Impingement with implant, bone, cement

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Design Process in Knee Arthroplasty

Unmet Needs and Opportunities

- Surgeon Quotes
  - "Address current areas of compromise"
  - **"Sizing issues with many systems"**
  - "Simplicity is key"
  - "Need options intra-operatively"
- Common Needs
  - A/P Sizing Refinement
  - Bone Conservation
  - Better Fit
  - Optimize stability
  - Eliminate Rules/Discontinuities

Evolution but not Revolution

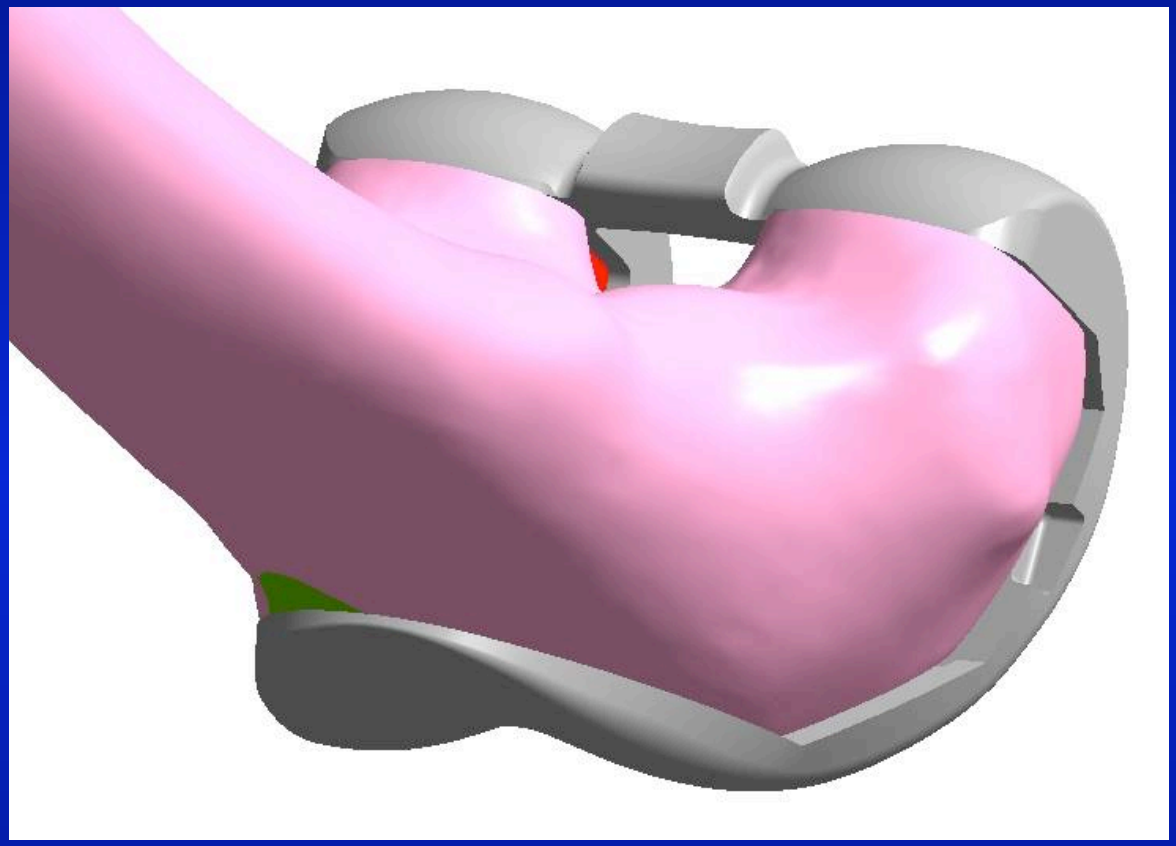
The Outcome of Rotating-Platform Total Knee Arthroplasty with Cement at a Minimum of Ten Years of Follow-up

Jean-Noel A. Argenson, MD, Sebastien Parratte, MD, Abdullah Ashour, MD, Bertrand Saintmard, MD, and Jean-Manuel Aubaniac, MD

Investigation performed at the Aix-Marseille University, Center for Arthritis Surgery, Marseille, France

Bony Impingement

Traditional Implant



Pink bone is representative of a typical female bone – gray implant shows how existing components overhang on the female bone

Bony Impingement

J Arthroplasty. 2012 Oct;27(9):1710-6. doi: 10.1016/j.arth.2012.03.041. Epub 2012 May 15.

The importance of bony impingement in restricting flexion after total knee arthroplasty: computer simulation model with clinical correlation.

Mizu-Uchi H[1], Colwell CW Jr, Fukagawa S, Matsuda S, Iwamoto Y, D'Lima DD.

Author information

- [1]Shiley Center for Orthopaedic Research and Education at Scripps Clinic Scripps Health, La Jolla, California, USA.

- The maximum flexion before impingement between the femur and the tibial insert was computed using a musculoskeletal modeling program during a weight-bearing deep knee bend.
- In the low-flex group, 4 cases had **impingement involving the bone cut at the posterior condyle,** and the average predicted knee flexion was 102° compared with 93° measured clinically.

➢ These results indicate that the level of the distal femoral resection should be carefully planned and that **exposed bone proximal to the tips of the posterior condyles of the femoral component should be removed** if there is risk of impingement.

HYPERFLEXION

Conventional P.S.

Impingement at 155°

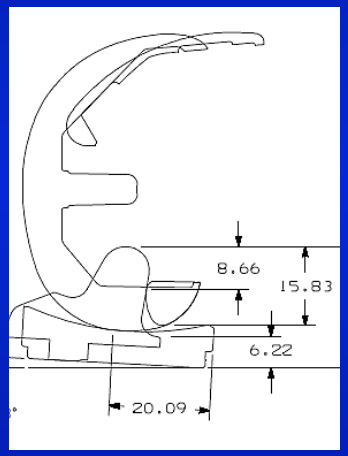
HIGHFLEX

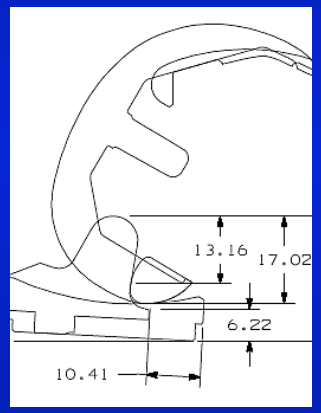
Conformity at 155°

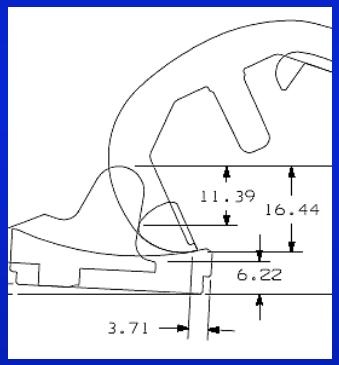
High Flex

Safe Flexion: More than Contact Area

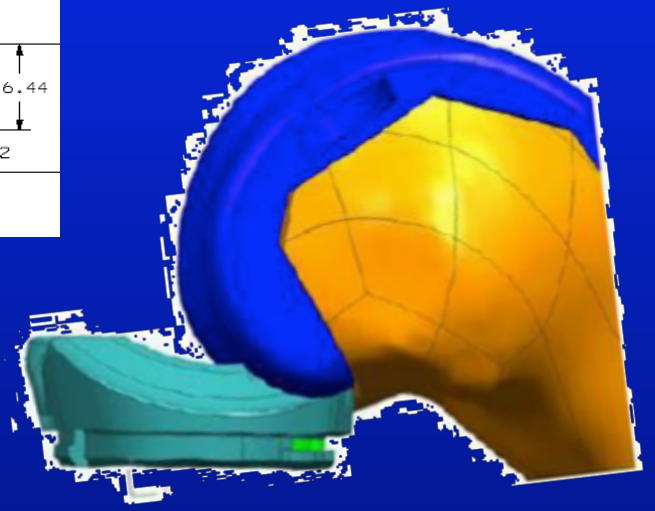
- Femoral Rollback
  - PS: cam/spine and tib-fem articulation





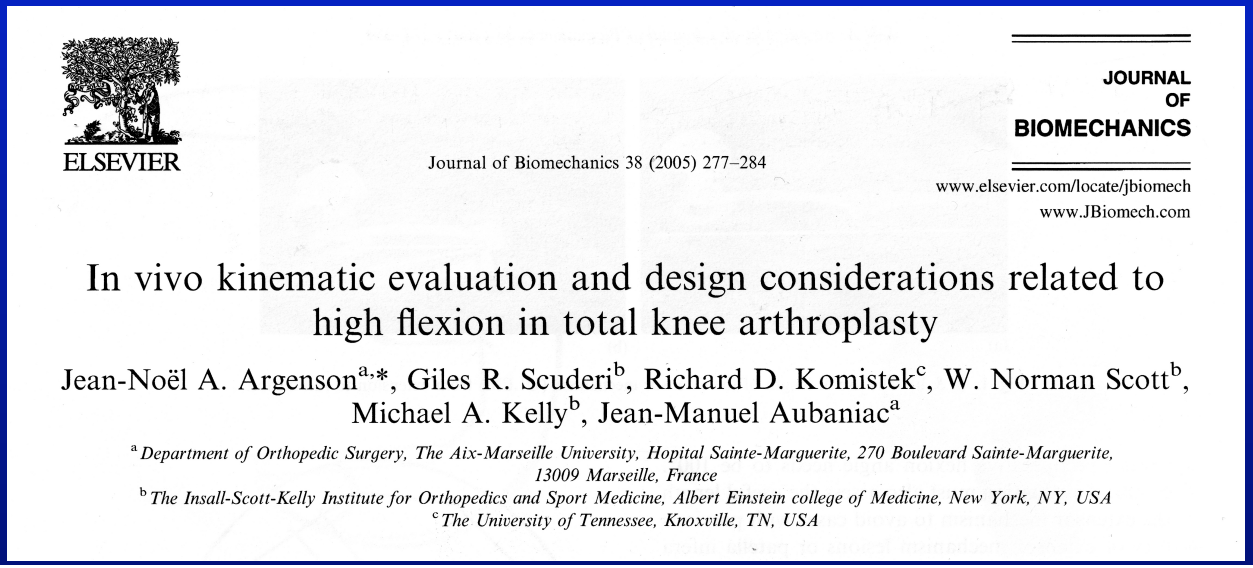


- Posterior condyle design – shape and length
  - Overstuffing PF joint in deep flexion
  - Overhanging bone leading to impingement



