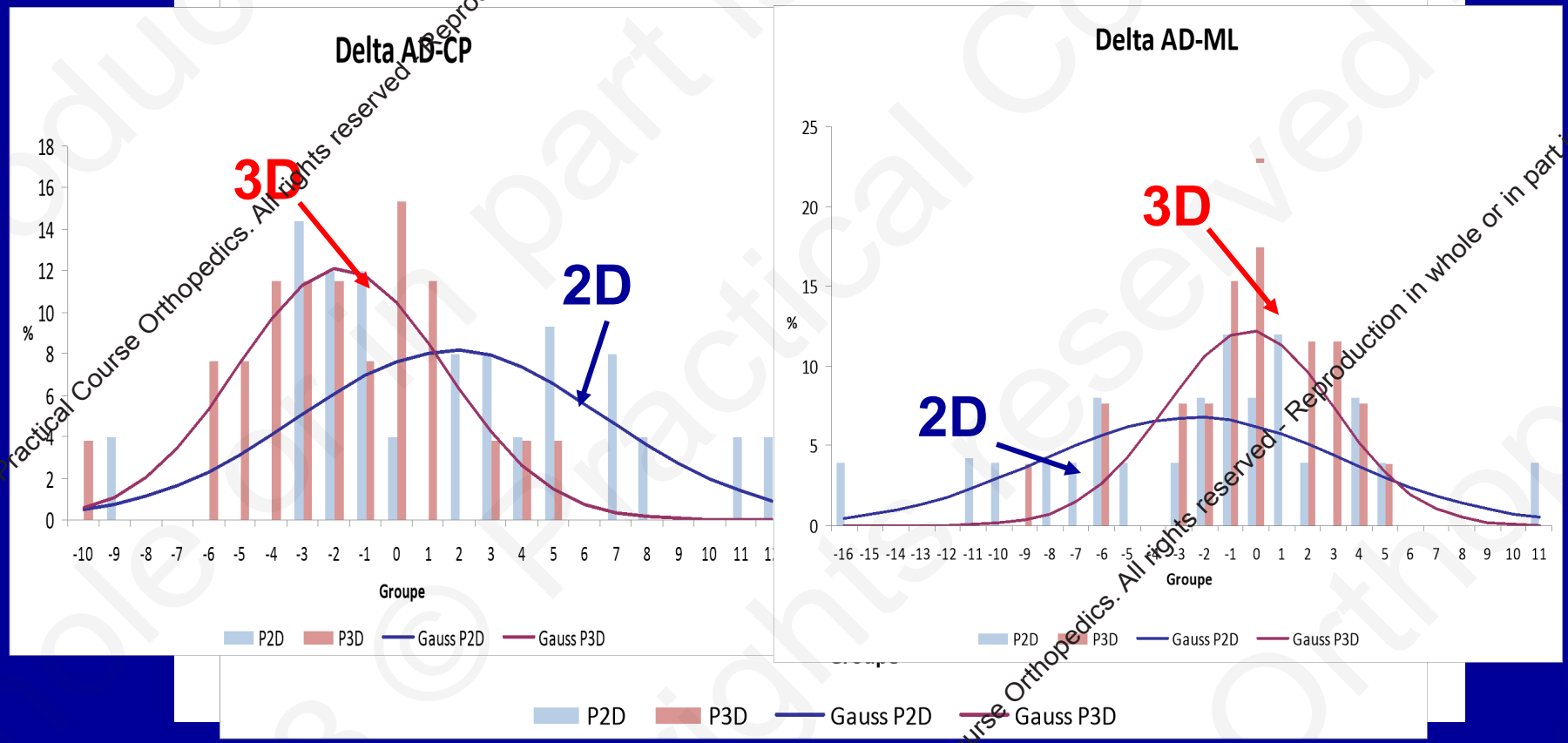
Reference Technique: 2D



- Templates magnification coefficient of: 1.15

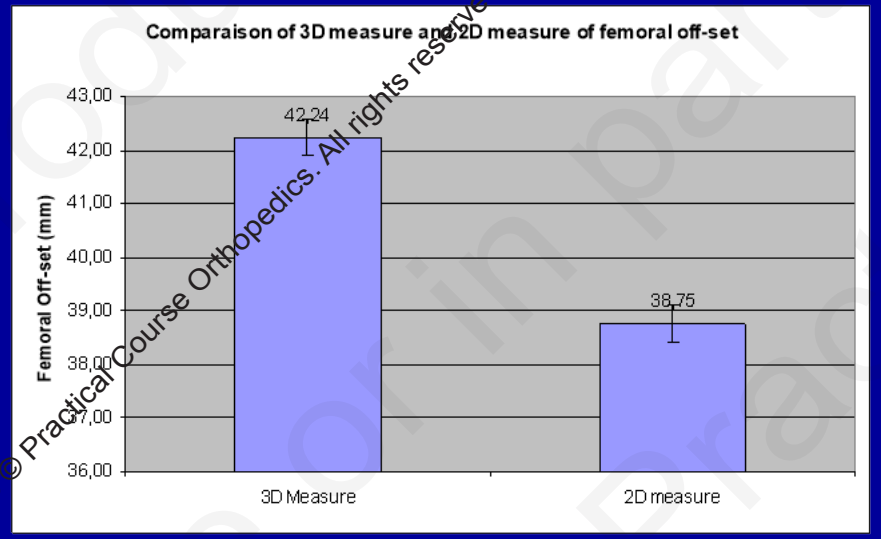
Limits of 2D planning:
Low accuracy: Length/ FO/ COR

