

Dr Andreas Loeffler

www.orthosports.com.au

29-31 Dora Street, Hurstville
160 Belmore Road, Randwick



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Dr Andreas Loeffler
Joint Replacement & Spine Surgery

CAS or Navigation in TKA

**New Software for a Full Range of
Motion Balanced Gaps Technique**

Andreas Loeffler

Prince of Wales Hospitals



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Evolution



CT-based planning & Navigation

CT-free Navigation

Keep it simple: pure alignment solutions

3rd Generation: beyond pure alignment

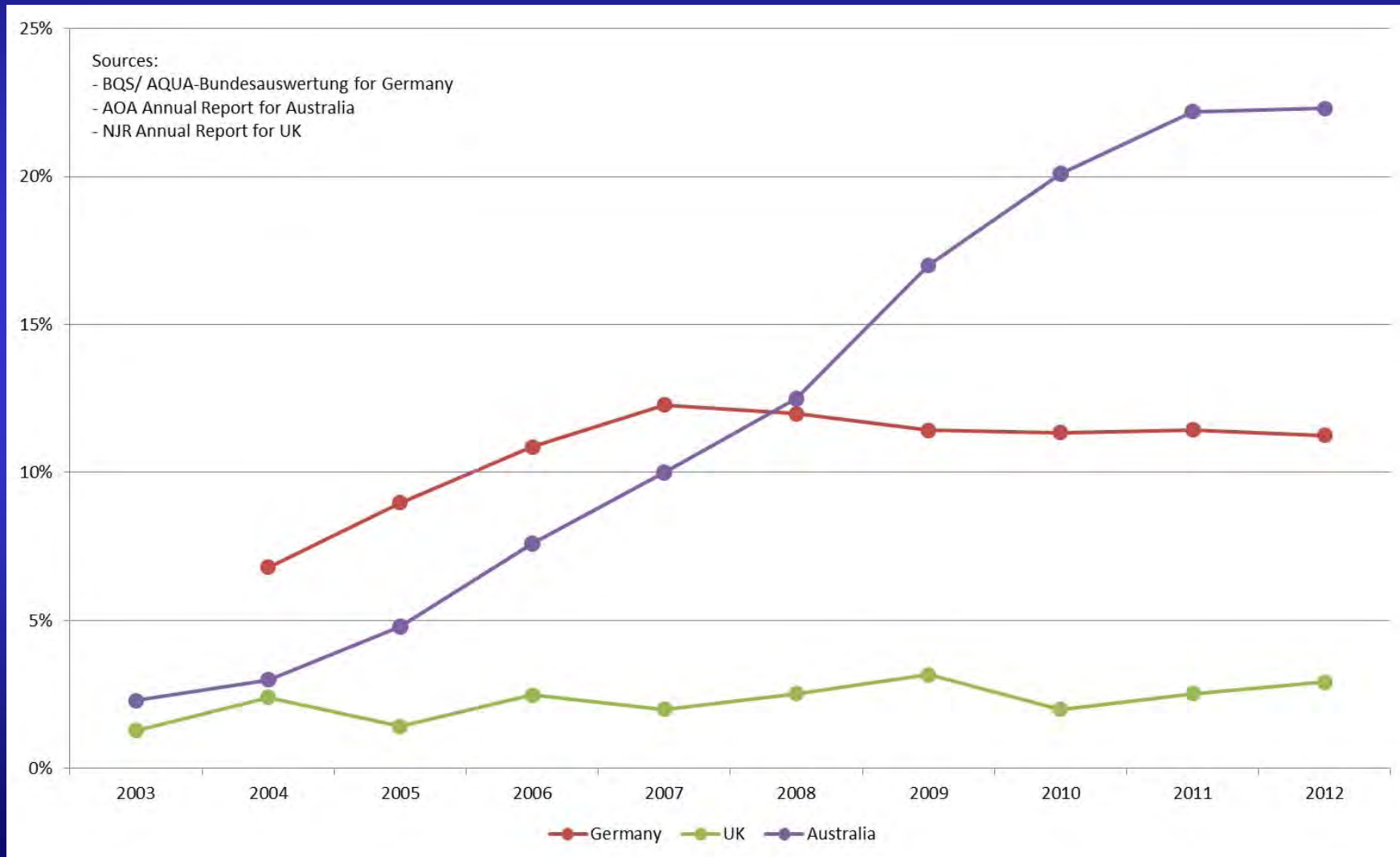


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How Popular Is CAS In TKA?