Background

1. Restore normal knee kinematics
2. Increase ROM
3. Restore patient function
4. Minimize wear and improve survivorship



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Journal of Biomechanics 38 (2005) 277–284

JOURNAL OF BIOMECHANICS

www.elsevier.com/locate/jbiomech
www.JBiomech.com

In vivo kinematic evaluation and design considerations related to high flexion in total knee arthroplasty

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[c] *The University of Tennessee, Knoxville, TN, USA*

Link to satisfaction

- Argenson, et al; CORR 2008: high postoperative range of knee flexion improves patient satisfaction

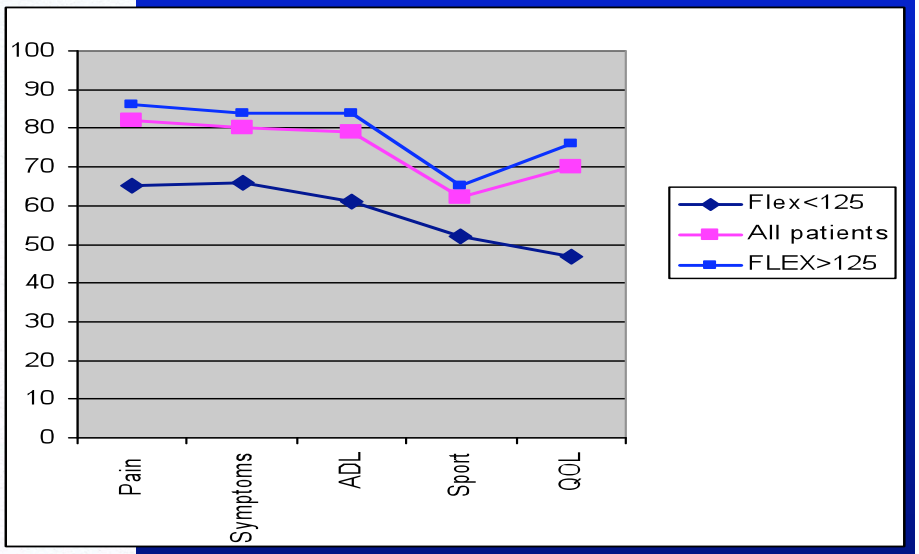
Clin Orthop Relat Res (2008) 466:2669–2676
DOI 10.1007/s11999-008-0418-x

SYMPOSIUM: PAPERS PRESENTED AT THE ANNUAL MEETINGS OF THE KNEE SOCIETY

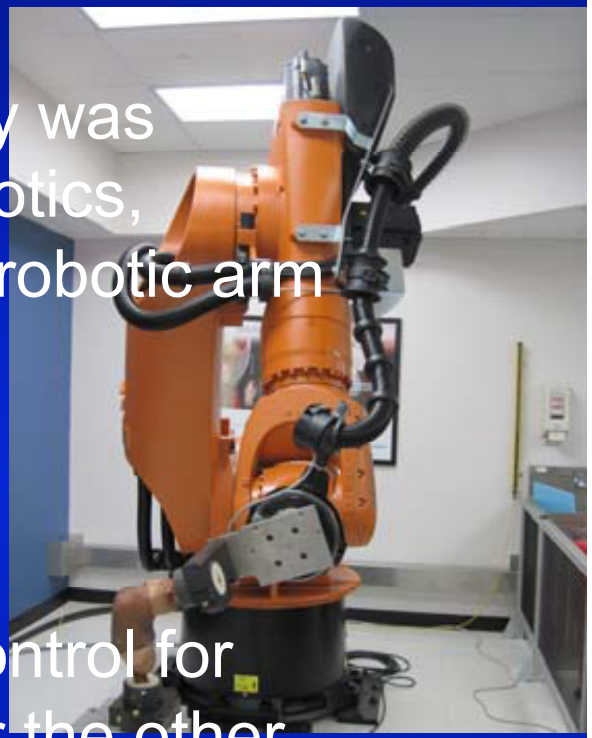
Patient-reported Outcome Correlates With Knee Function After a Single-design Mobile-bearing TKA

Jean-Noel Argenson MD, Sebastien Parratte MD,
Abdullah Ashour MD, Richard D. Komistek PhD,
Giles R. Scuderi MD

Published online: 15 August 2008



Kinematic Promise
In vitro Research



- A full load (2 X BW) physiologic lunge activity was simulated using a KUKA KR500 (KUKA Robotics, Augsburg, Germany), 6 degrees of freedom robotic arm

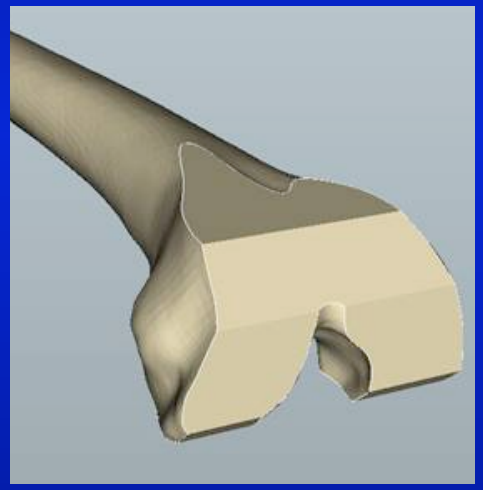
- The lunge was simulated using kinematic control for flexion/extension and force-torque control for the other degrees of freedom. The inputs for the force-torque control were taken from joint kinetics from live patients during the lunge activity

Personalized Fit

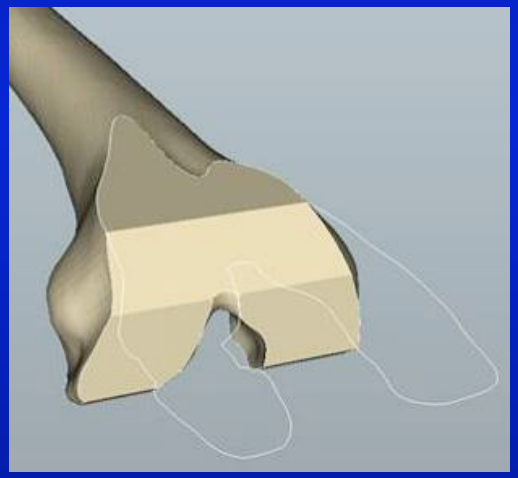
Sizing/Shape Refinements

Femoral Shape

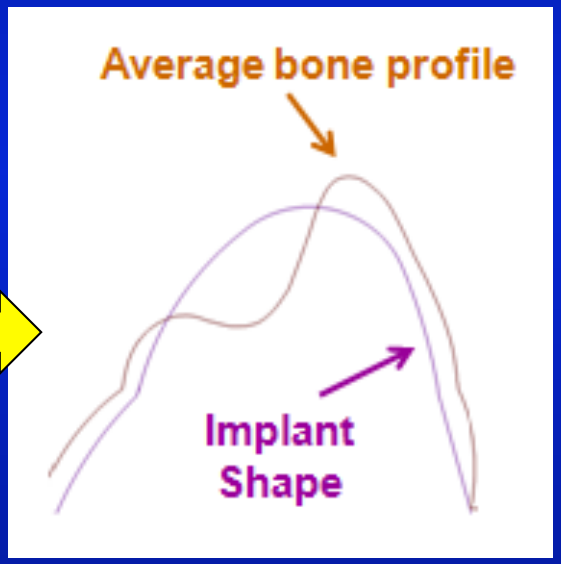
- Surgeon input driver of shape
- Evaluated shape with ZiBRA data



ZiBRA resection



Bone resection profiles



Implant shape

Implant Impigement: current compromises

- Laxity

  Insufficient options to match the patient's unique soft tissue balance

Clin Orthop Relat Res. 1998 Nov;(356):39-46.

Flexion instability after primary posterior cruciate retaining total knee arthroplasty.

Pagnano MW, Hanssen AD, Lewallen DG, Stuart MJ.

- Mal-positioned components

  Non-anatomic shapes and sizes inhibit accurate placement, creating unphysiologic articulation *Clin Orthop Relat Res. 2007 May;458:131-6.*

Early revision for component malrotation in total knee arthroplasty.

Incavo SJ, Wild JJ, Coughlin KM, Beynnon BD.

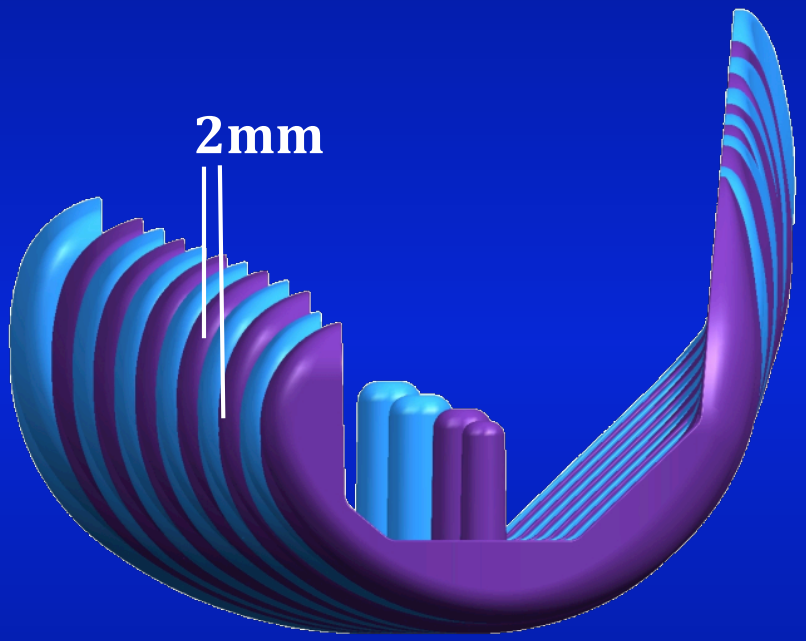
- Aberrant kinematics caused by unbalanced soft tissues *J Arthroplasty. 2003 Sep;18(6):804-8.*

Knee stiffness on extension caused by an oversized femoral component after total knee arthroplasty: a report of two cases and a review of the literature.