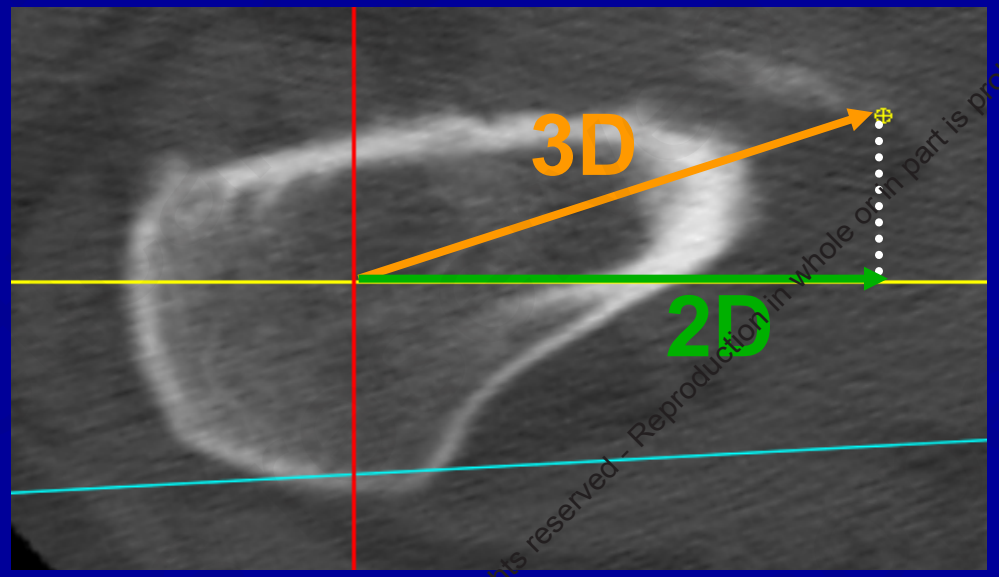
Sariali et al: JBJS 2009 et OTSR 2012



- 25 to 75% versus 94 to 10% for 3D
- Length and offset: +/- 6mm → outliers

Limits of 2D planning
Under estimation FO
Sariali et al JOA 2008



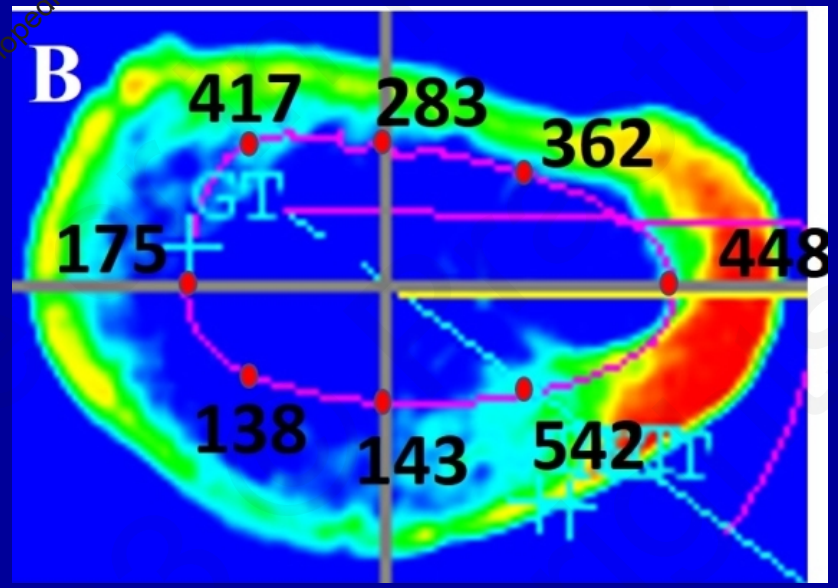


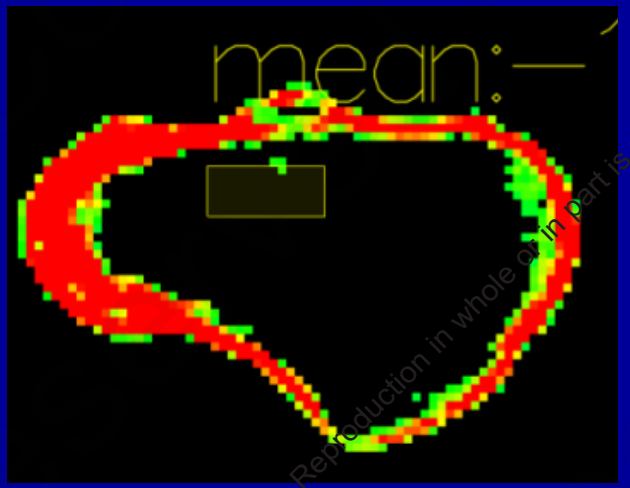
3.5 +/- 2.6 mm

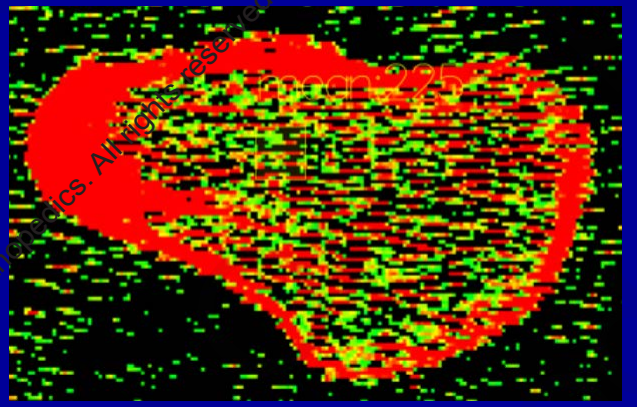
Max 13 mm

Limits of the 2D Templating unavailable date : bone Density

- impose →
  - Fixation mode
  - where stem will be seated

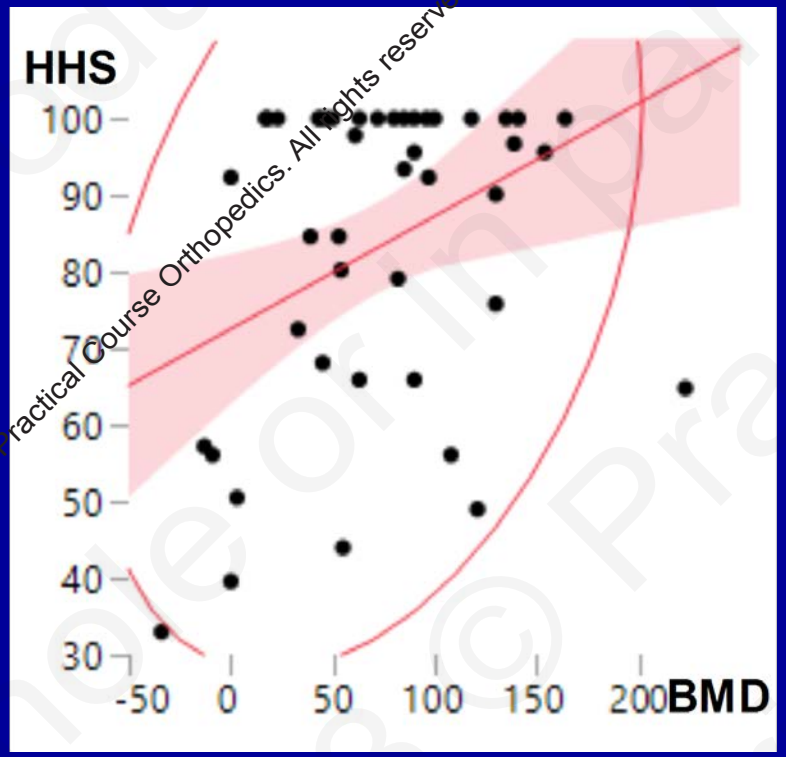




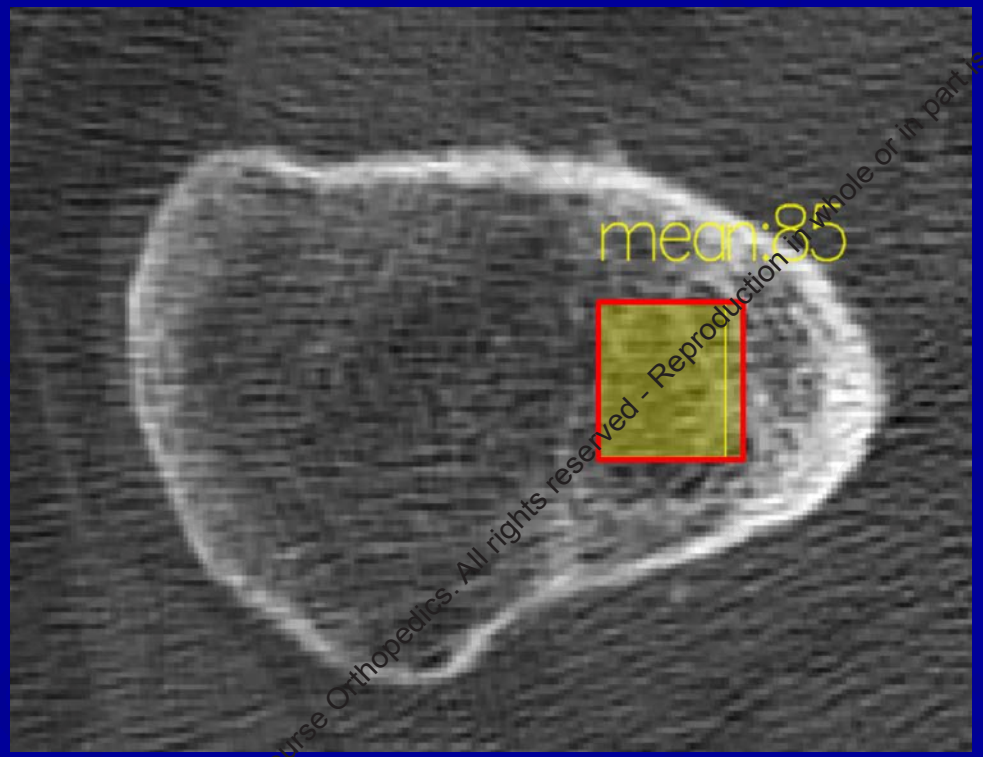


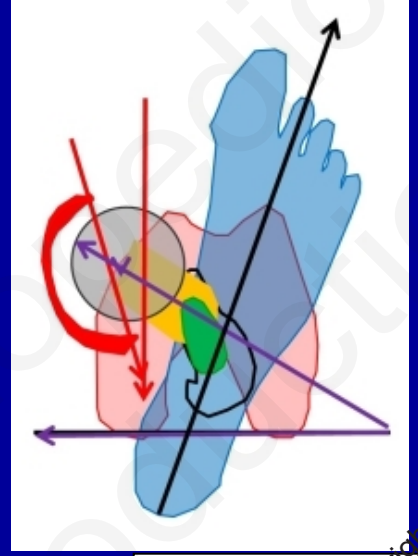
Preop BMD correlates with clinical outcomes

Sariali et al Int Ortho 2020



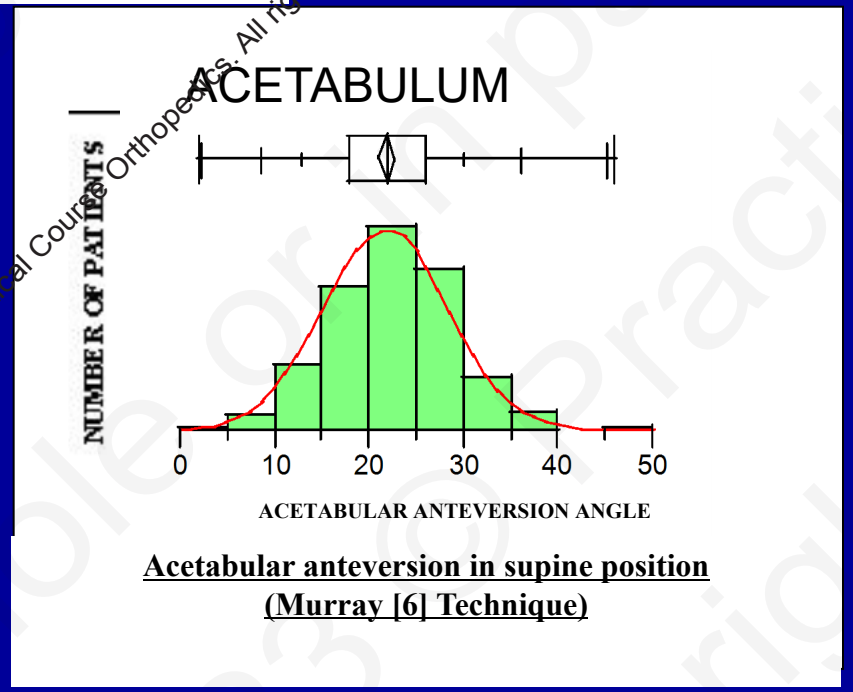
Cut-off: 72 g/cm3





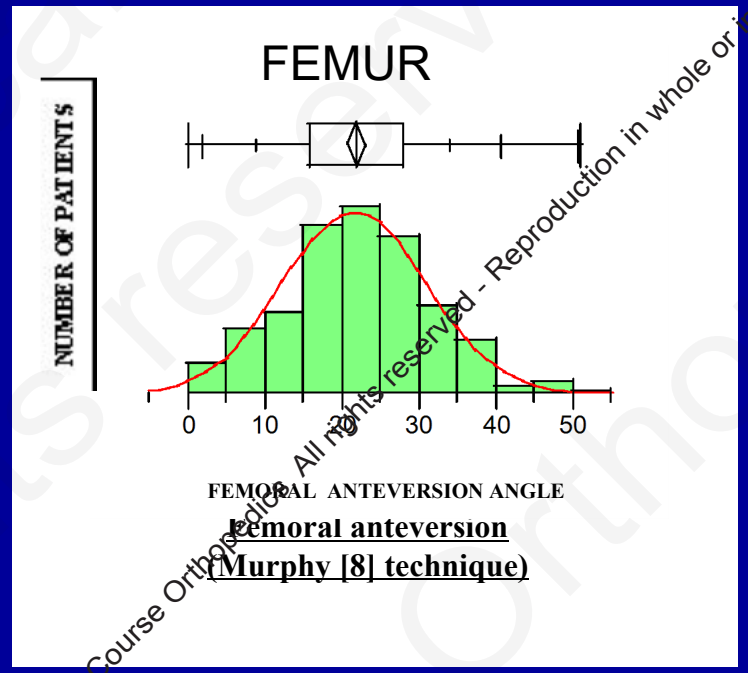
Limits of the 2D Templating unavailable date :Torsions

Sariali et JBJS 2009



Acetabular anteversion in supine position (Murray [6] Technique)

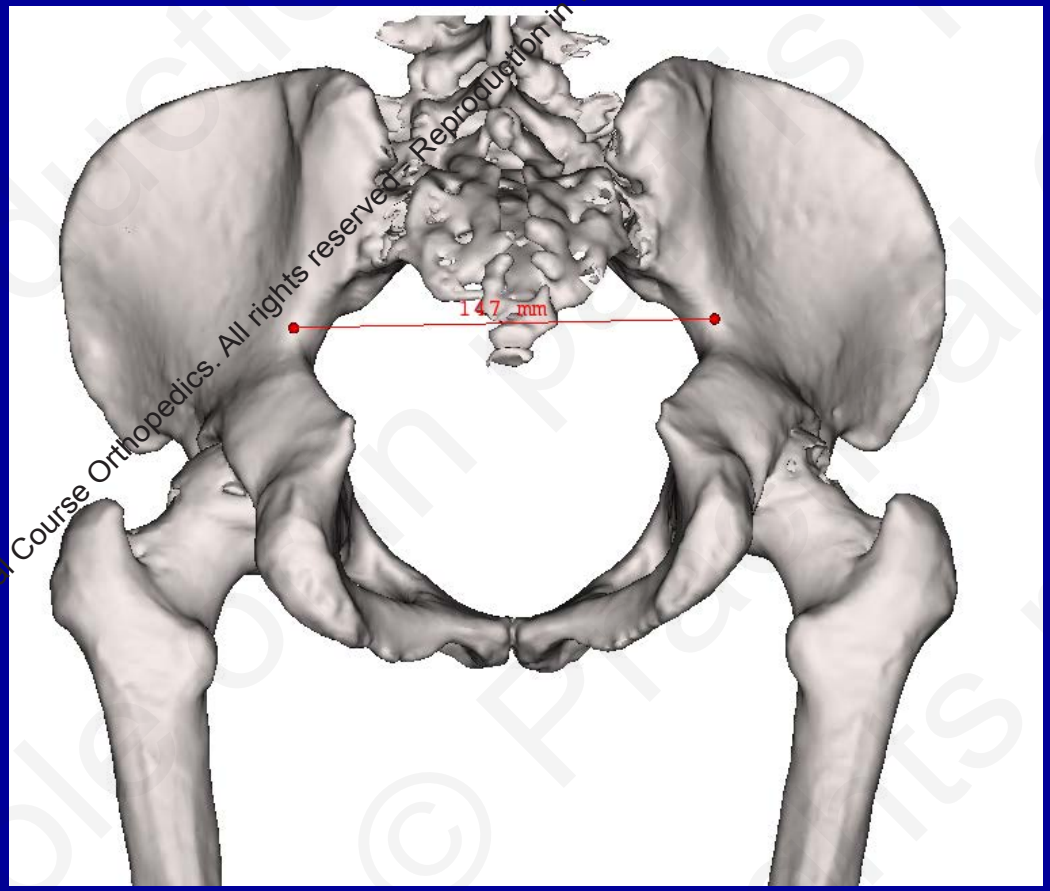
21.9° +/- 6.6°

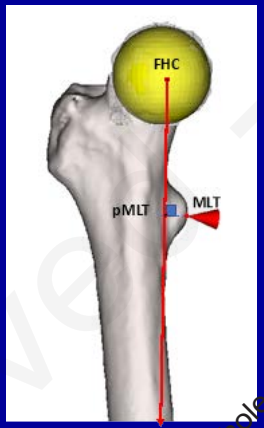


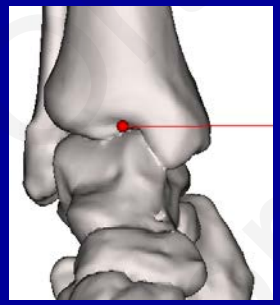
Femoral anteversion (Murphy [8] technique)

21.9° +/- 9.4°

3D Models for LLD ANALYSIS







Higher Reliability for 3D measurments

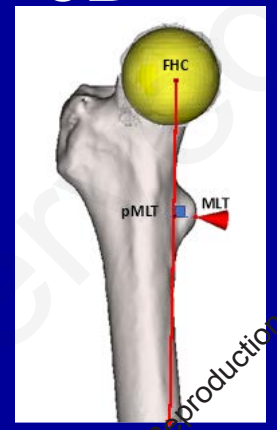
Sariali et al Int Orthop 2021

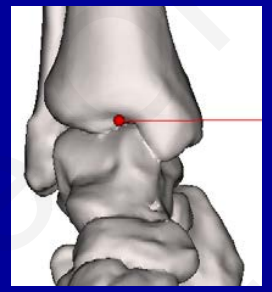
- Intra-articular LLD

2D

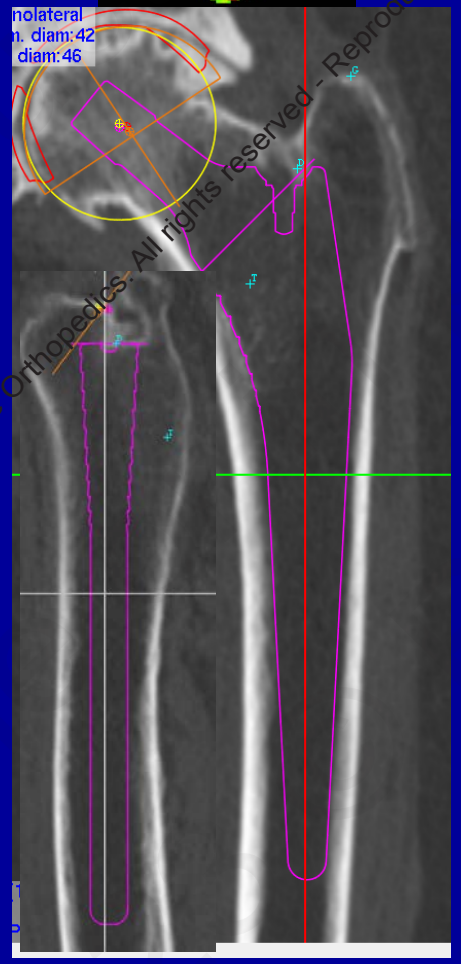
- Intra class correlation
  - 0.8 for 2D
  - 0.95 for 3D