Computer Assisted Surgery

MARKET SITUATION

- Several different solutions have been launched over the last 2-3 years
- There seems to be a clear request for some sort of guidance in Orthopaedic surgery



Factors for a good Knee Replacement

Patient factors

Prosthesis

Surgical technique



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Factors for a good Outcome

From the Literature

1. Alignment

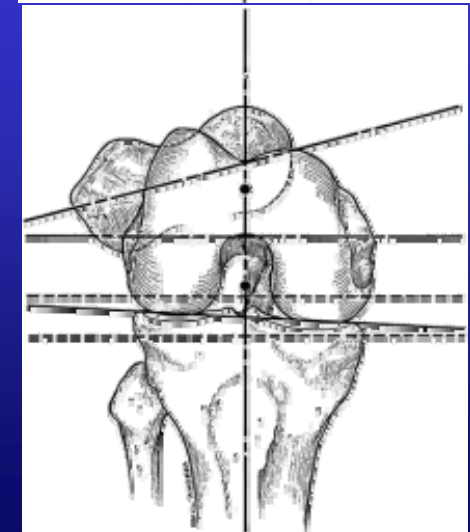
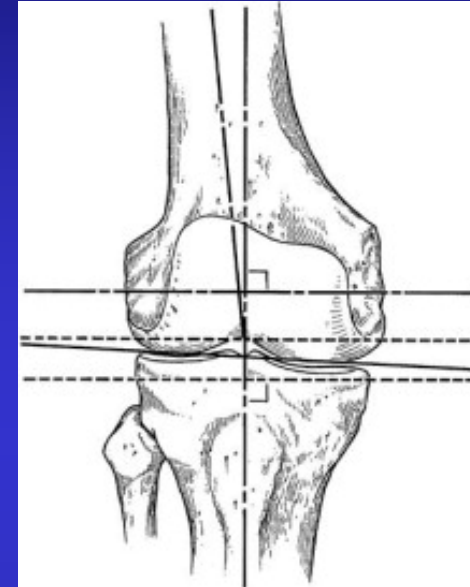
- Jeffery RS, Morris RW, Denham RA. Coronal alignment after total knee replacement. *J Bone Joint Surg Br.* 1991 Sep;73(5):709-14

2. Femur rotation: Whiteside 1995

- Whiteside LA, Arima J. The anteroposterior axis for femoral rotational alignment in valgus total knee arthroplasty. *Clin Orthop Relat Res.* 1995, Dec;(321):168-72

3. Balanced Gaps: Whiteside 2000

- Buechel FF, Pappas MJ. The New Jersey Low-Contact-Stress Knee Replacement System: biomechanical rationale and review of the first 123 cemented cases. *Arch Orthop Trauma Surg.* 1986;105(4):197-204
- Whiteside LA. Positioning the femoral component: the effect of femoral rotation on ligament balance. *Am J Knee Surg.* 2000 Summer;13(3):173-80



Straight Alignment

- **There are solutions available to get a straight cut**
 - Navigation is proven to be accurate: Mason JB, Fehring TK, Estok R, Banel D, Fahrbach K. Meta-analysis of alignment outcomes in computer-assisted total knee arthroplasty surgery. *J Arthroplasty*. 2007 Dec;22(8):1097-106
- **BUT straight alignment alone does not guarantee good knee**
 - Parratte S, Pagnano MW, Trousdale RT, Berry DJ. Effect of postoperative mechanical axis alignment on the 15-year survival of modern, cemented total knee replacements. *J Bone Joint Surg Am*. 2010;92:2143–9