Lo CS, Wang SJ, Wu SS.

Design Solutions ?

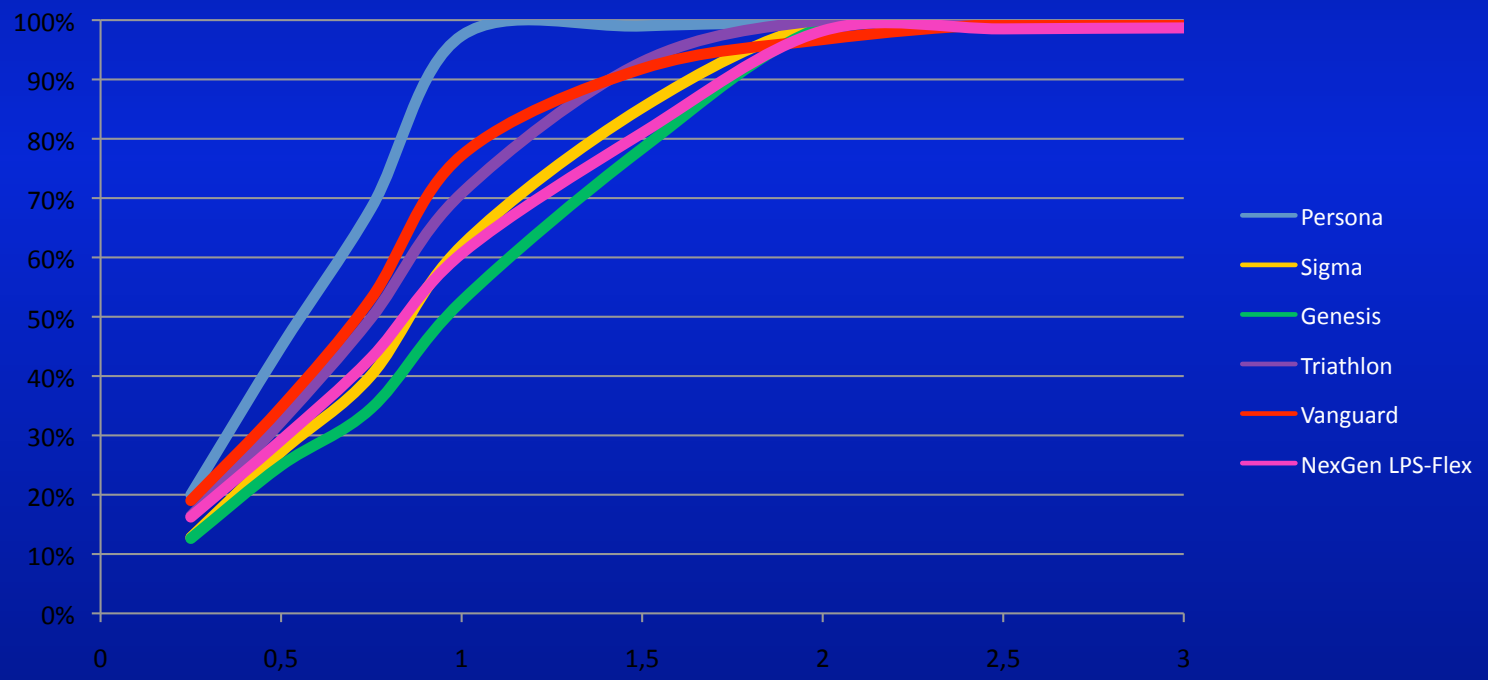
2mm A/P Sizing Increments



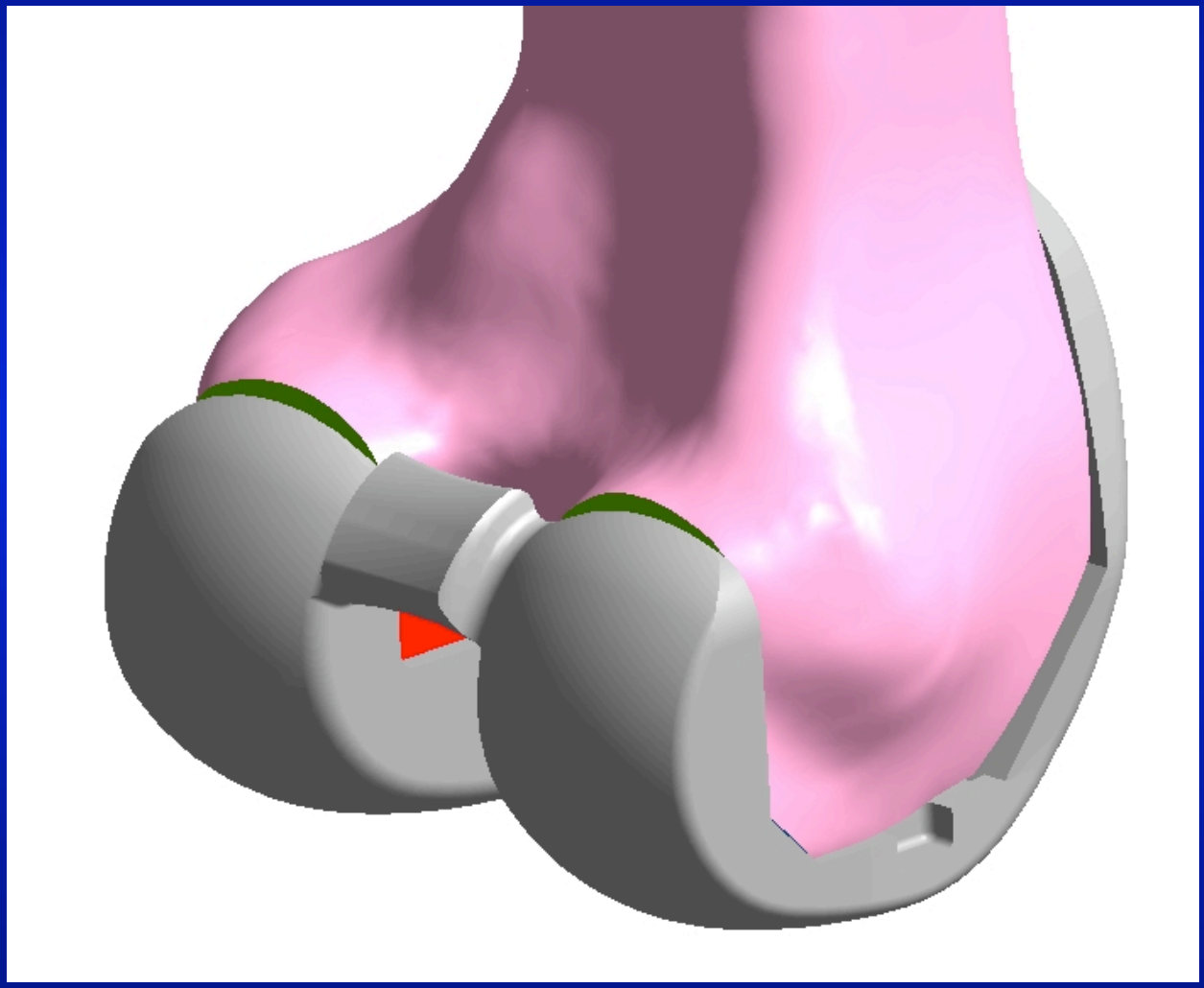
- The goal is to facilitate upsizing/downsizing

Personalized Fit

- How often are bones within 1mm of closest A/P Size?
  - Traditional knee systems, on average, are within 1mm in 65% of cases – i.e. 1/3 of cases require compromise



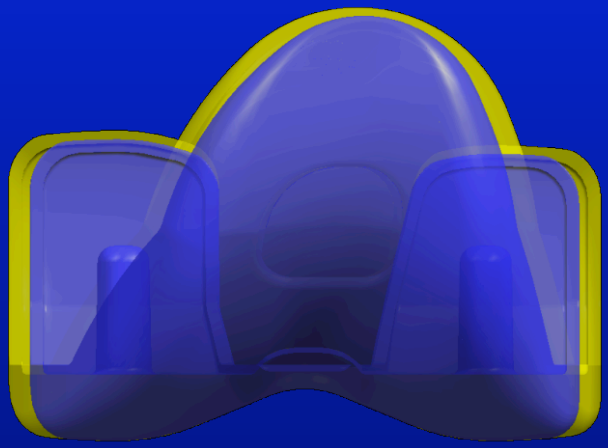
Traditional M/L Impingement with Implant

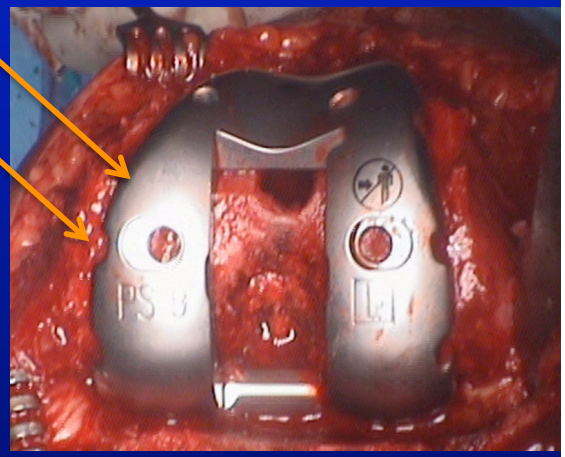


Note: M/L overhang is most noticeable distally and as you move anterior

Need for Morphologic Femur ?