3D

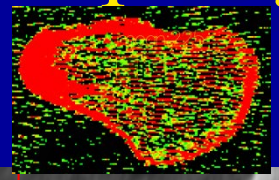


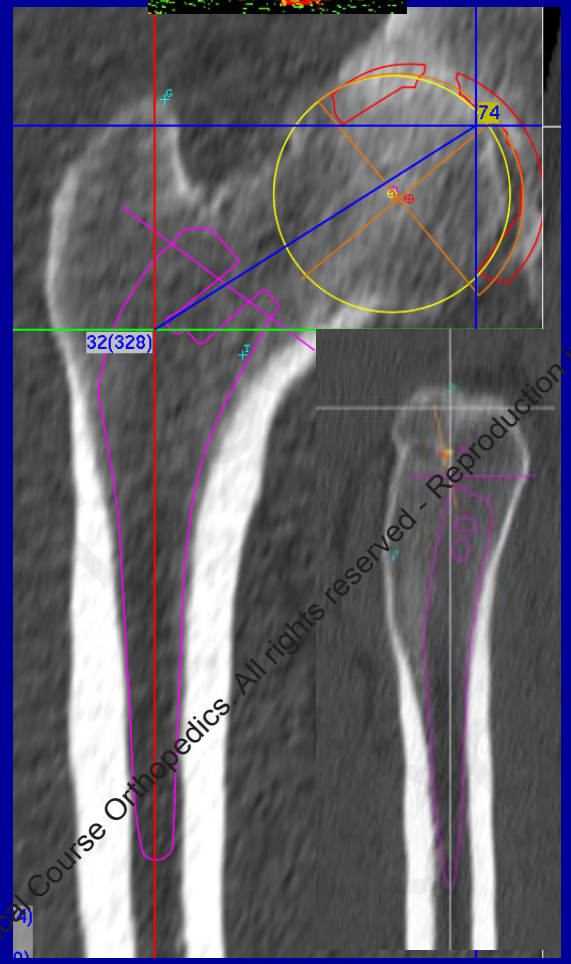


Bone Density/ Femoral Morphotype



STOVE PIPE/ EMPTY FEMURS

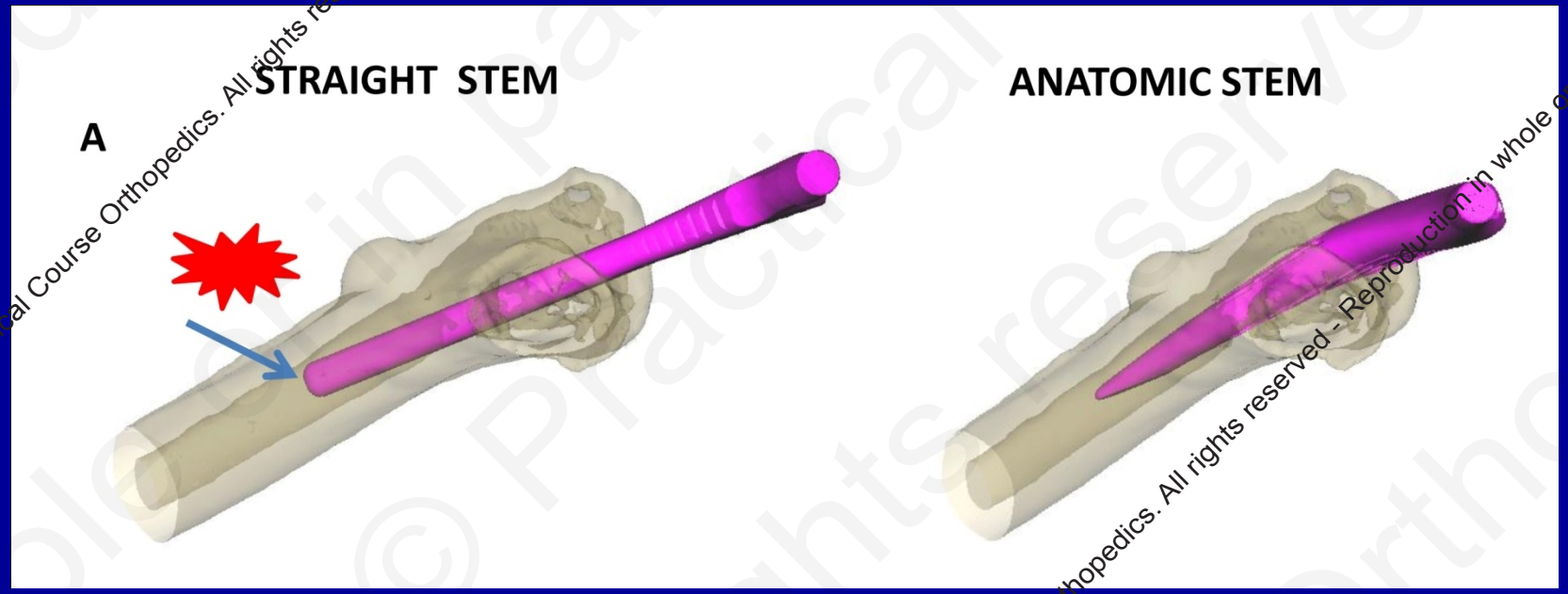




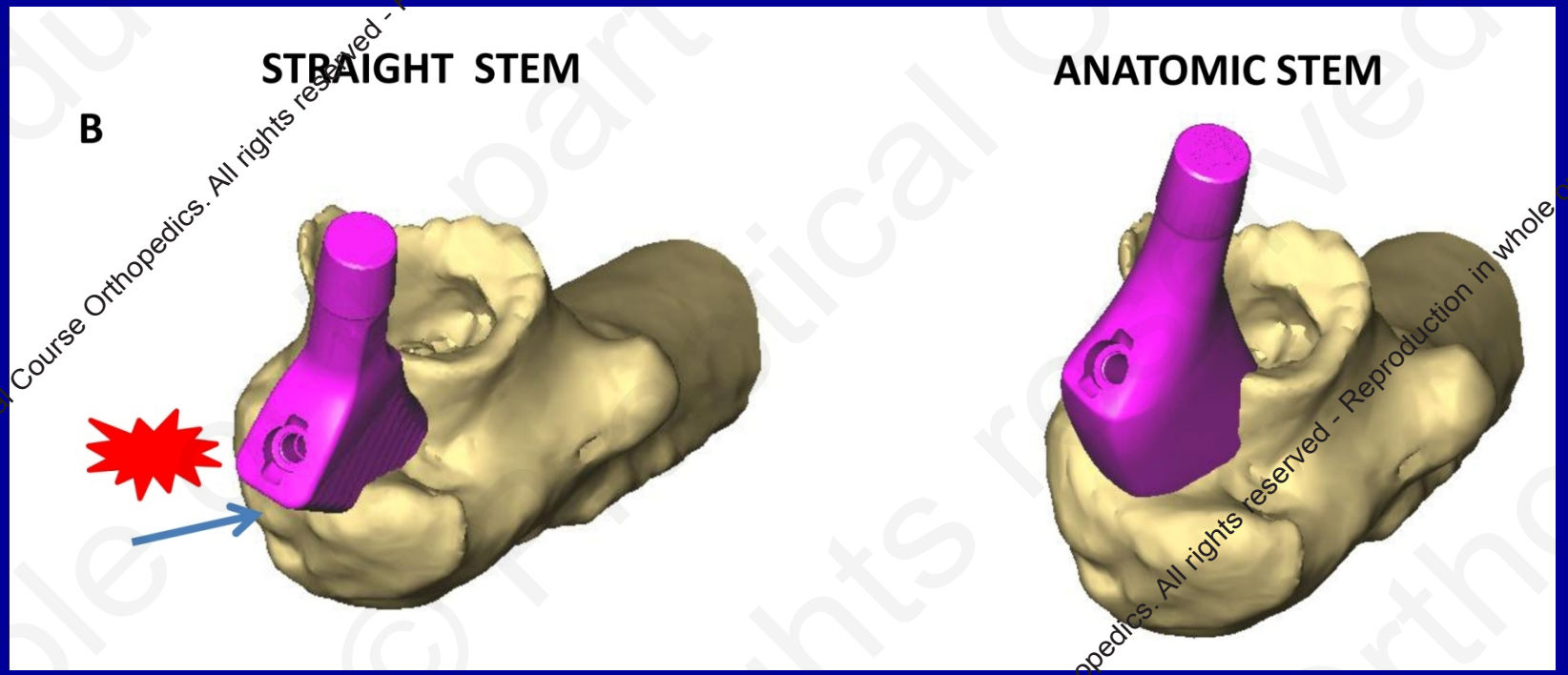
CHAMPAGNE FLUT/ HARD BONE

Adapt the stem design according to the femur morphotype

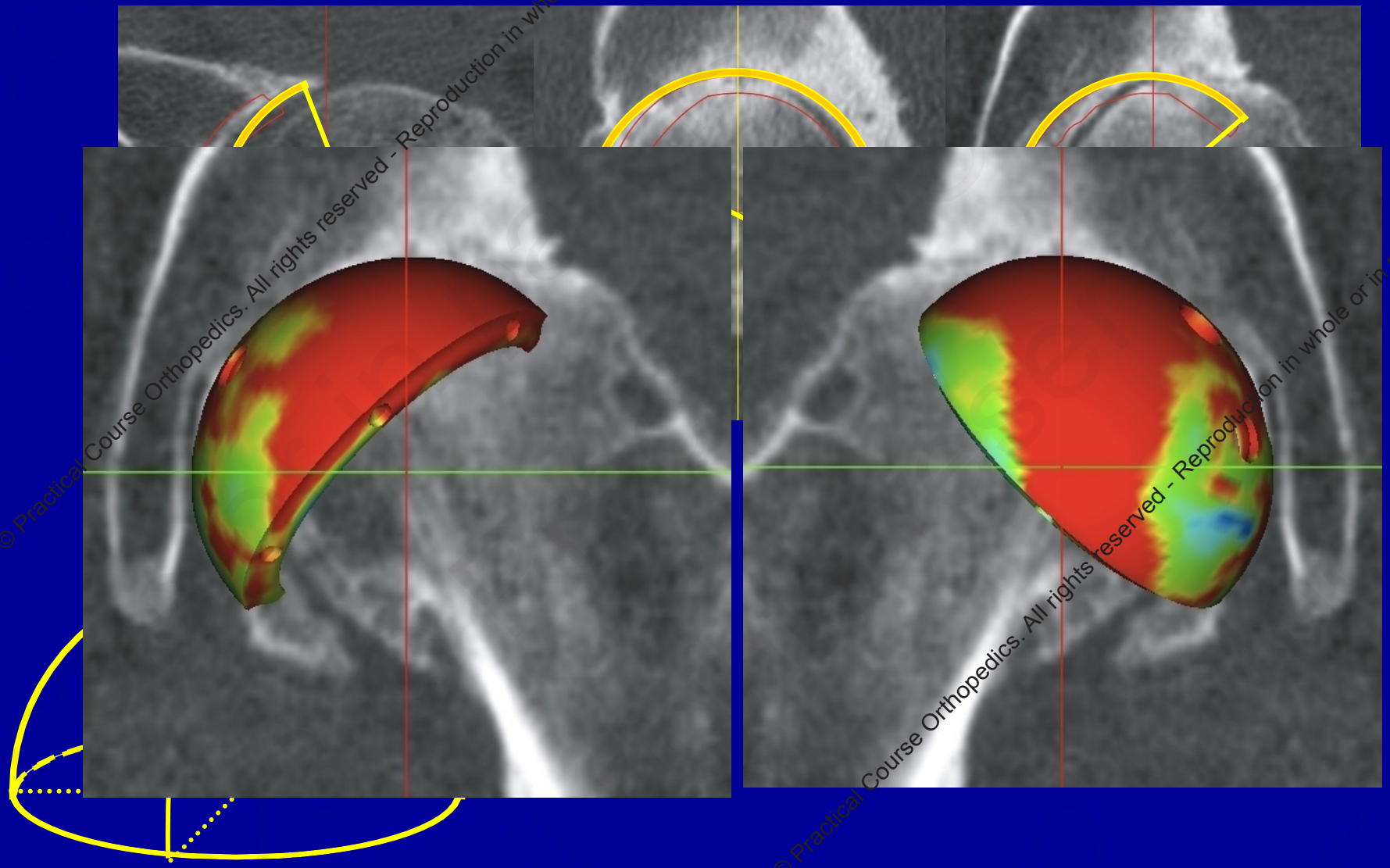
Anatomic stem in case of a high anterior proximal femur flare