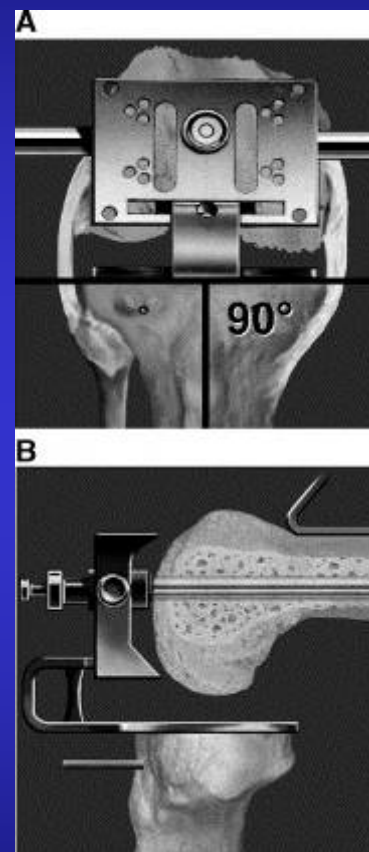
Femur Rotation

Make your Choice

- **Pure bone referenced**
 - Referencing off posterior condyles, sometimes other (additional) landmarks
- **Ligament based**
 - LCS „horseshoe“ – (completely) disregard bony landmarks
- **Something in between?**

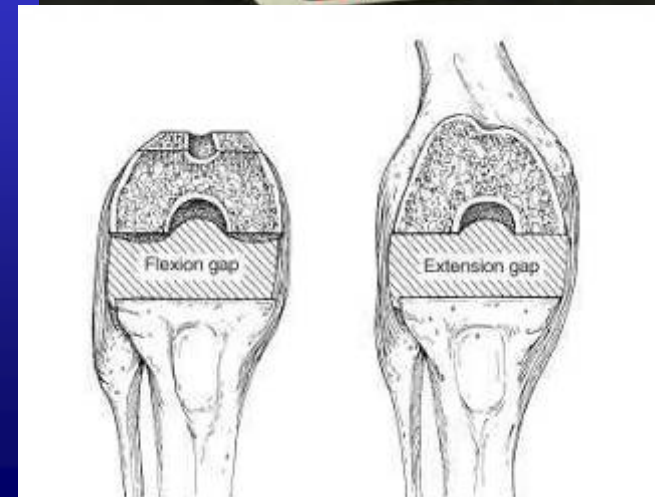
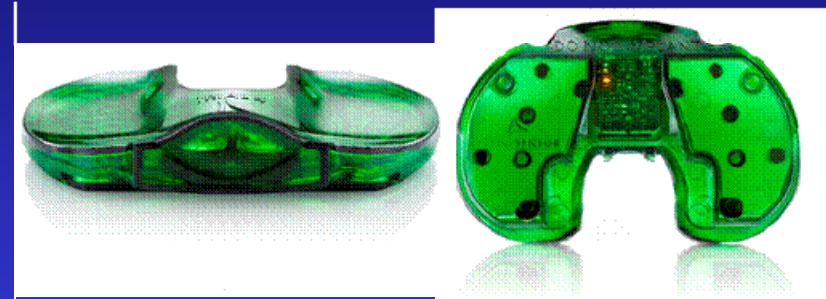


OR



Balanced Gaps

- **Balanced gaps means**
 - Rectangular (medial/lateral)
 - Equal (flexion/extension)
- **Can be achieved before resection (LCS) or at trialling (soft tissue releases)**
- **Supported by mechanical instruments/ surgical technique or additional devices**



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Do gaps matter?