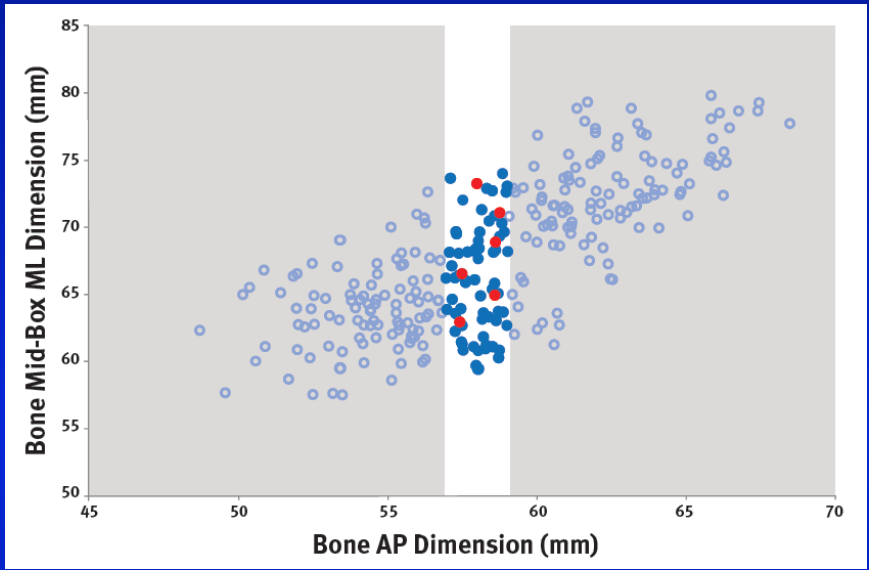
- Distinct femoral profiles
  - Narrow and Standard
  - Avoid M/L overhang and potential downsizing and ↓ flexion
  - Maintain biomechanical efficiencies critical to kinematics
  - Maximize bone coverage for improved fixation

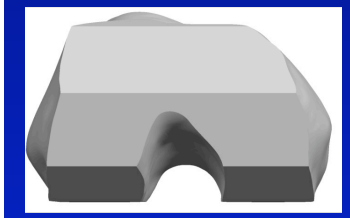




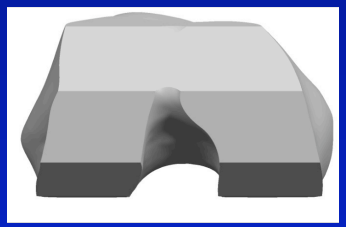
Personalized Fit

Shape: Advancing Morphology

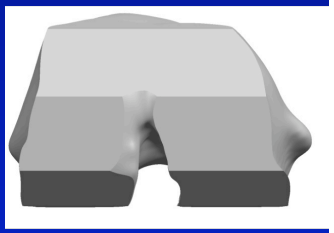




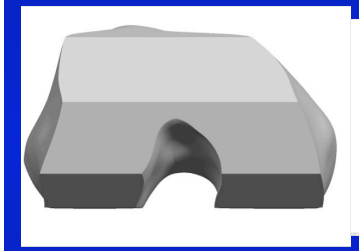
M, Korean



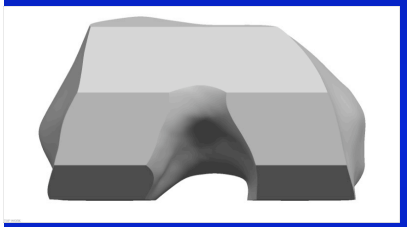
M, Caucasian



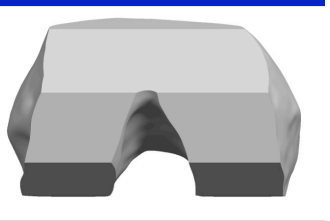
F, Caucasian



M, Indian



M, Caucasian



F, Caucasian

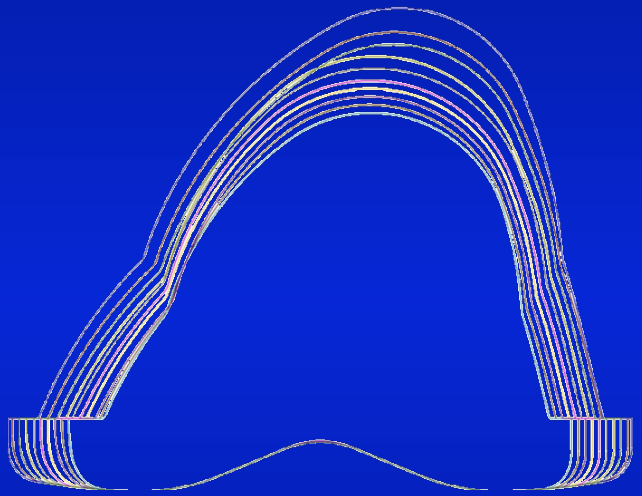
Fact: For a given A/P dimension, the mid-box M/L dimension displays wide variability

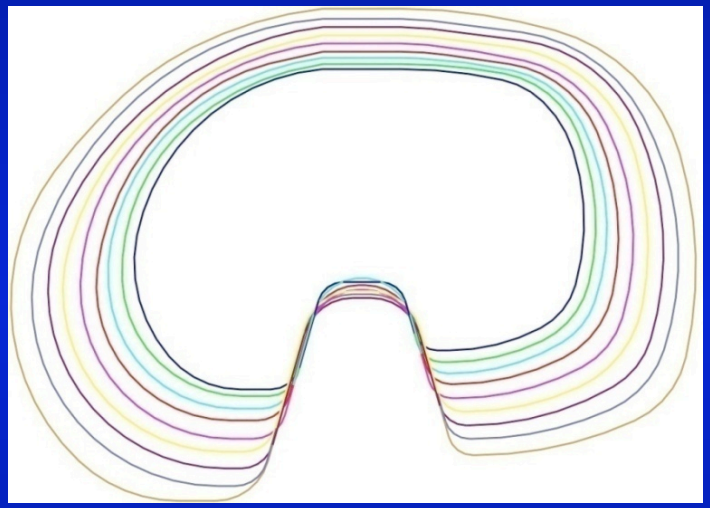
Problem: 56% of patients demonstrated femoral overhang >3mm and its associated two-fold increase in pain

Mahoney JBJS 2010

Solution: *System which can* provide uniquely shaped Standard and Narrow femoral components to deliver fit and coverage without overhang

Anatomies and Activities Require More . . .

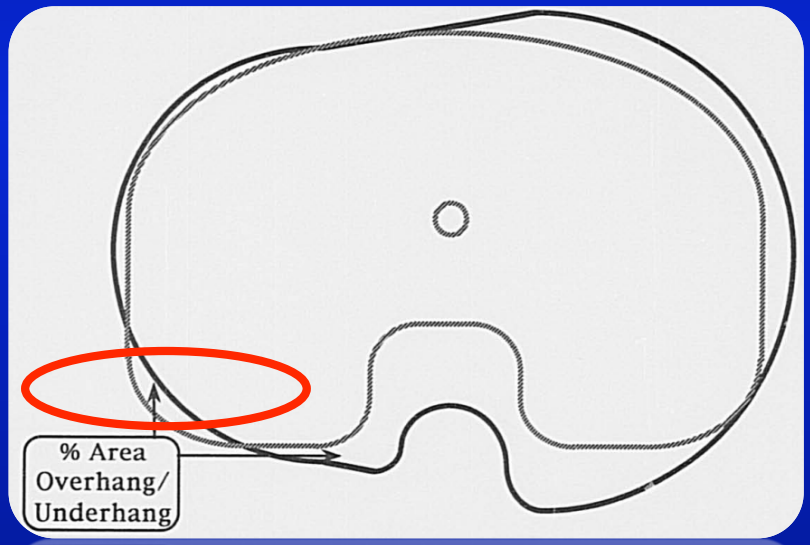


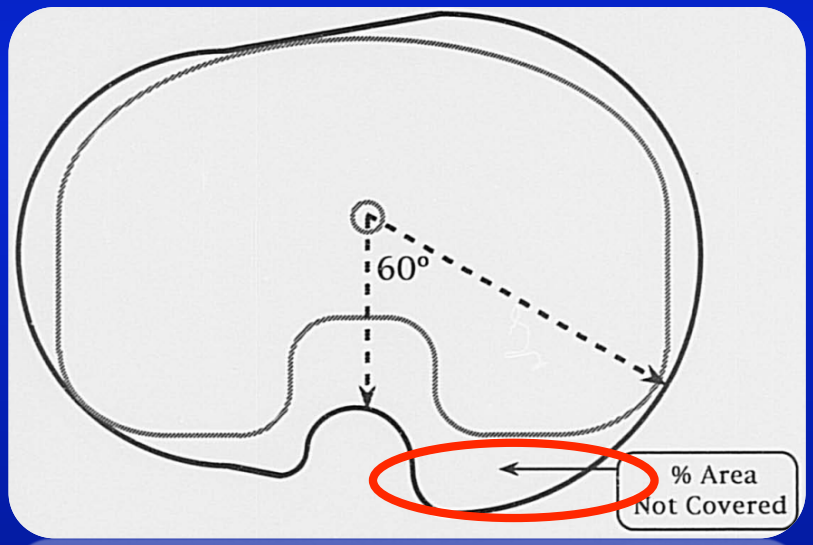


A morphologic knee system is designed for the global population

TKA Leading Case of Failure for Pain : Tibia Mal-alignment

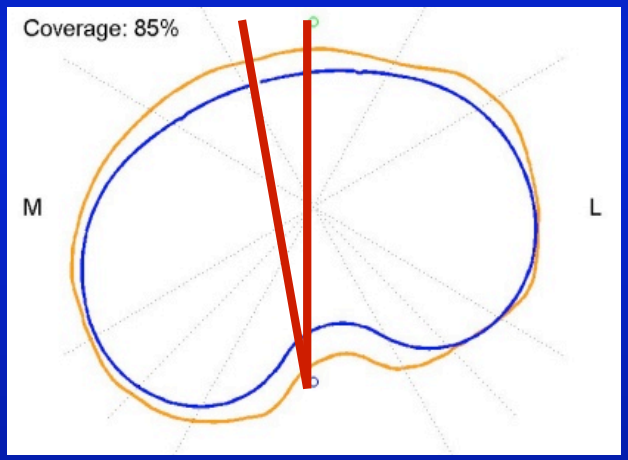
- **A compromise position must be found by the surgeon to simultaneously meet optimal bone coverage and satisfactory PF tracking - Lemaire, 2009**