The value of anatomic stem in medially deformed greater trochanter

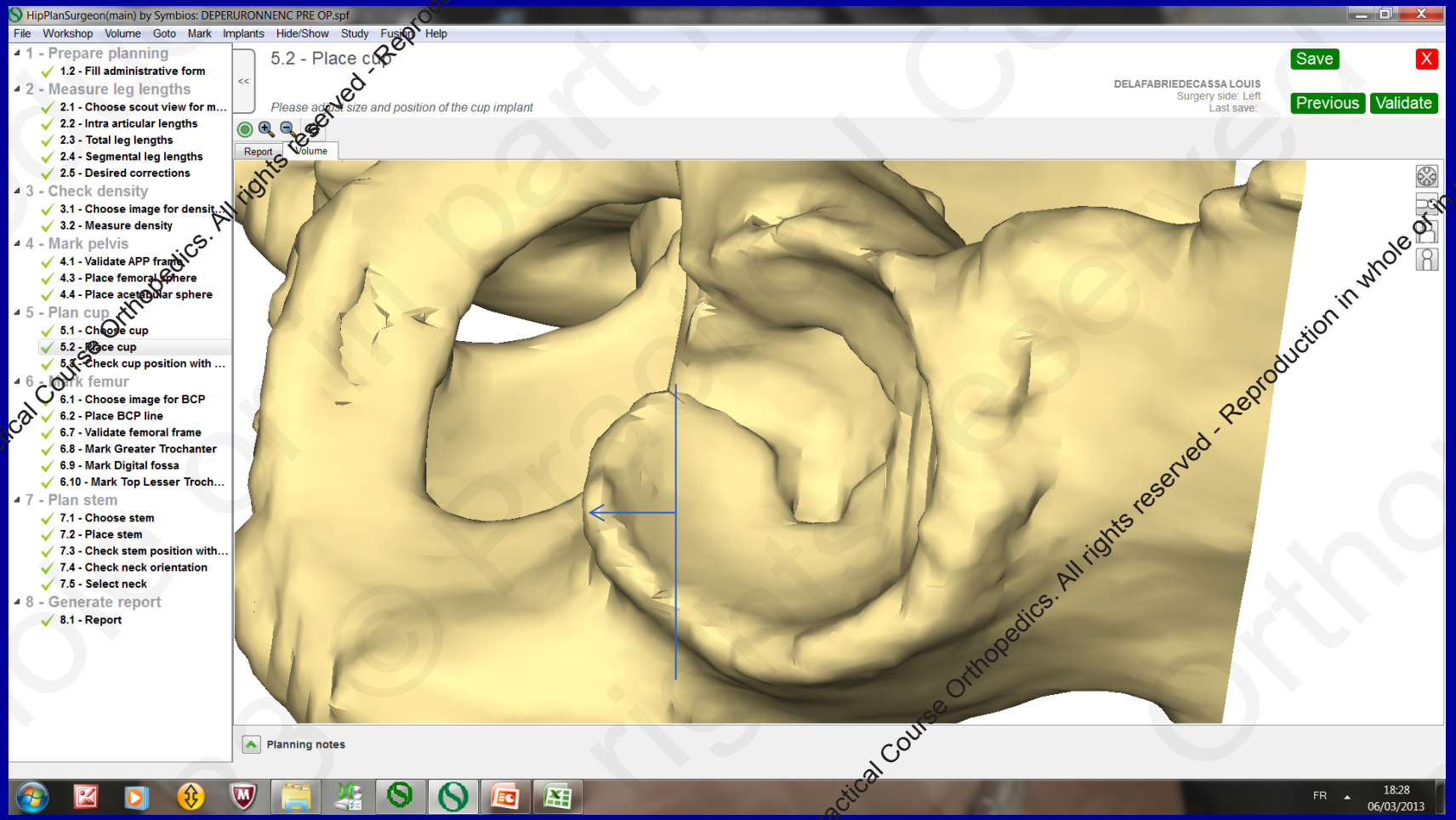


3D Cup Planning

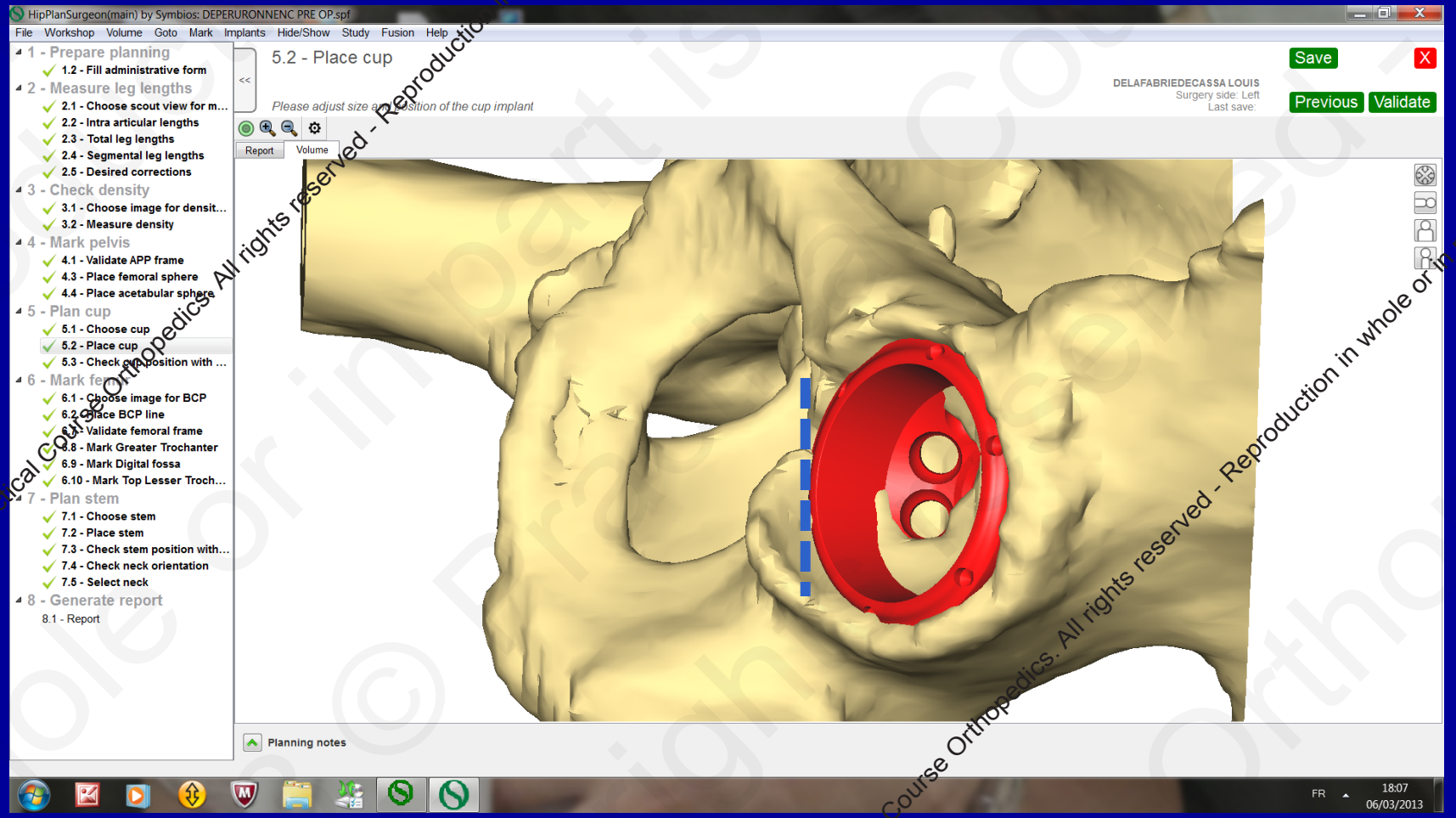


Half-sphere

Preoperative Visualization tool

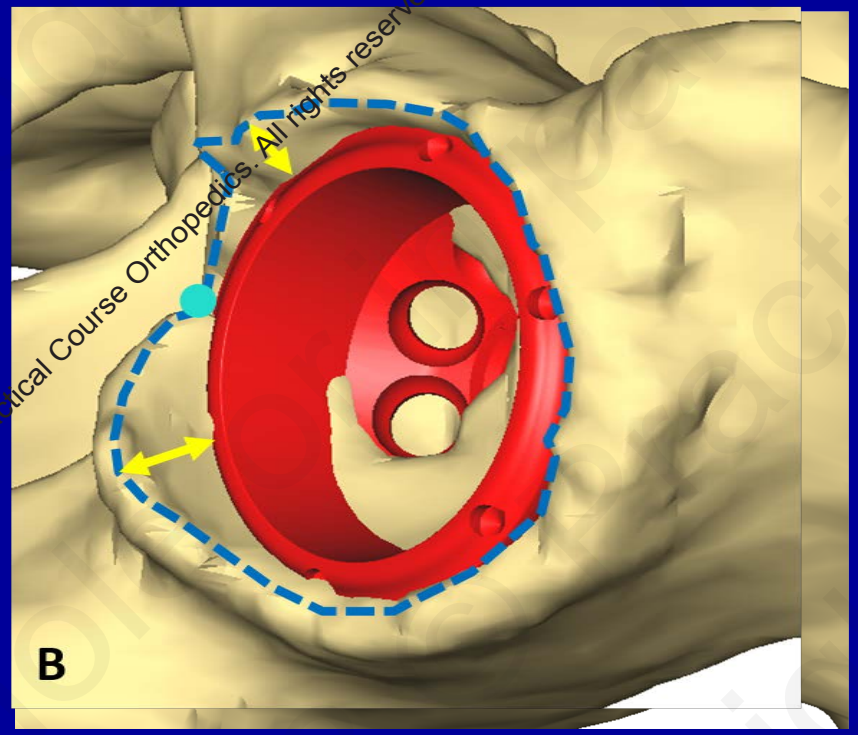


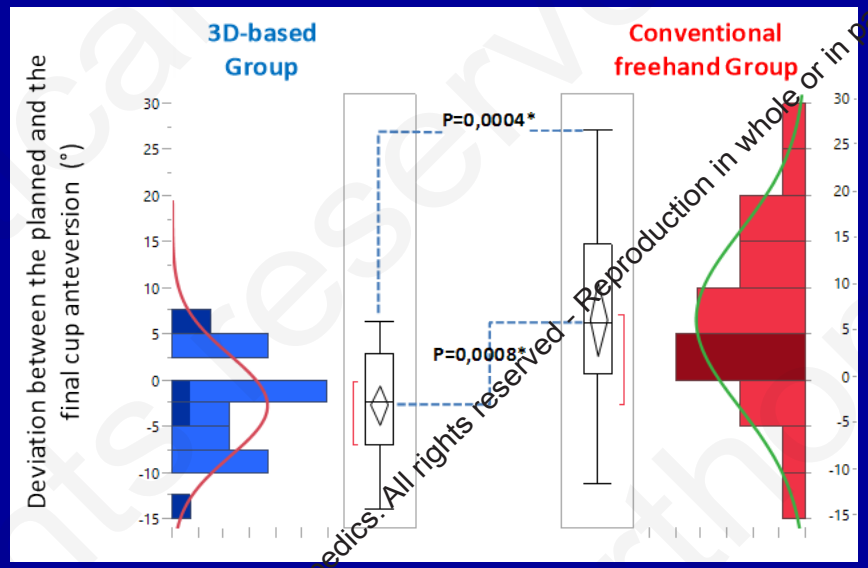
Preoperative Visualization tool



The value of 3DP visualisation tools for cup positionning

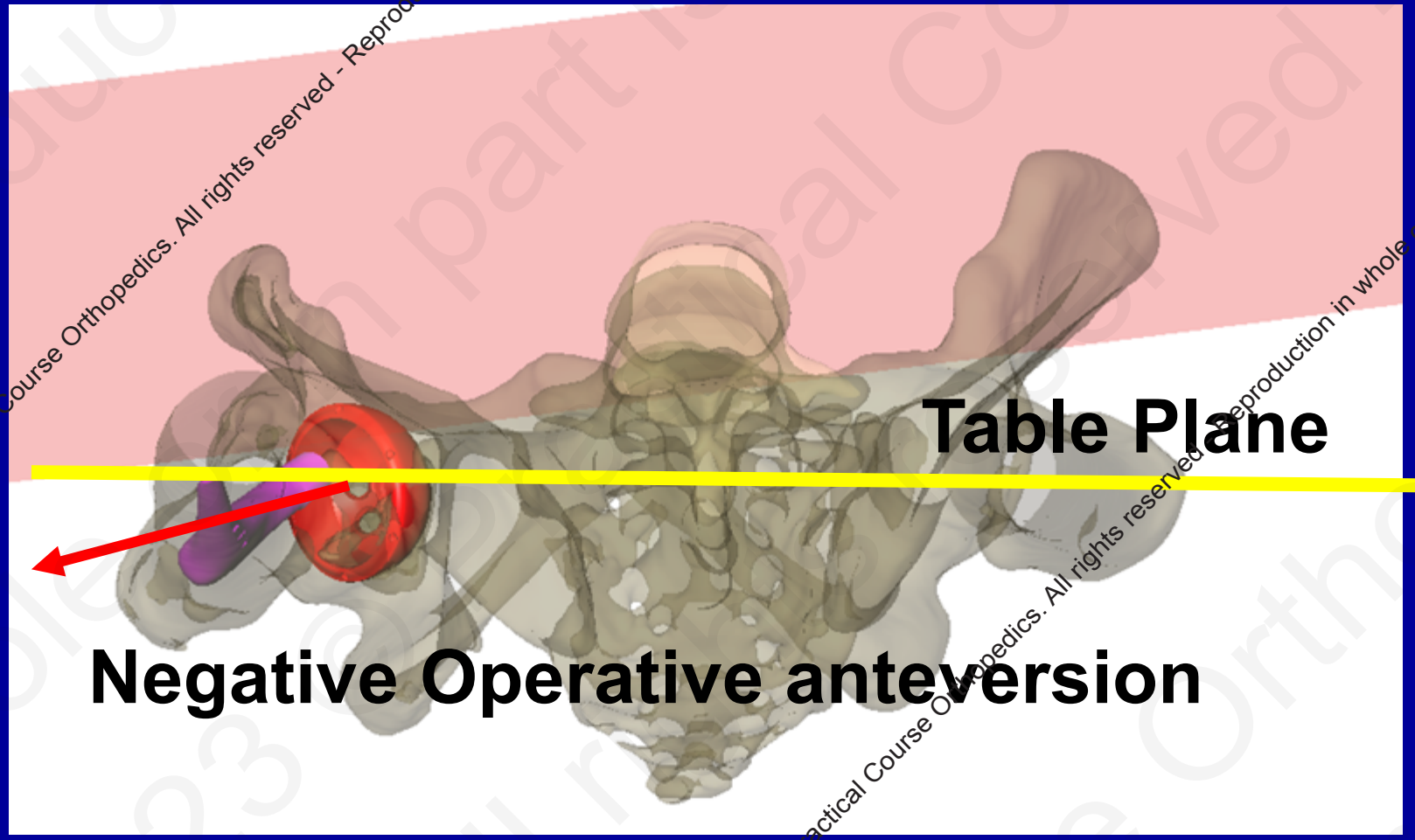
Sariali et al JBJS Am 2016



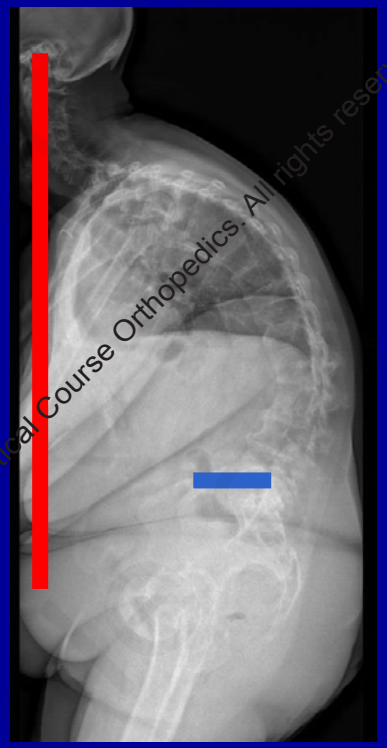


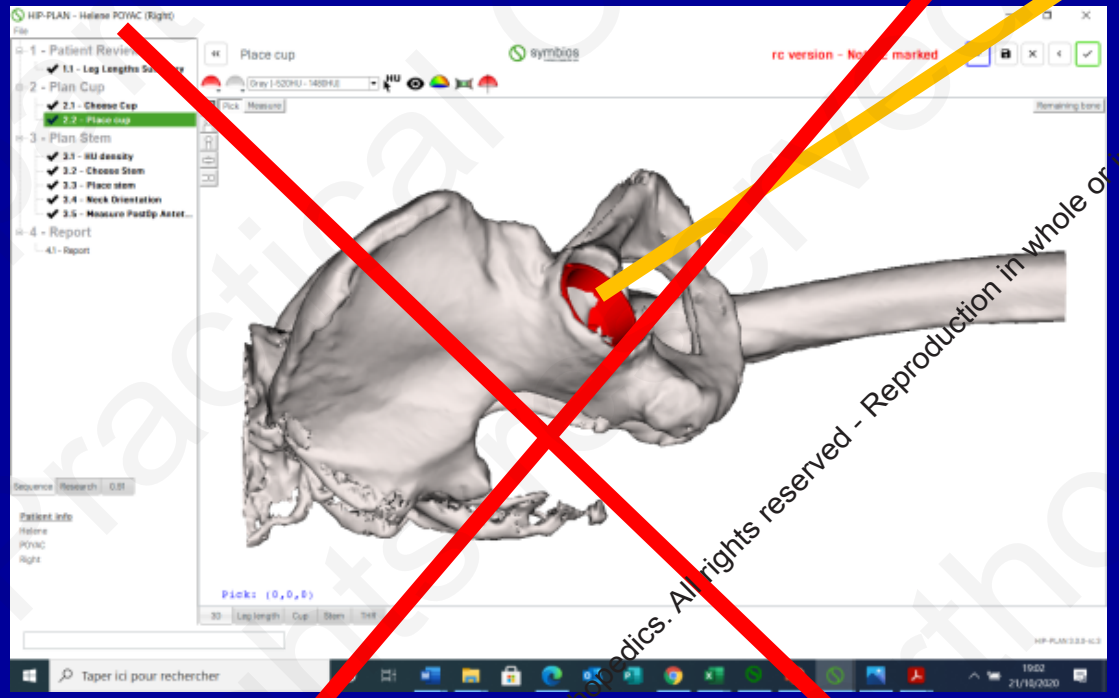