Patient and Surgeon awareness

Refinement of technique

Improved tools

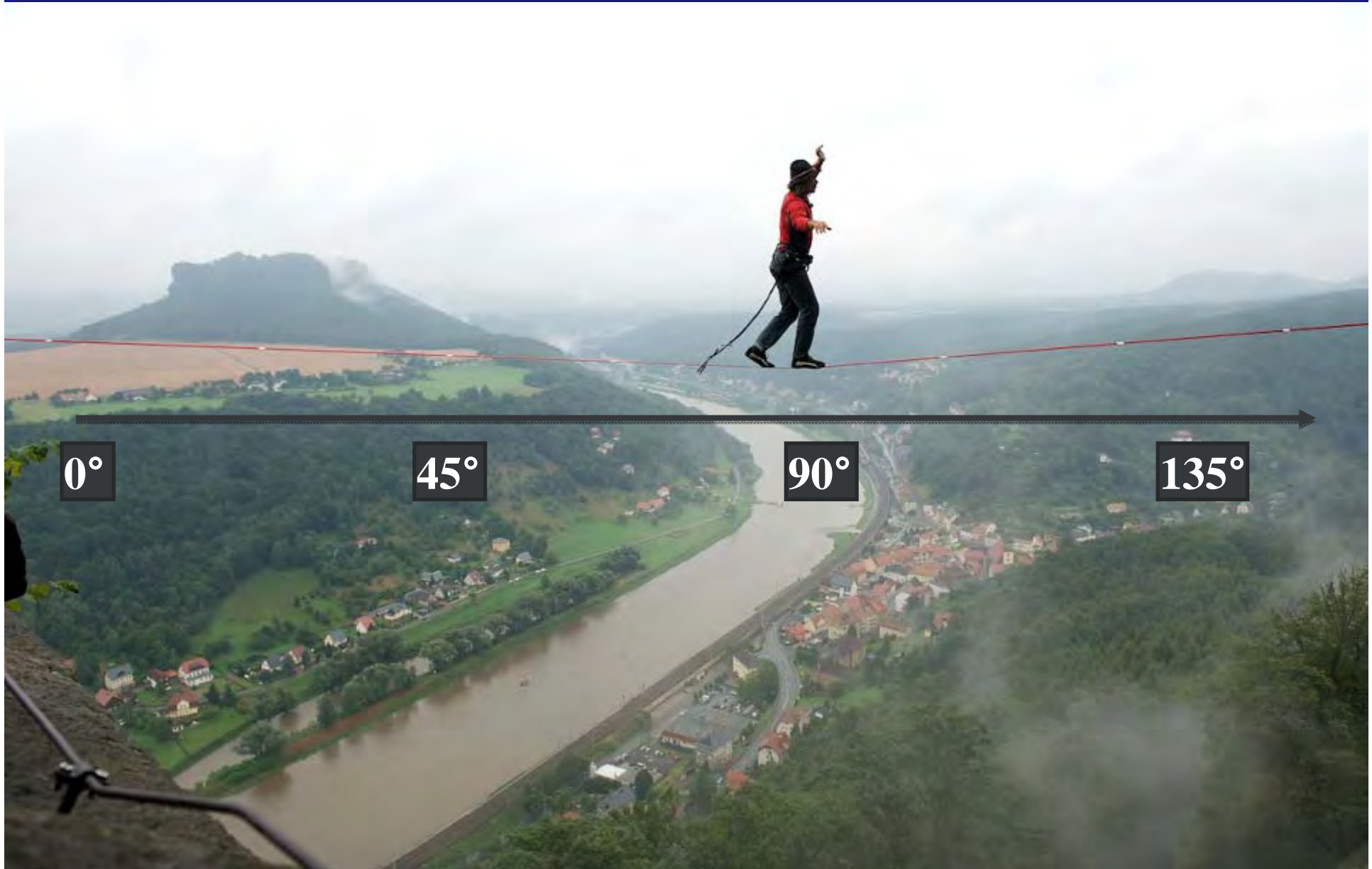
Better outcomes



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Balance over full range of motion



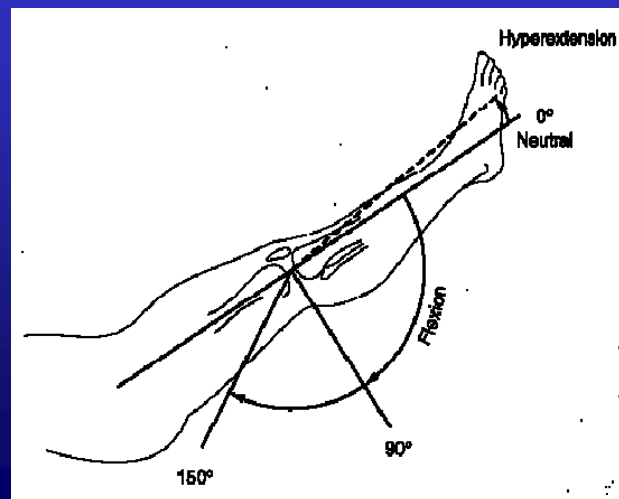
Balanced Gaps Technique

•Balanced Gaps Technique

- Extension gap first or flexion gap first
- Make first resection, plan second resection to achieve the same gap
- CAS: Plan implant position, perform both resections