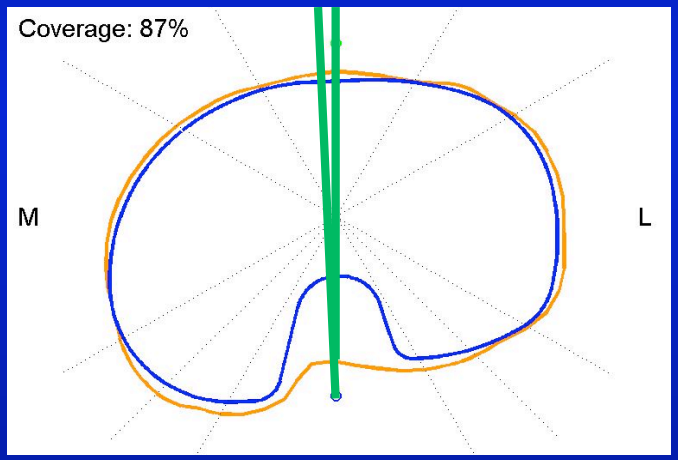


Compromise for Tibial Plate

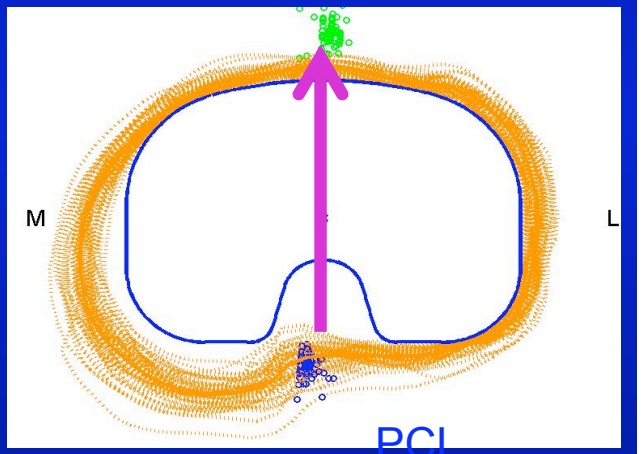
- *Tibial* Plate designed to provide optimal coverage and appropriate rotational axis
  - Address pain, tracking, and wear



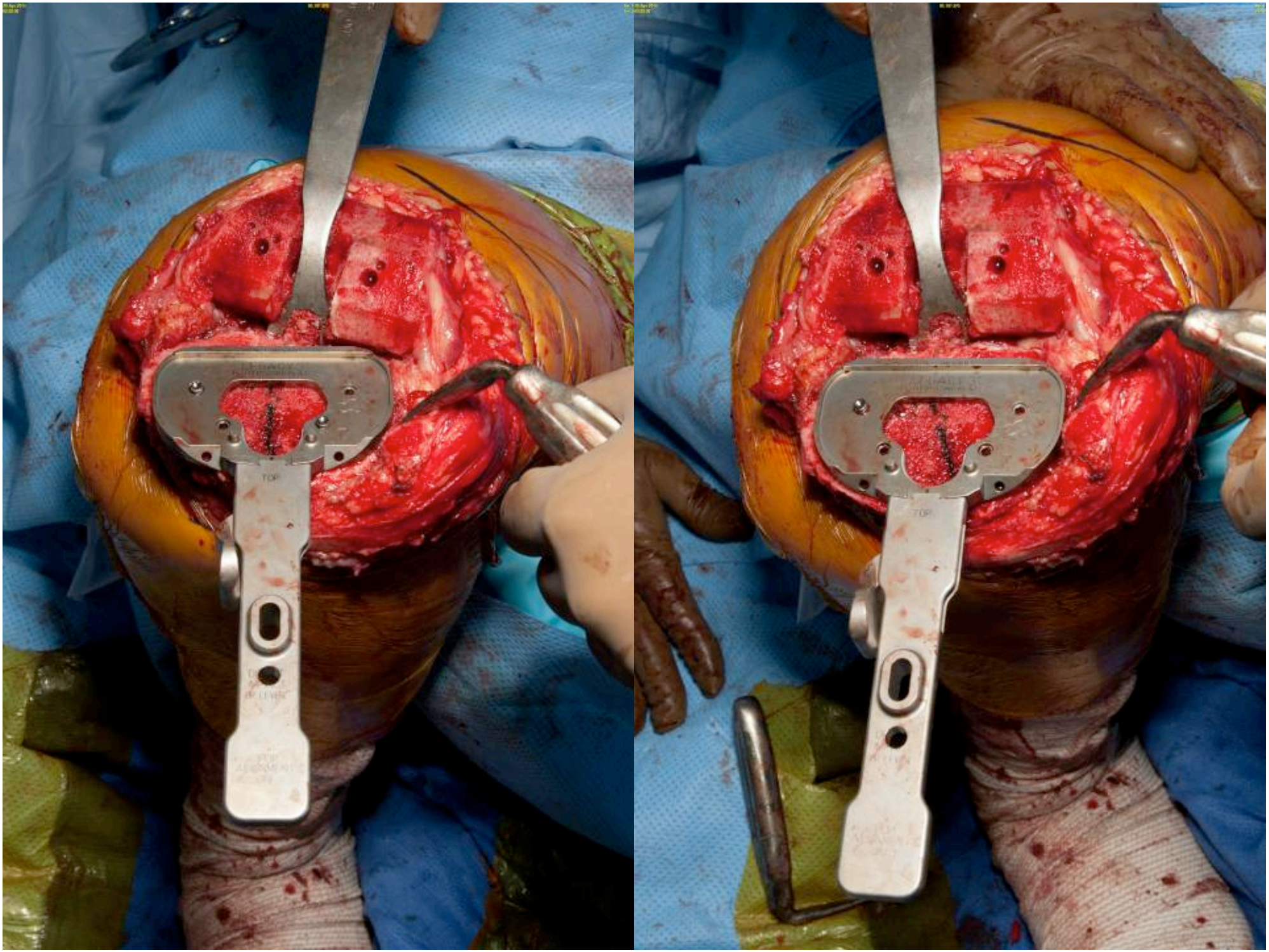
Biomet Vanguard Tibia
85% Coverage/14^0 Int Rot
Med