Etude prospective randomisée en cours de publication

Pelvis fixed anterior flexion



Fixed Spine deformity: no adaptation avoid increased operative cup anteversion

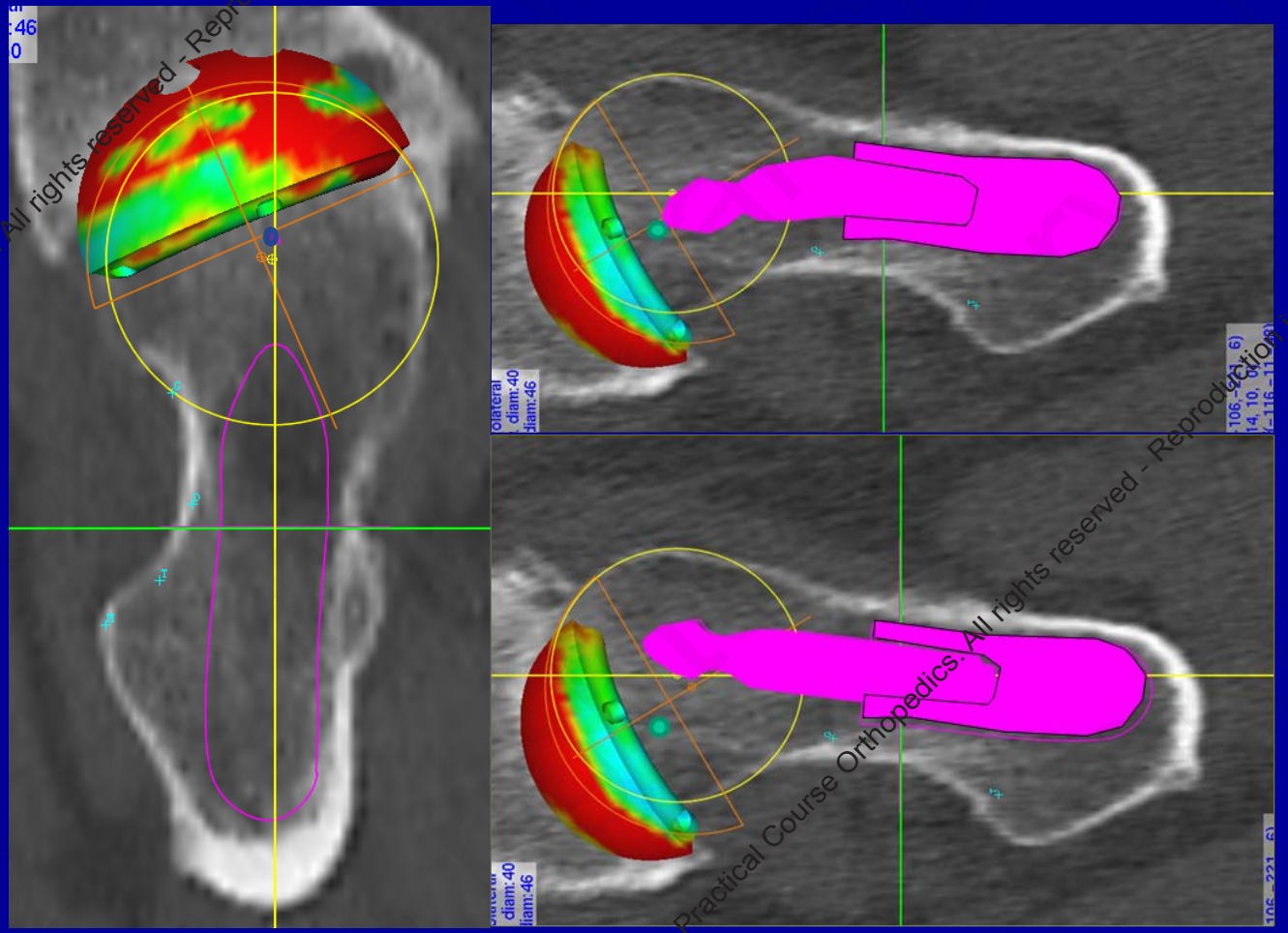




don’t follow bone landmarks

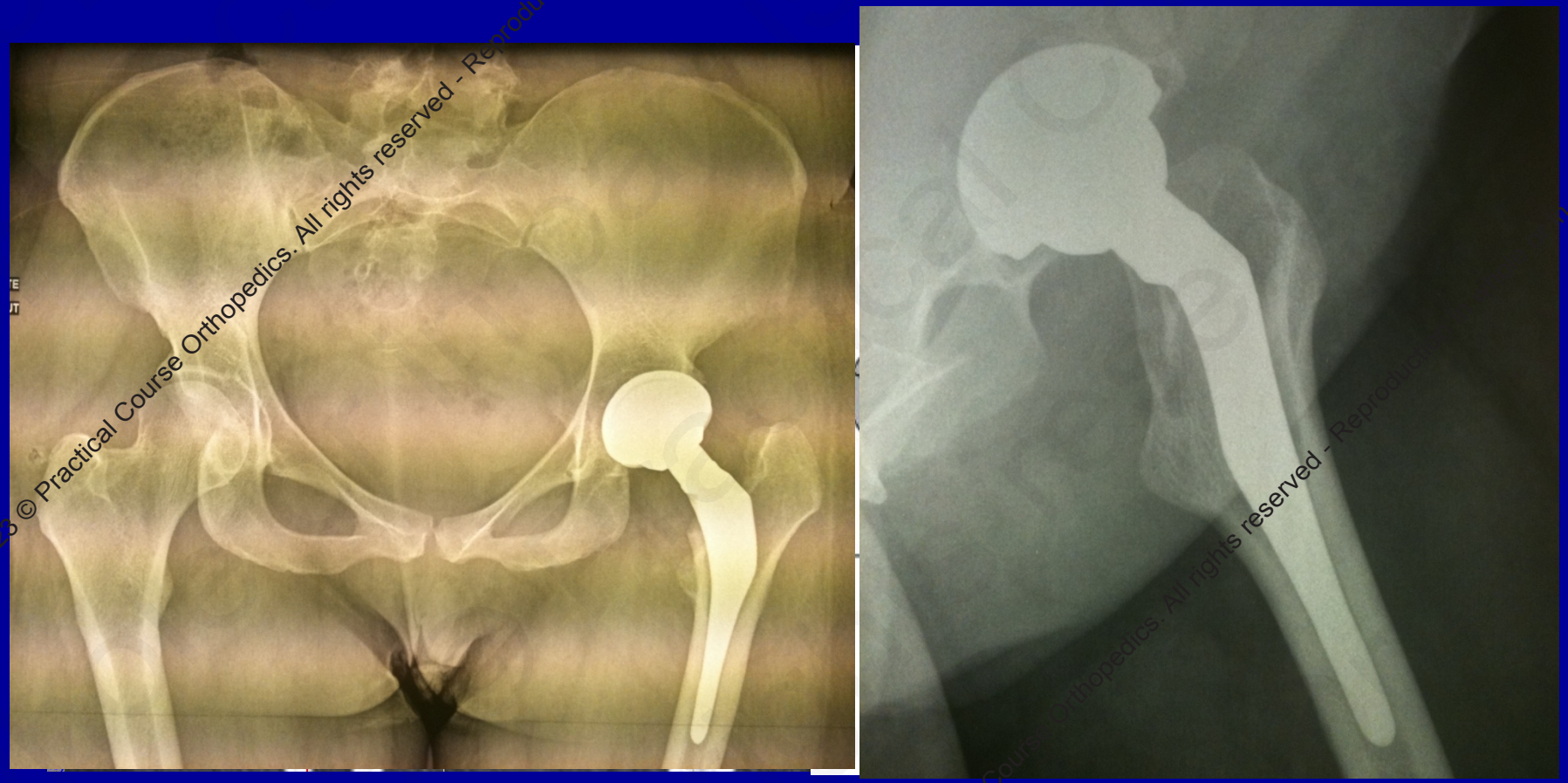
Adapt femoral anteversion

- Mismatch between the acetabulum center Femoral ball center



Custom designed stems based on CT scan

- Torsional abnormality of the femur



A 20-year follow-up evaluation of total hip arthroplasty in patients younger than 50 using a custom cementless stem.