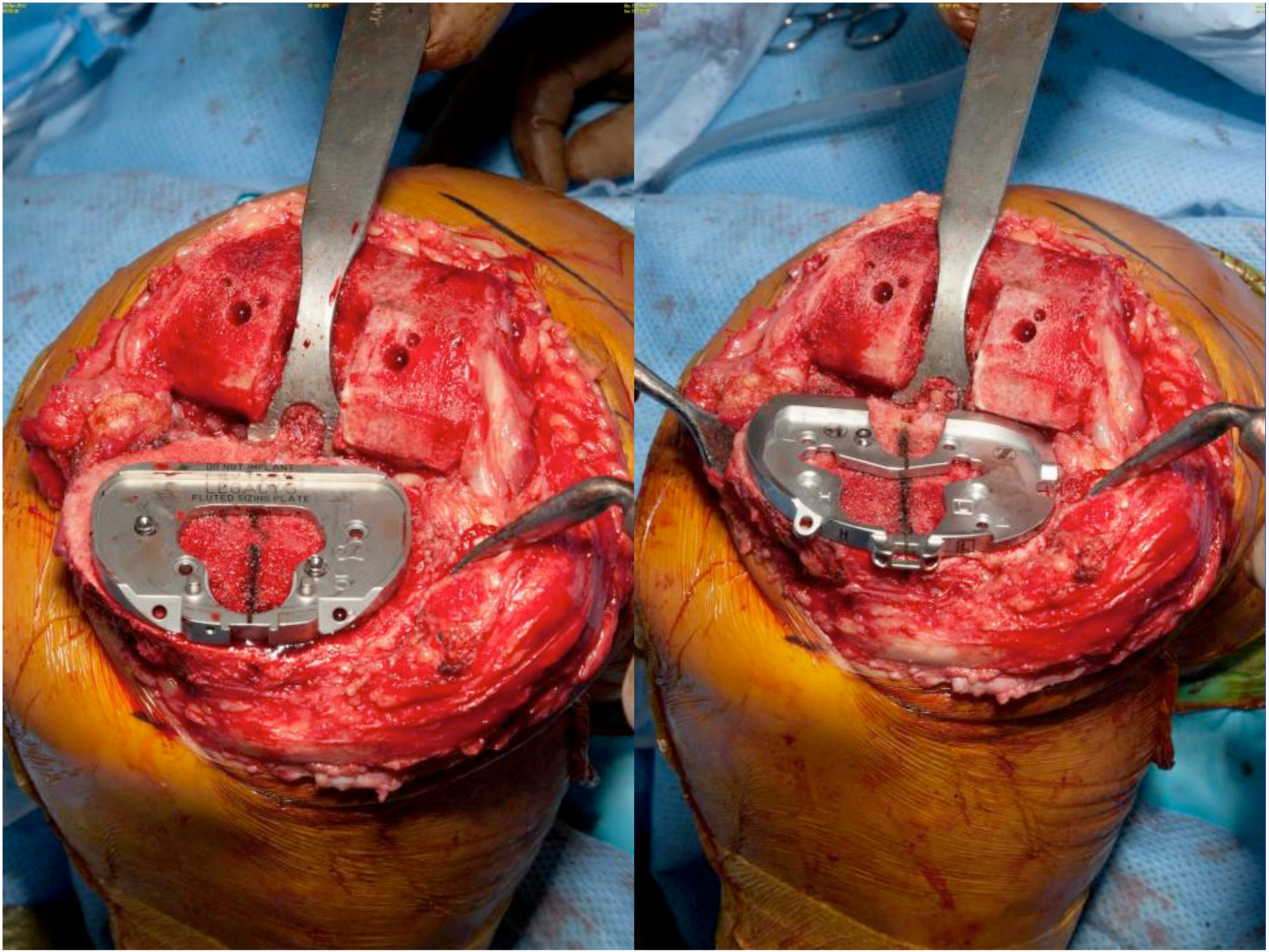


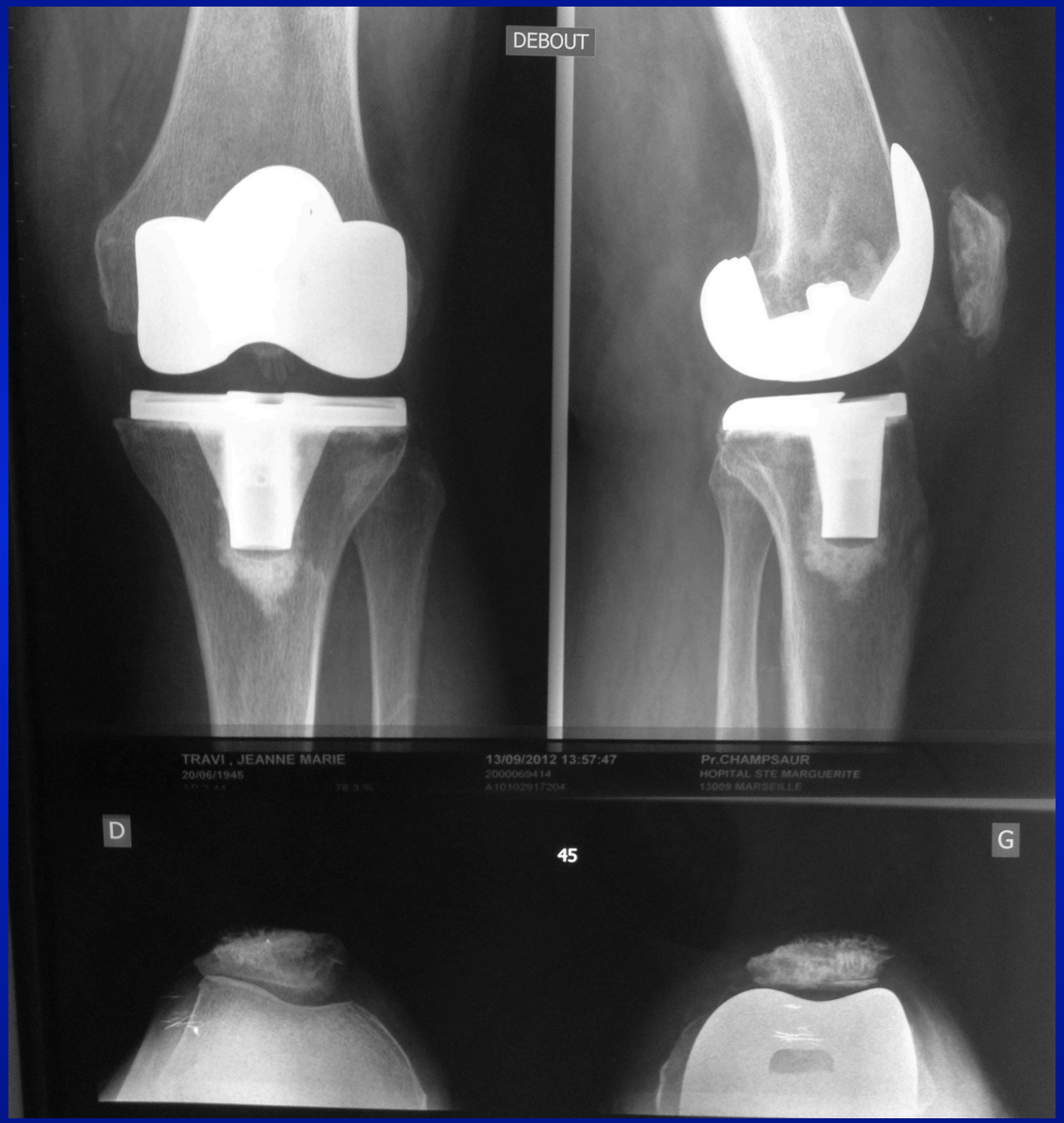
Anatomic Tibia
87% Coverage/3^0 Int Rot



Zimmer *NexGen* Tibia
Post/Med Uncovered/Axis
1/3 tubercle




DO NOT IMPLANT
LEGACY
FLUTED SIZING PLATE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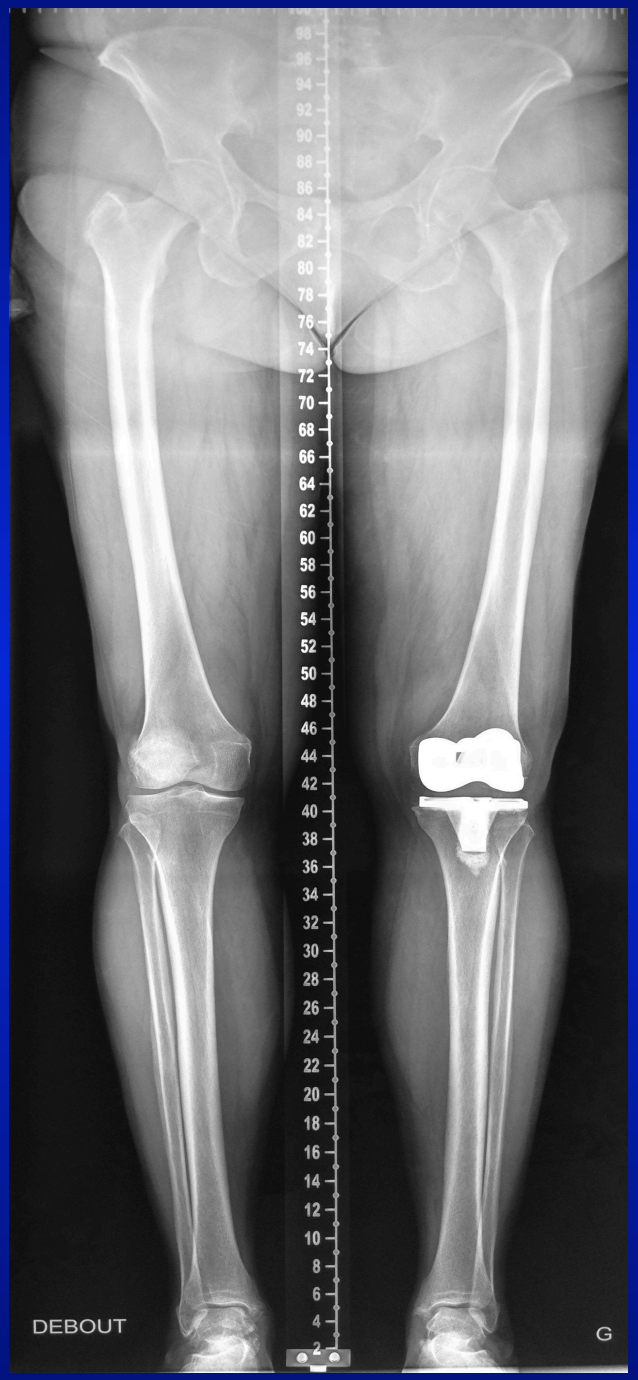

DEBOUT
G

Cement Impingement

J Arthroplasty. 2010 Oct;25(7):1168

Tibial nerve impingement secondary to posterior cement extrusion after unicompartmental knee arthroplasty.

Bhutta MA[1], Doorgakant A, Marynissen H.

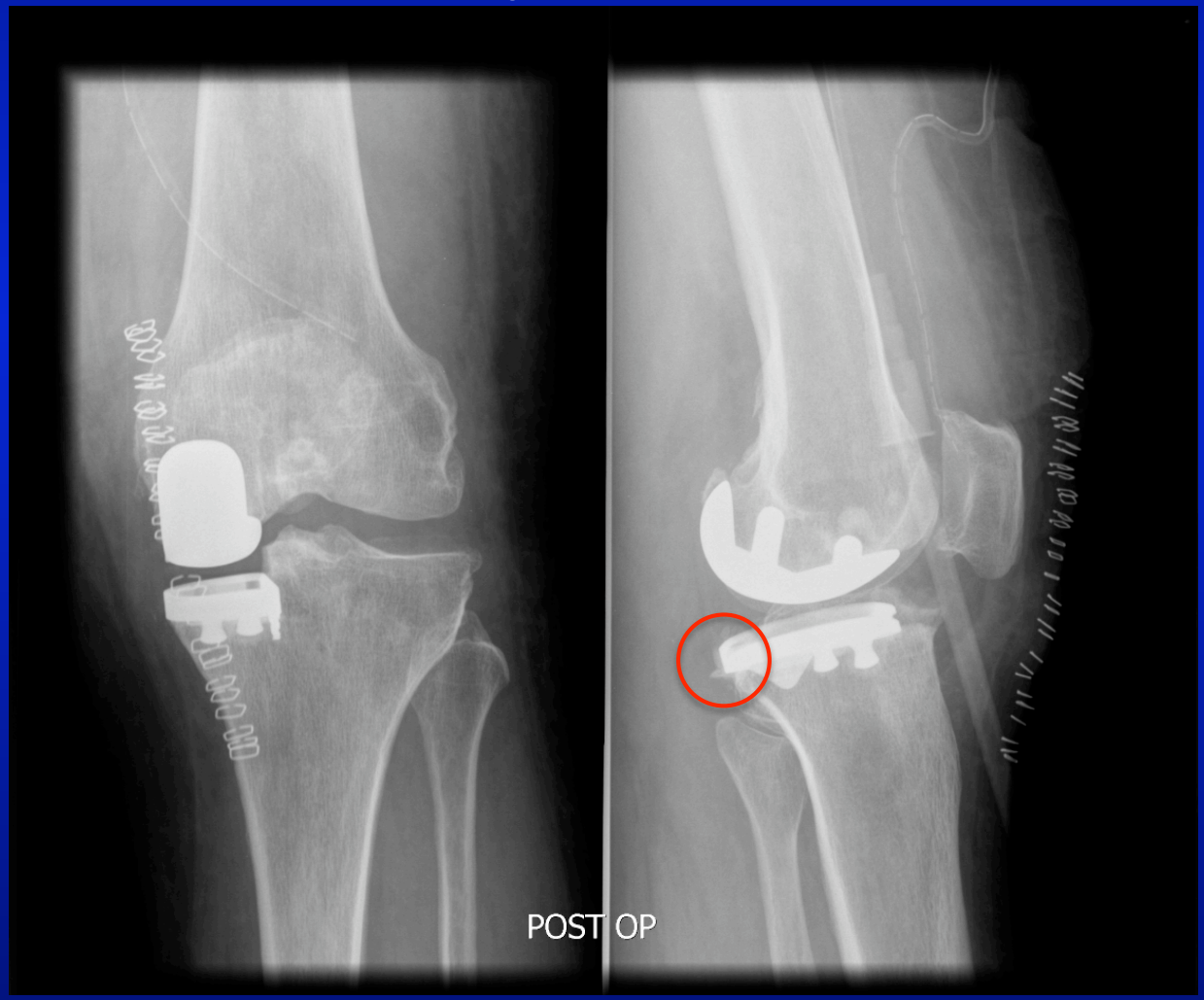
We present a previously unreported case of tibial nerve impingement as a consequence of posterior cement extrusion after a unicompartmental knee replacement.

Cement Impingement

Question: when is it symptomatic ?

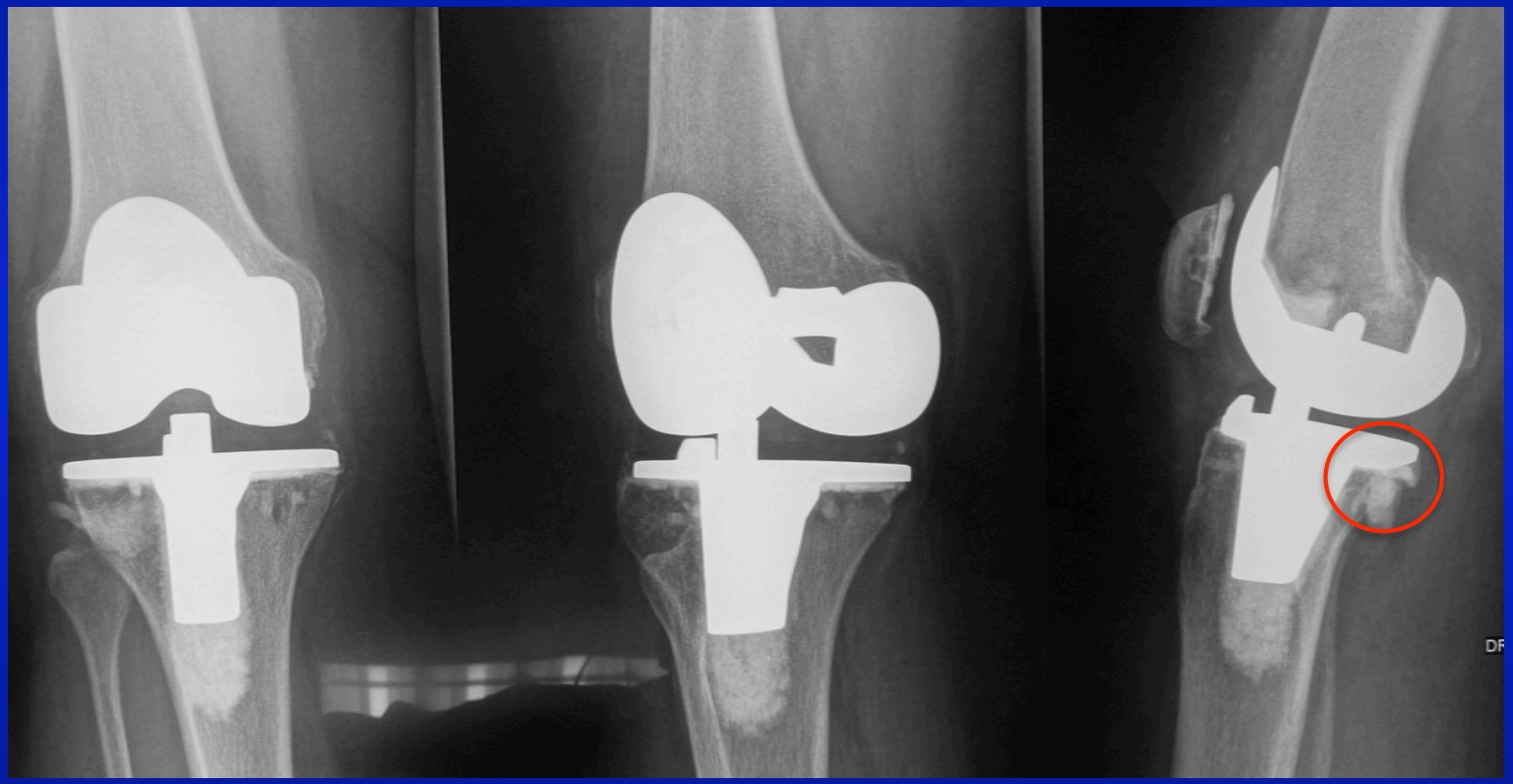
Cement Impingement

Question: when is it symptomatic ?

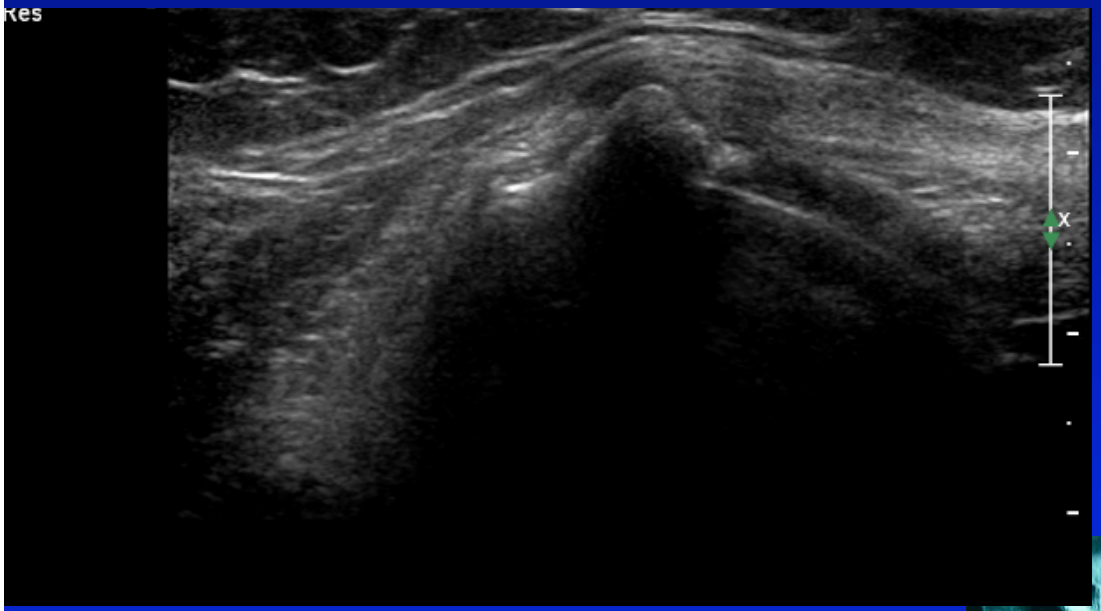


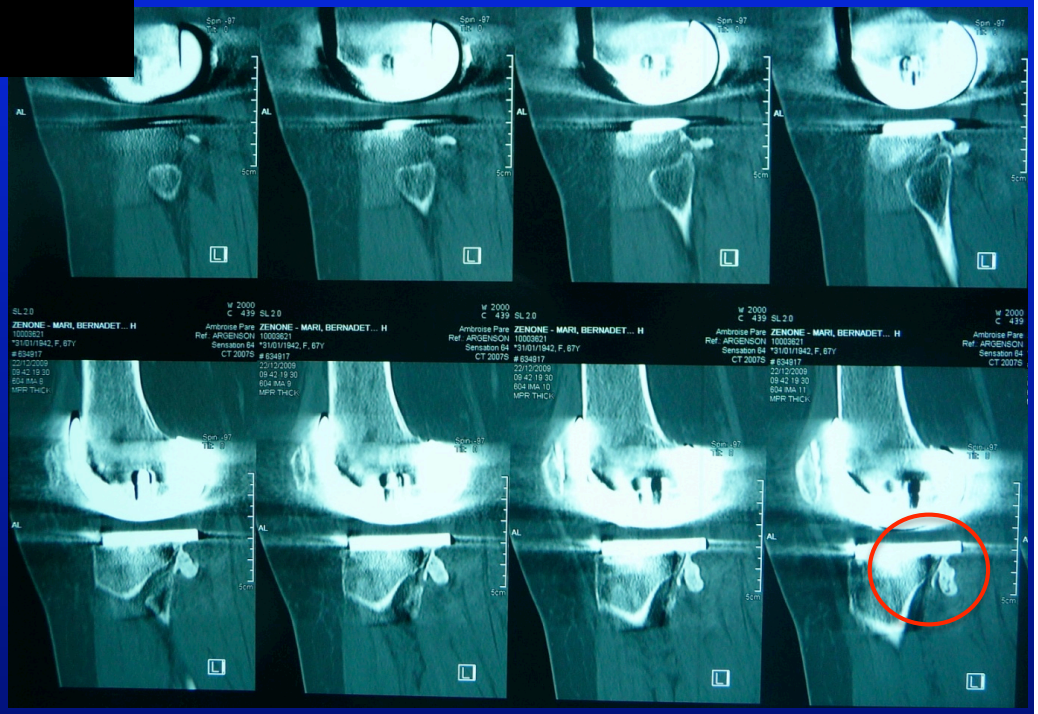
Cement Impingement

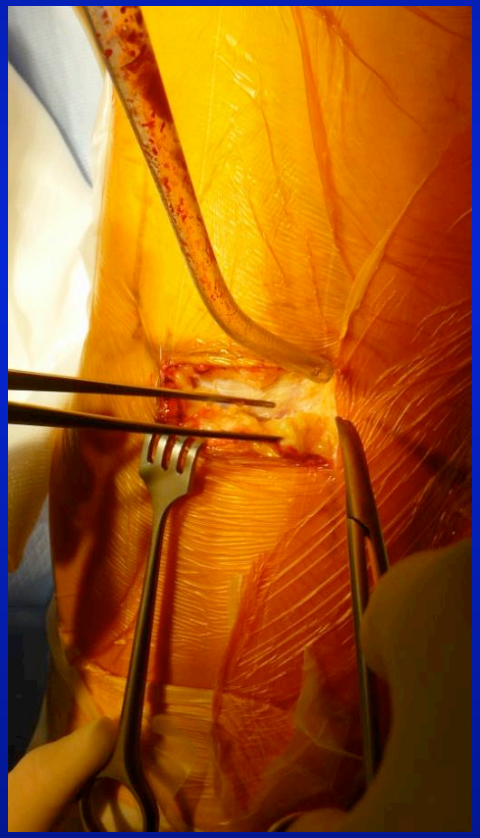
Question: when is it symptomatic ?