Dessyn E[1], et al

Accuracy and clinical results

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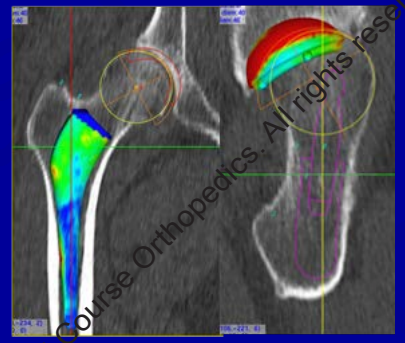
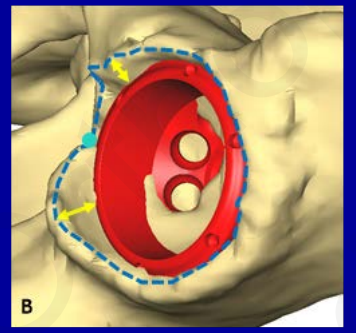
Material and methods

- Study data collected prospectively : Orthowave v7
  - 1210 consecutive patients
  - 603 F 607 M
  - Aged: 60 ans ±14;
  - Operated 2009 - 2015: 1 senior surgeon
  - Direct anterior approach

- Preop CT-Scan
  - 3D Planning(Hip Plan)
  - Taille position implants

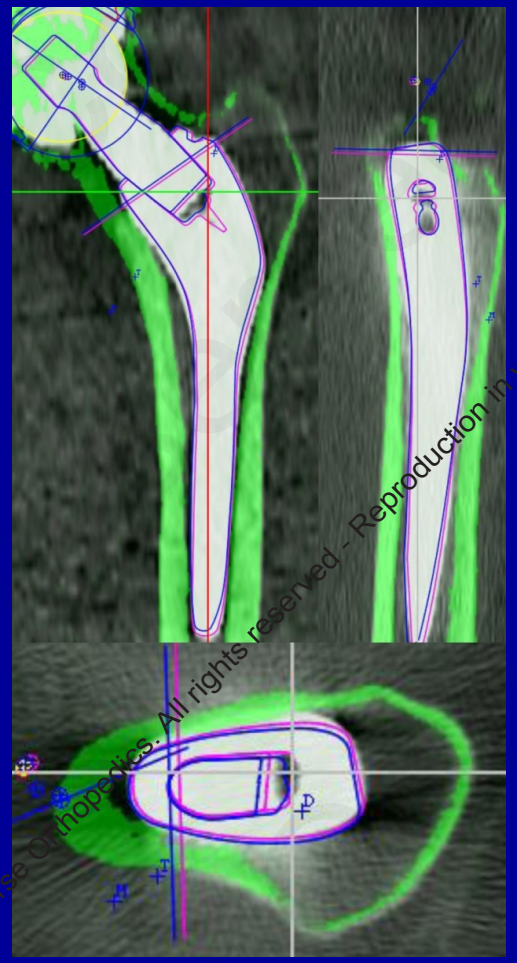




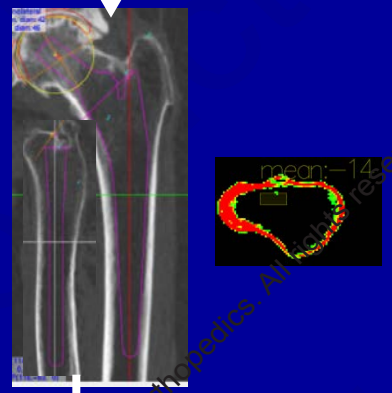
Material and methods

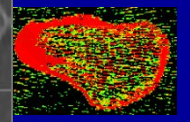
- Patients assessed at the last Follow-up with PROMS:
  - OHS: either by e-mail or phone
  - HHS:
  - Less than 5% of lost patients

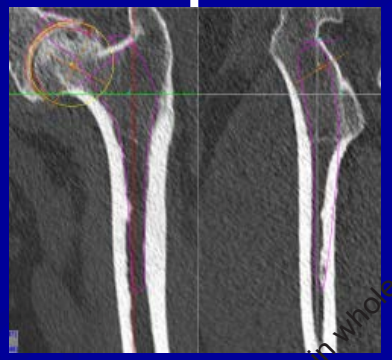
- 256 patients had: PostOP CT-scan and a matching Preop-PostOp



3D Computerised planning HIP-PLAN

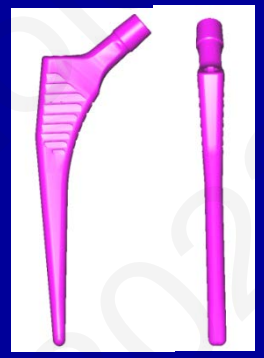






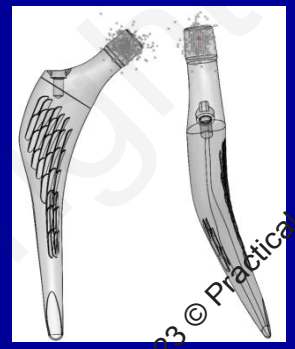
HARMONY

26%



SPS Evol

63%

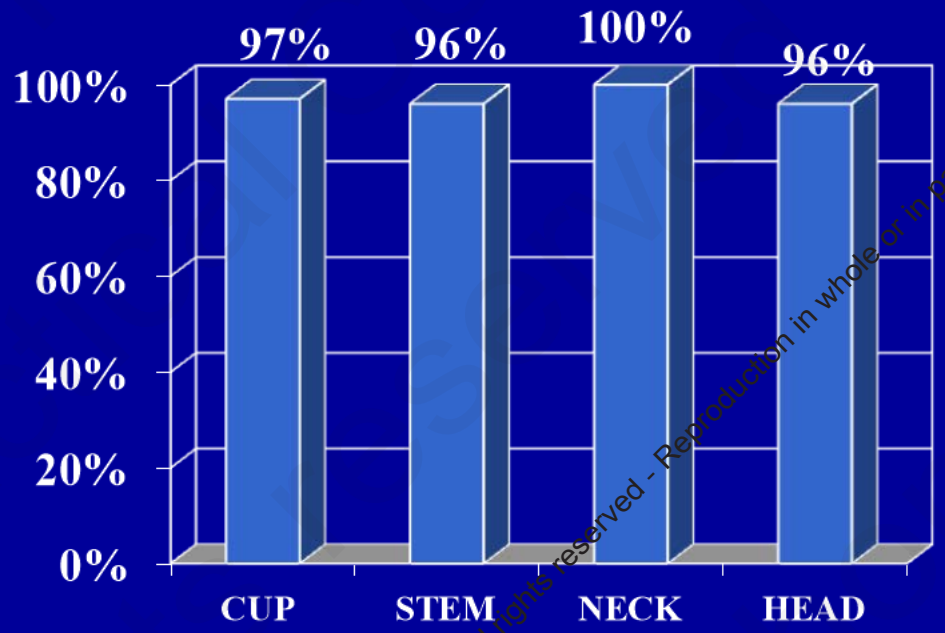


Custom Patient specific

11%

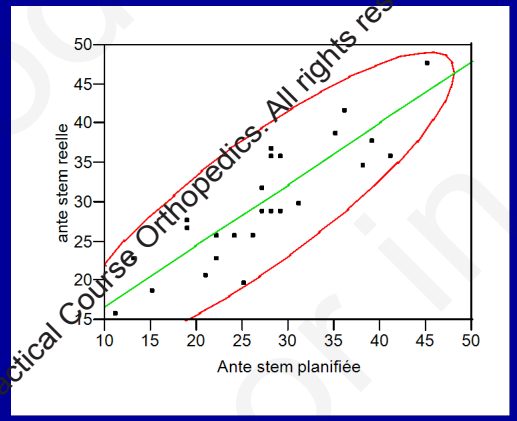
High Accuracy reconstruction

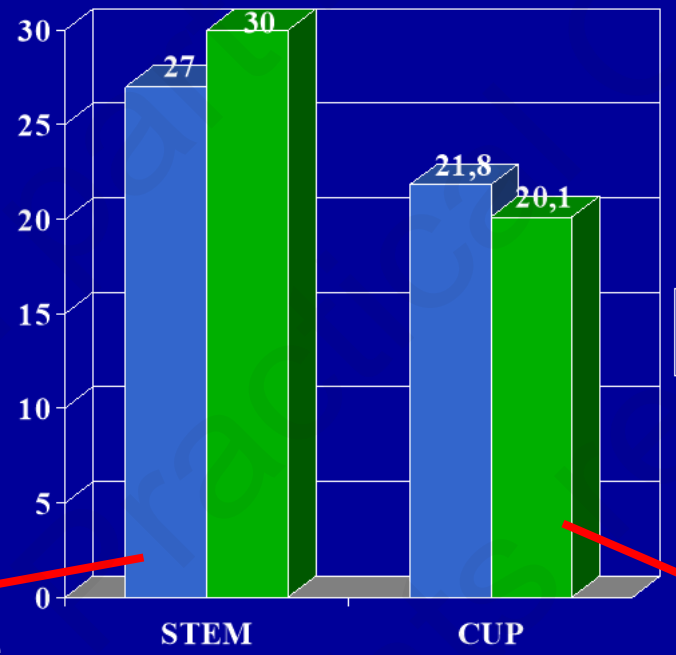
- Anticipation surgical difficulties
- High accuracy for hip reconstruction

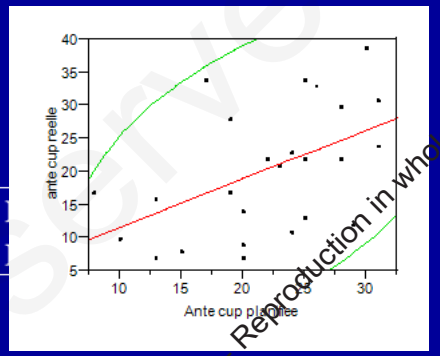


Within +/- 1 size : 100 %

Accuracy of anteversion angles restoration
256 patients







1- No significative difference (p=0.1)

2- Excellente correlation 0.87 (p<0.000001)

1- No significative difference (p=0.24)

2- good correlation 0.5 (p<0.000001)

Accuracy of reconstruction
Centre of Rotation, Length, Off-set
256 patients

	Hip Rotation center			Femoral Off-set	Lower limb lenght
	Cranio Caudal	Medial lateral	Antero posterior	Medial lateral	Cranio Caudal
Mean	-0.7	-0.4	-0.0	0,7	-1.3
Stdev	3	3	2.6	2.5	3.5
p	0,002	0,00001	0,62	0,008	0,40