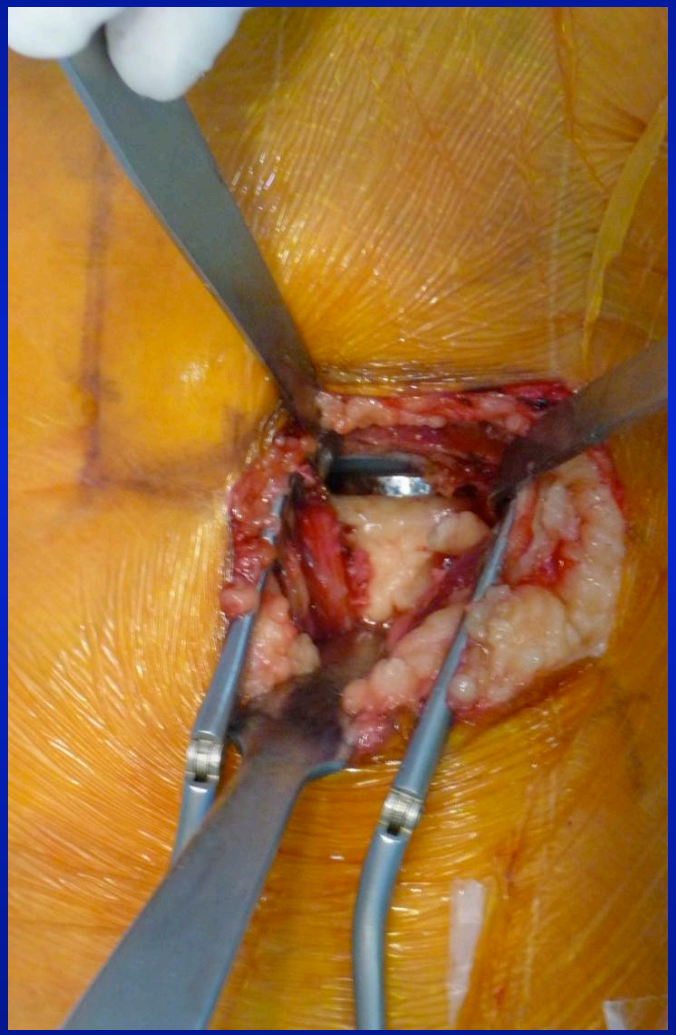


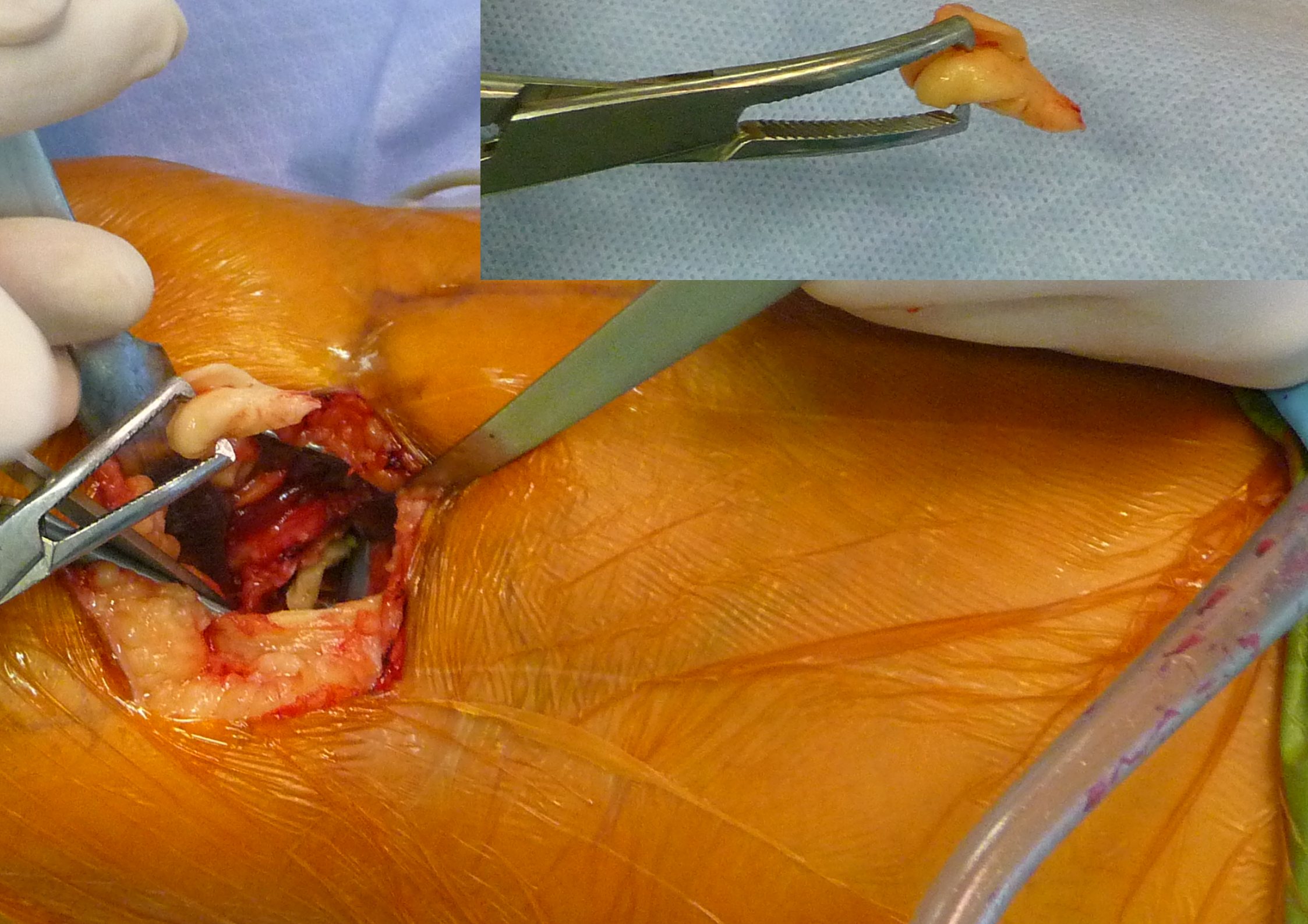
Mrs Z, 62 years-old



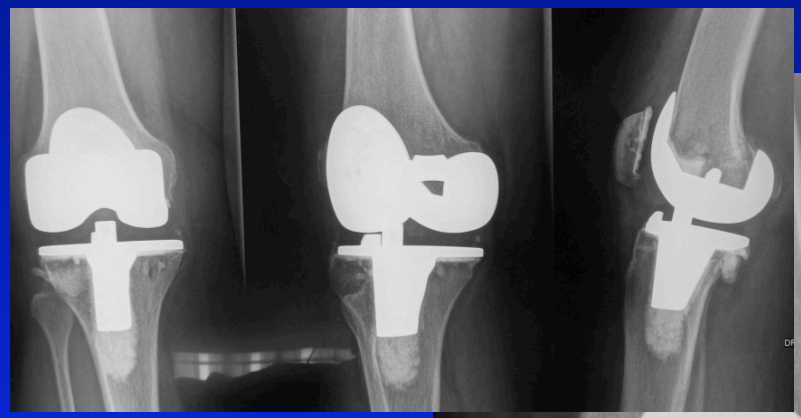




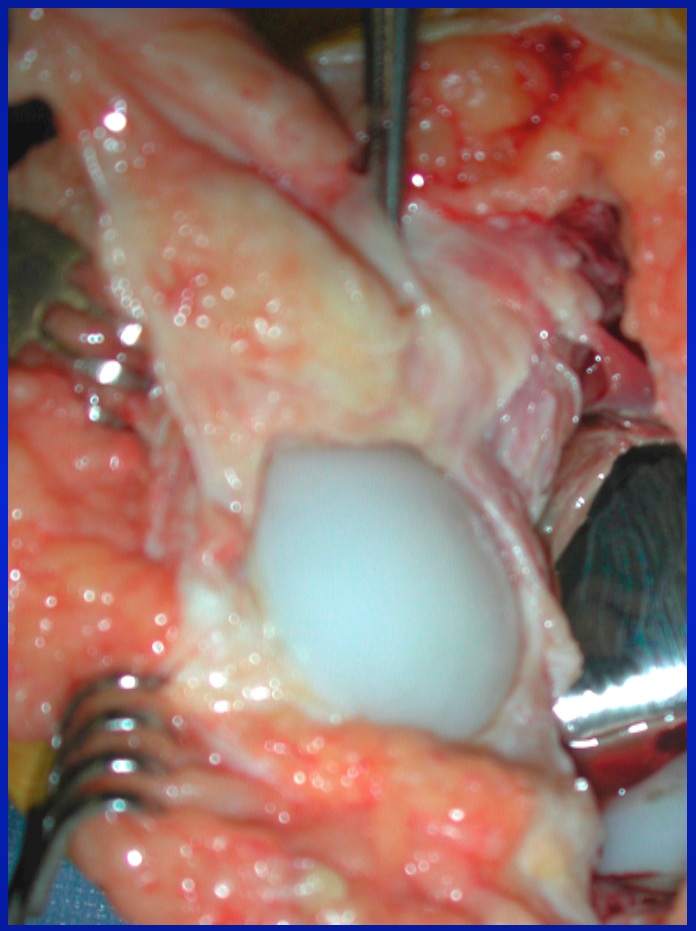




Post-op



Soft-tissue Impingement



J Arthroplasty. 2010 Oct;25(7):1061-5.

Femoral notch stenosis caused by soft tissue impingement in semi or open-box posterior-stabilized total knee arthroplasty.

Bonutti PM[1], Zywiel MG, Rudert LA, Gough AK, McGrath MS, Mont MA.

Conclusion

1. Maintain superior results and improve patient satisfaction
2. Improve surgeon satisfaction with sizes and shapes, while matching the unique identity of each patient
3. Use a reproducible surgical technique with dedicated instrumentation and adequate exposure