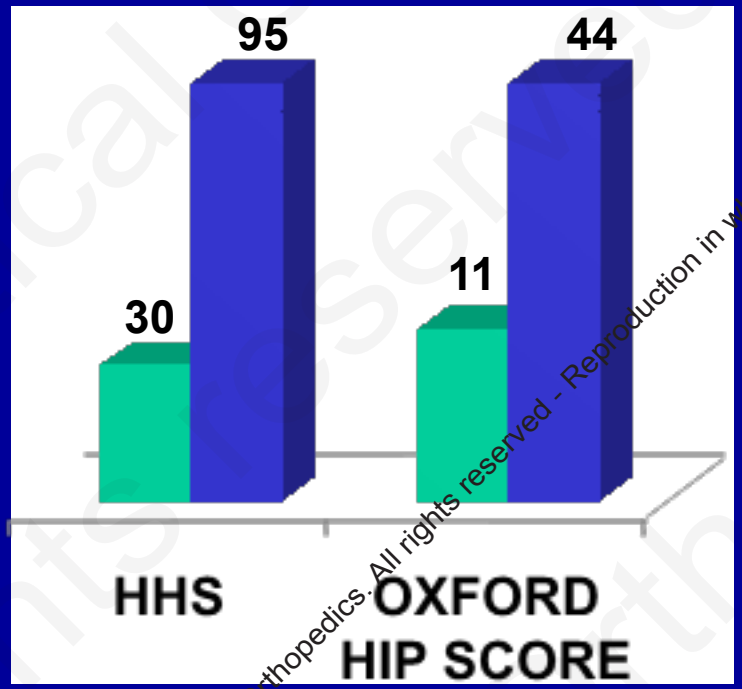
0.8 mm +/- 2.7

Excellent clinical outcomes

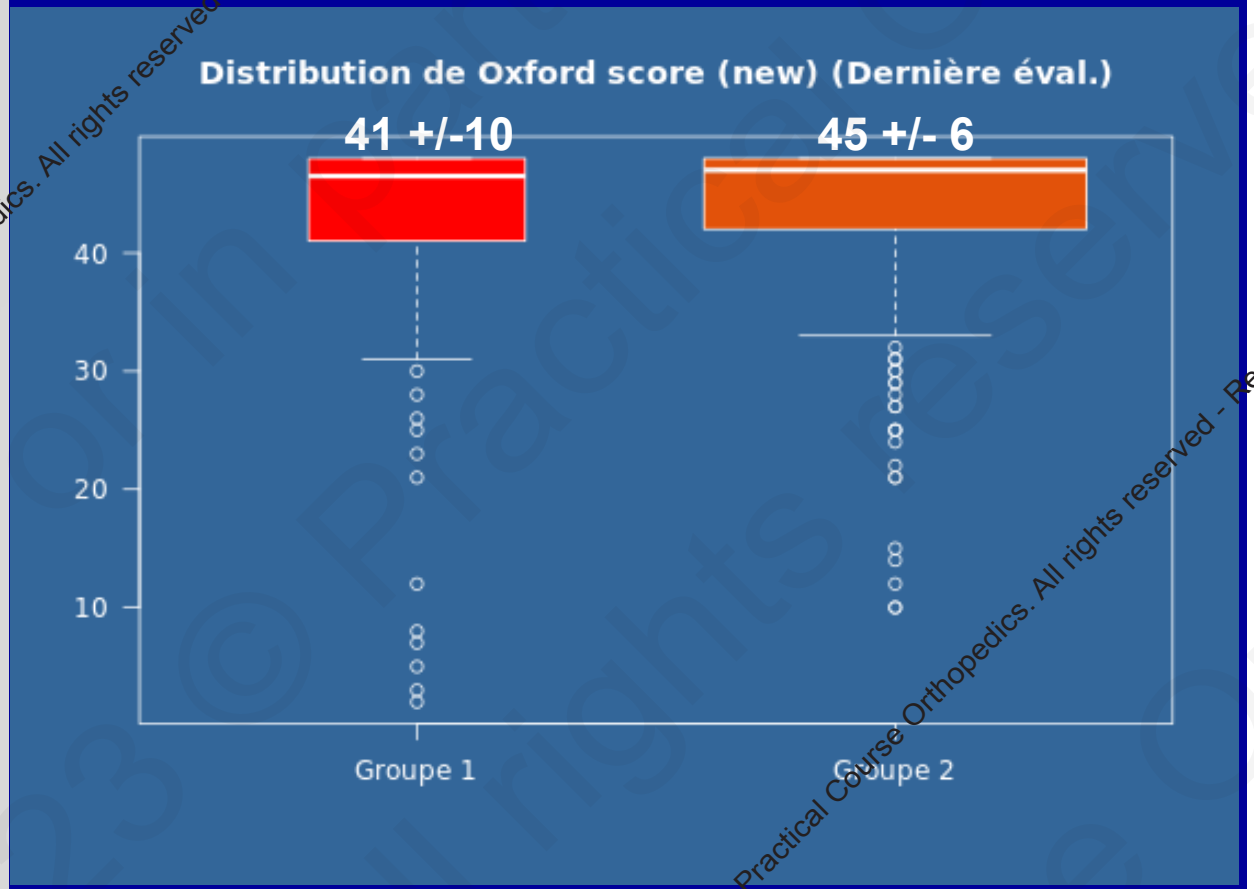
- At 10±3 years follow up

- Excellent clinical results
  - 95 ± 12
  - 44 ± 6

- 63% Forgotten hip joint

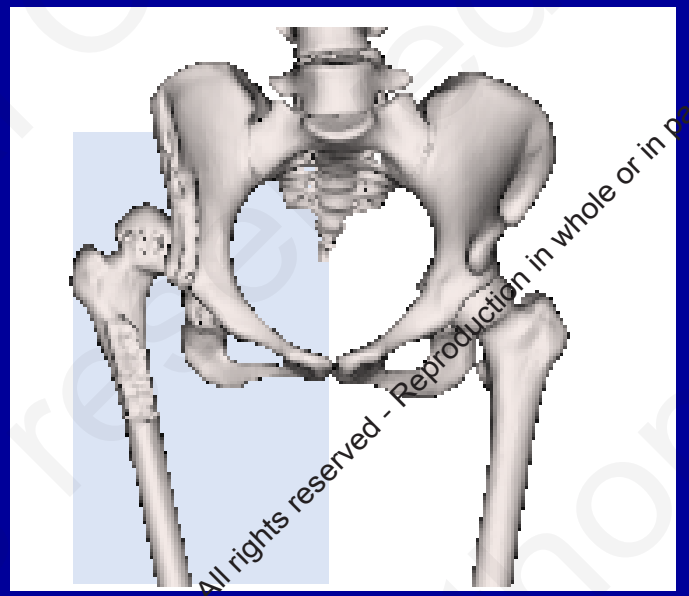


Better outcomes PROMS with SPS anatomic stem/Straight Stem



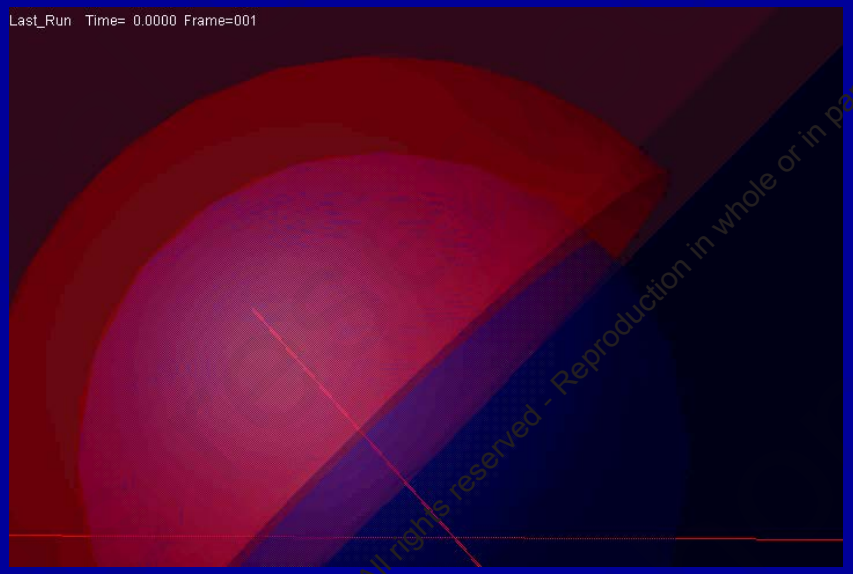
Dislocation 7: 0.5%
Taux de reprise d'implants 0%
Associated Factors

- Severe dysplasia
  - Crowe IV
- Head diameter
  - 28 mm: 4
  - 32 mm : 3
  - 36 mm: 0

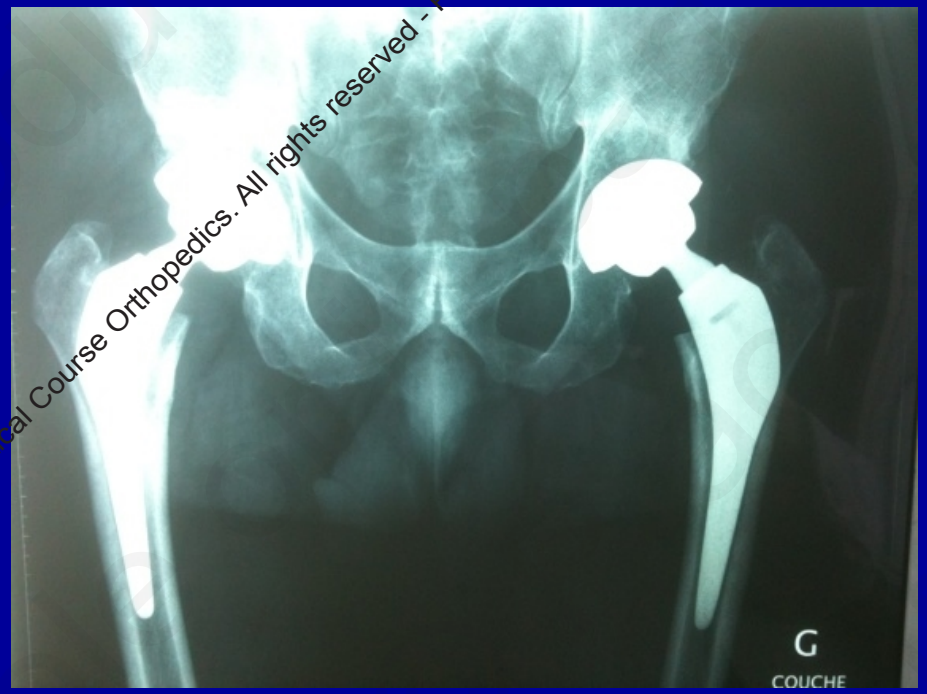


Reproducible Squeaking 7: 0.5%

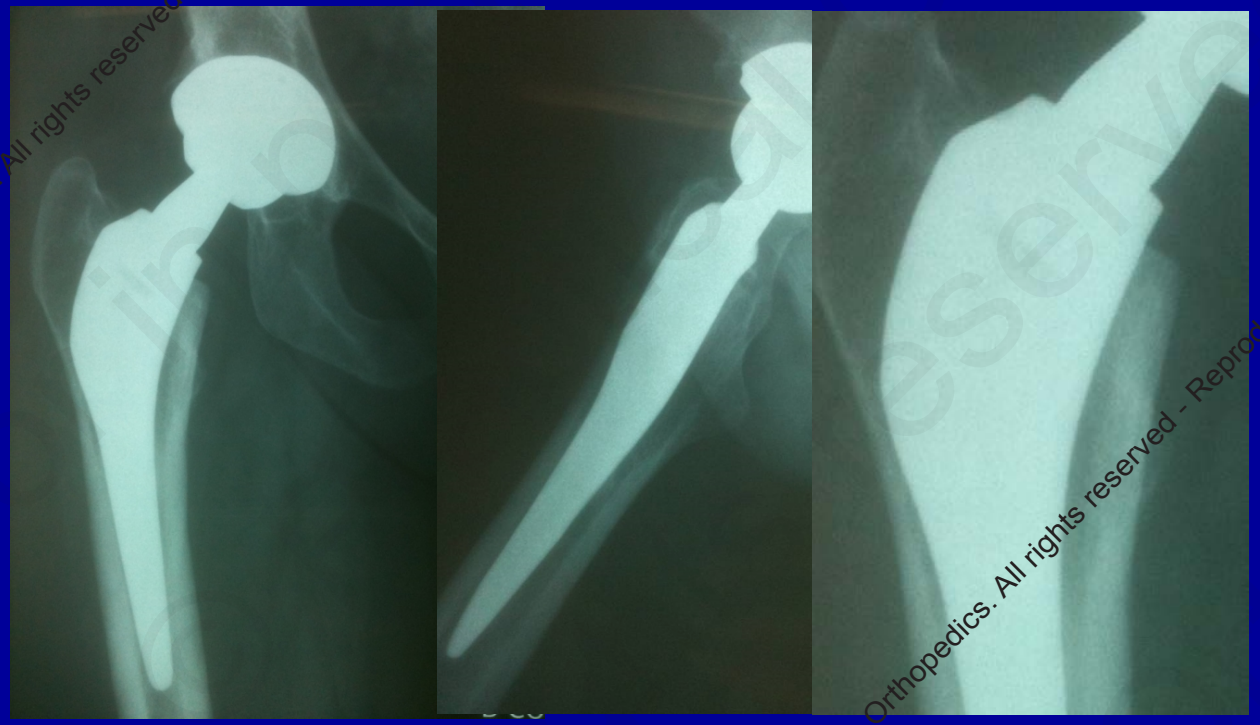
- Younger: 51 years
- More active :sports
- No 3D alteration of the anatomy
- Higher Range of motion??
  Impingement??



10 years Follow-up



Nice bone remodelling at 10 years Fup



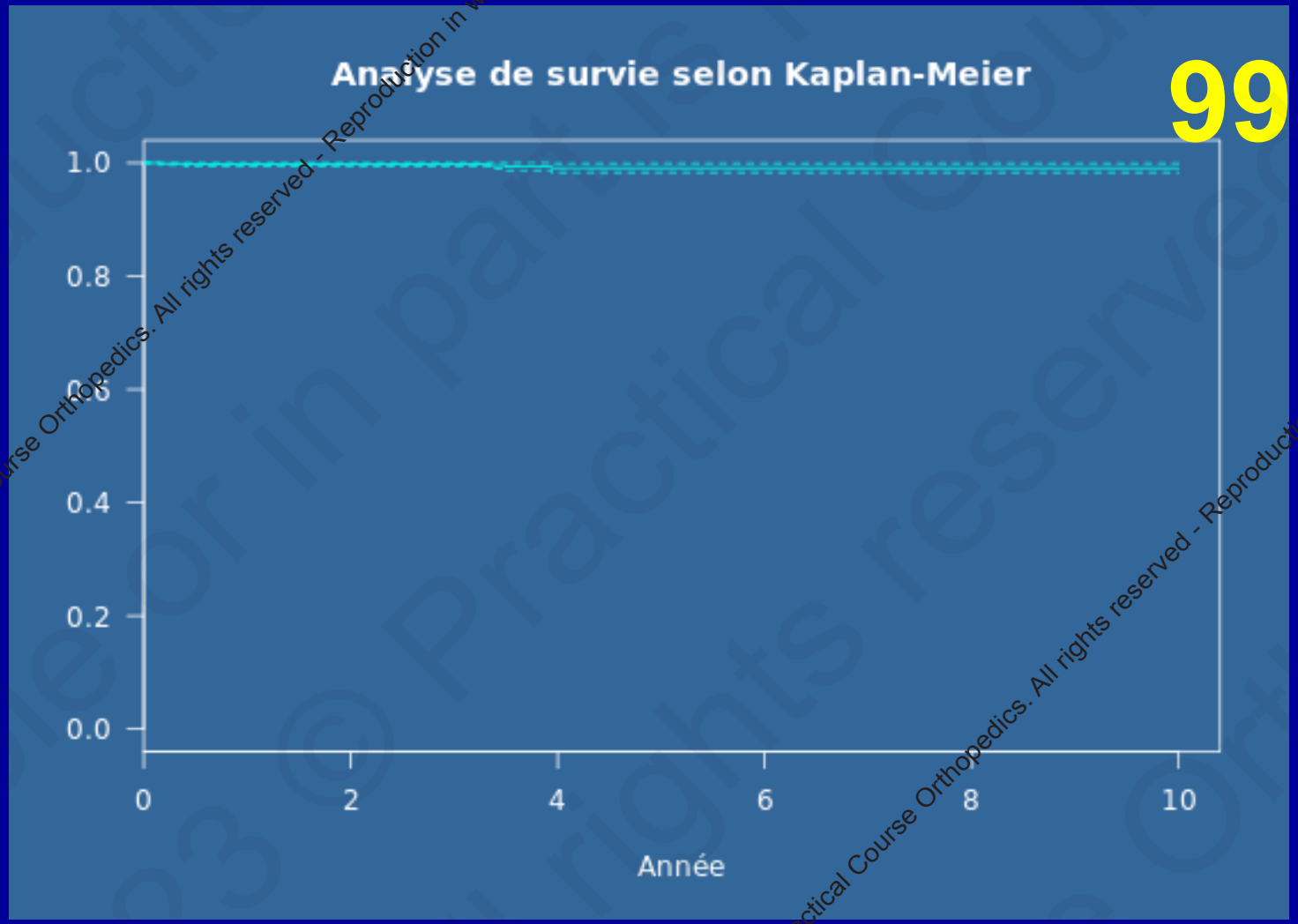
Results: gait analysis: 24 patients

- No significant difference
  significative: THA/ healthy hip

PTH
SAIN
CONTROLE

All patients were within the envelopp of normality as defined by the control group: for all the parameters

End Point: Mechanical Failure



99.1%

For Whom?
Usefull for Everyone!!
Mandatory in 12%

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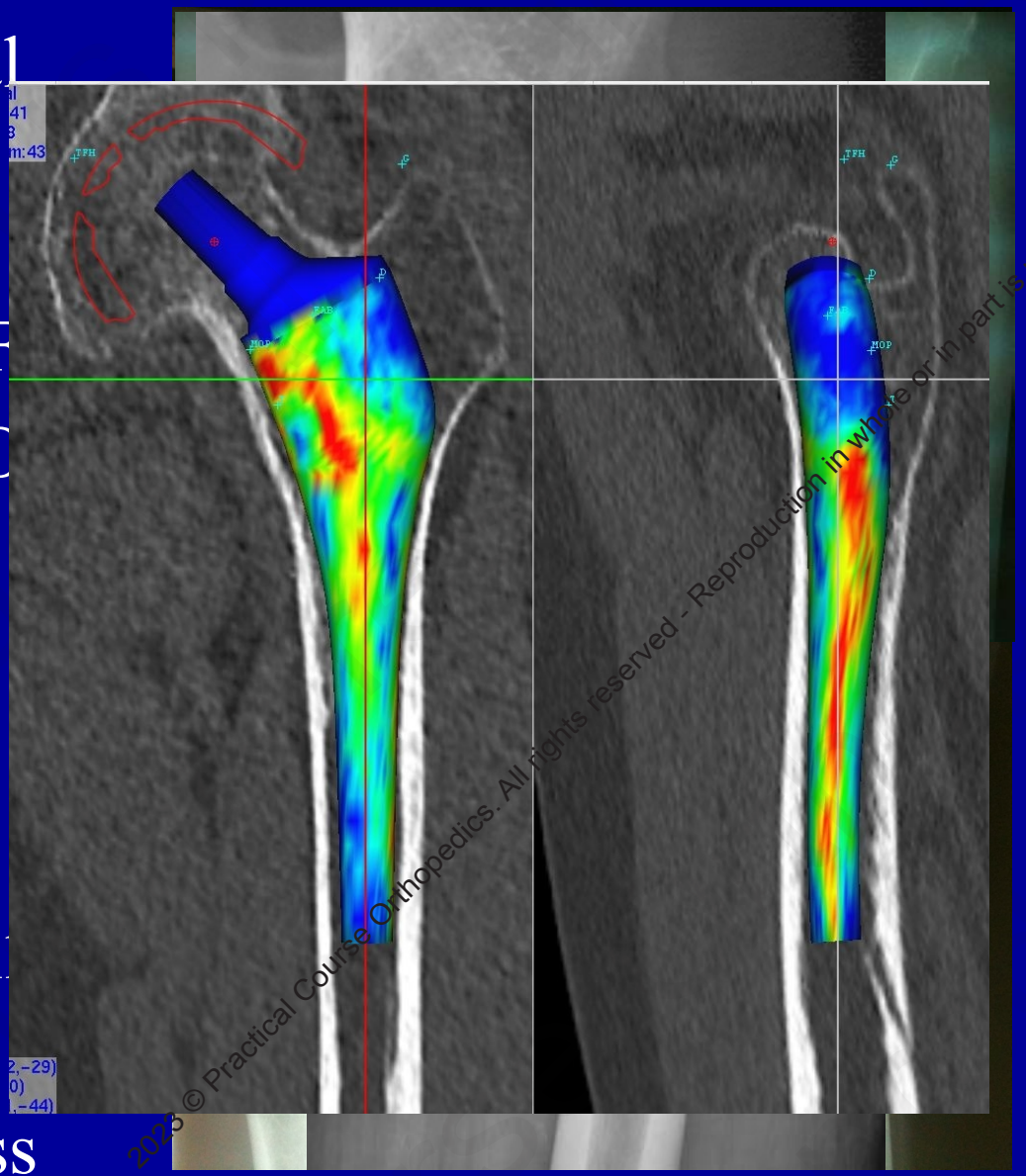
Screening to detect the 12%

- Severe femoral torsional abnormality
- Coxa valga: to avoid a fracture/ don't increaseF
- Coxa vara: to restore FC lower limb
- Long necks
- Very small femurs
- Achieve a correct fit :
  - to increase primary stabi
  - Avoid a fracture
- Pelvis abnormal stiffness



Future technology:

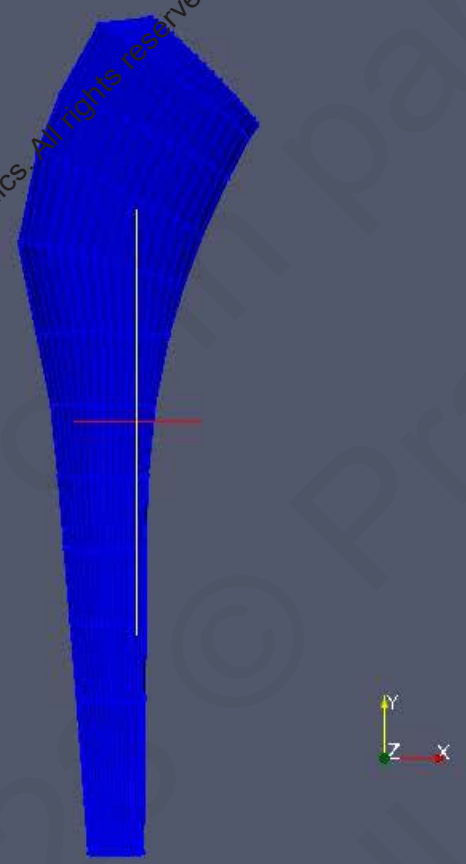
- Resonant frequency analysis based on CT-scan

- To assess: implants stability and bone remodeling
- Computing the constraints at the stem/ bone Interface

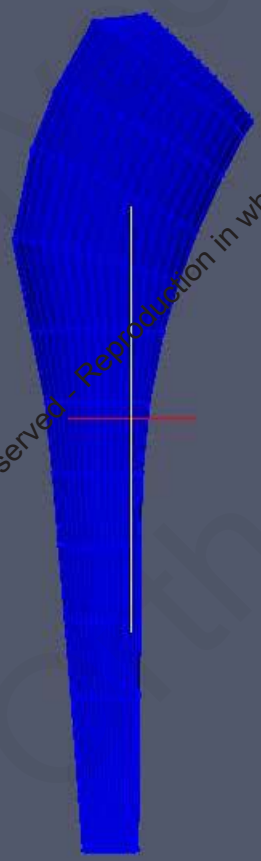
Modal analysis for the assessment of cementless hip stem primary stability

Orthopaedic Research Society, New Orleans 2017

Stable Stem



Unstable stem



Modal analysis for the assessment of cementless hip stem primary stability

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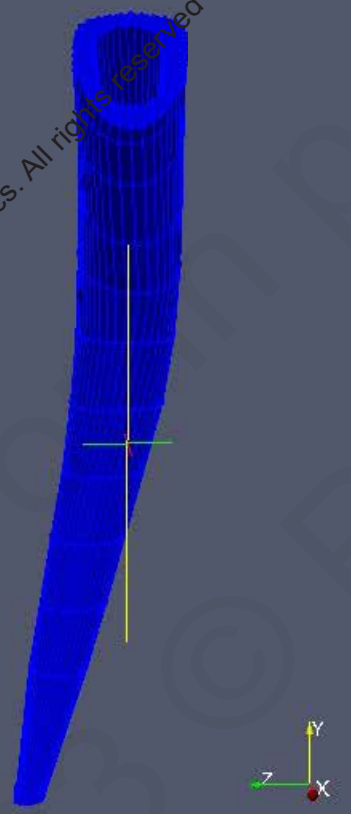
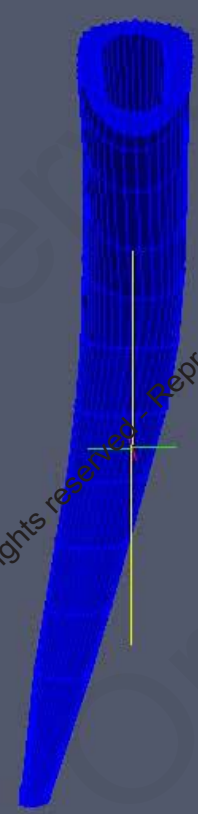
Stable Stem



Unstable Stem



THANK YOU