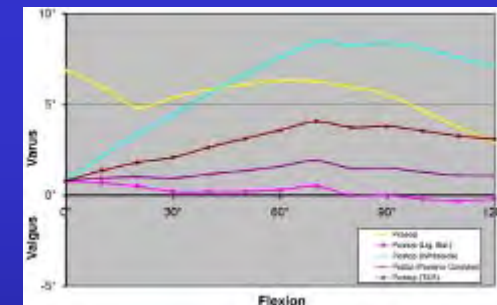
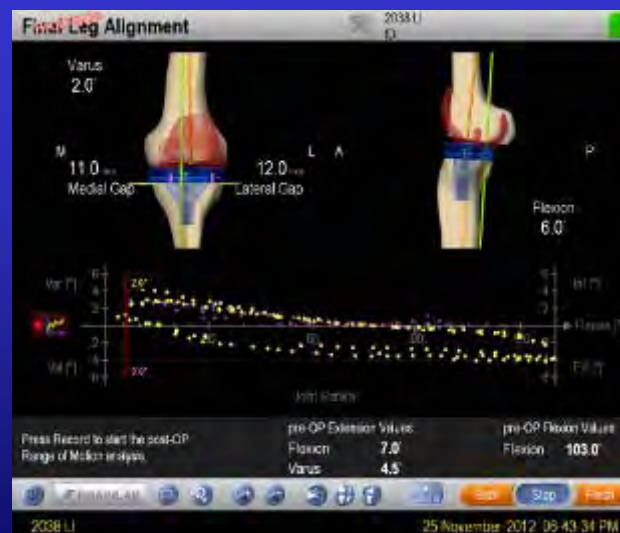
•Result: Balanced in Extension (0°) and Flexion (90°)

- What about 60° (standing up from a chair)?
- What about 45° (climbing up stairs)
- What about 15° (walking down stairs)



Current State of the Art

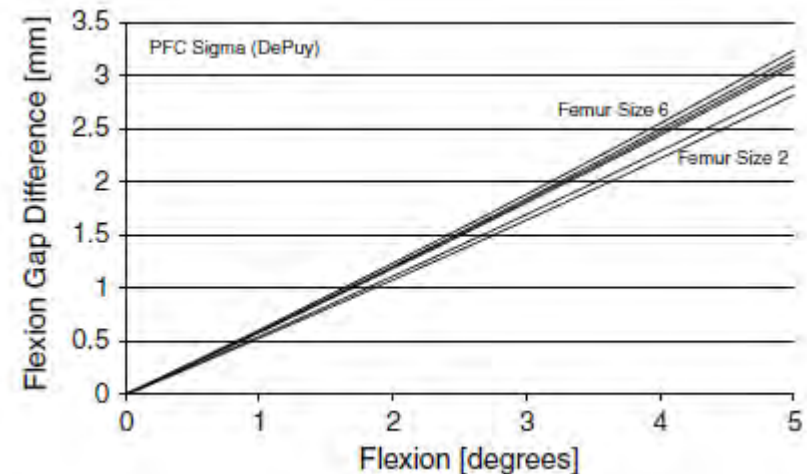
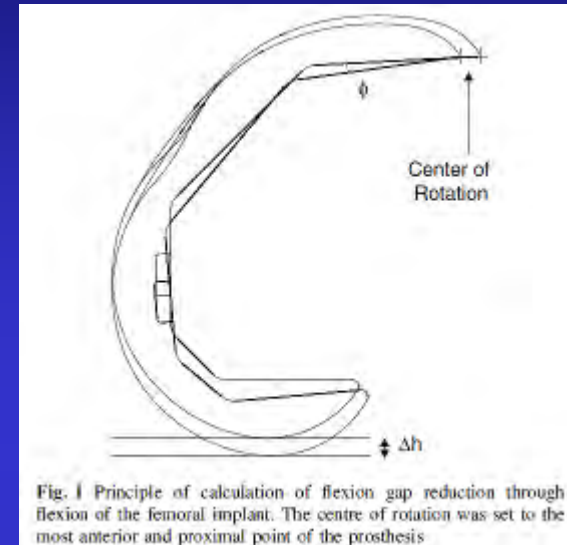
- Recording of soft tissue balance over full range of motion is possible in software
 - Before resections
 - During trialling
- Full range of motion is used for planning



Balance over full Range of Motion

Influence of femoral component position

- **Based on implant geometries, visualize joint stability over full range of motion**
 - *Matziolis et.al.*, Increased flexion position of the femoral component reduces the flexion gap in total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc.* 2012 Jun;20(6)
 - *Nowakowski et.al.*, Influence of tibial slope on extension and flexion gaps in total knee arthroplasty: increasing the tibial slope affects both gaps. *Int Orthop.* 2014 May 25
- **Patient specific stability information of the knee joint used before any bone cuts have been made**



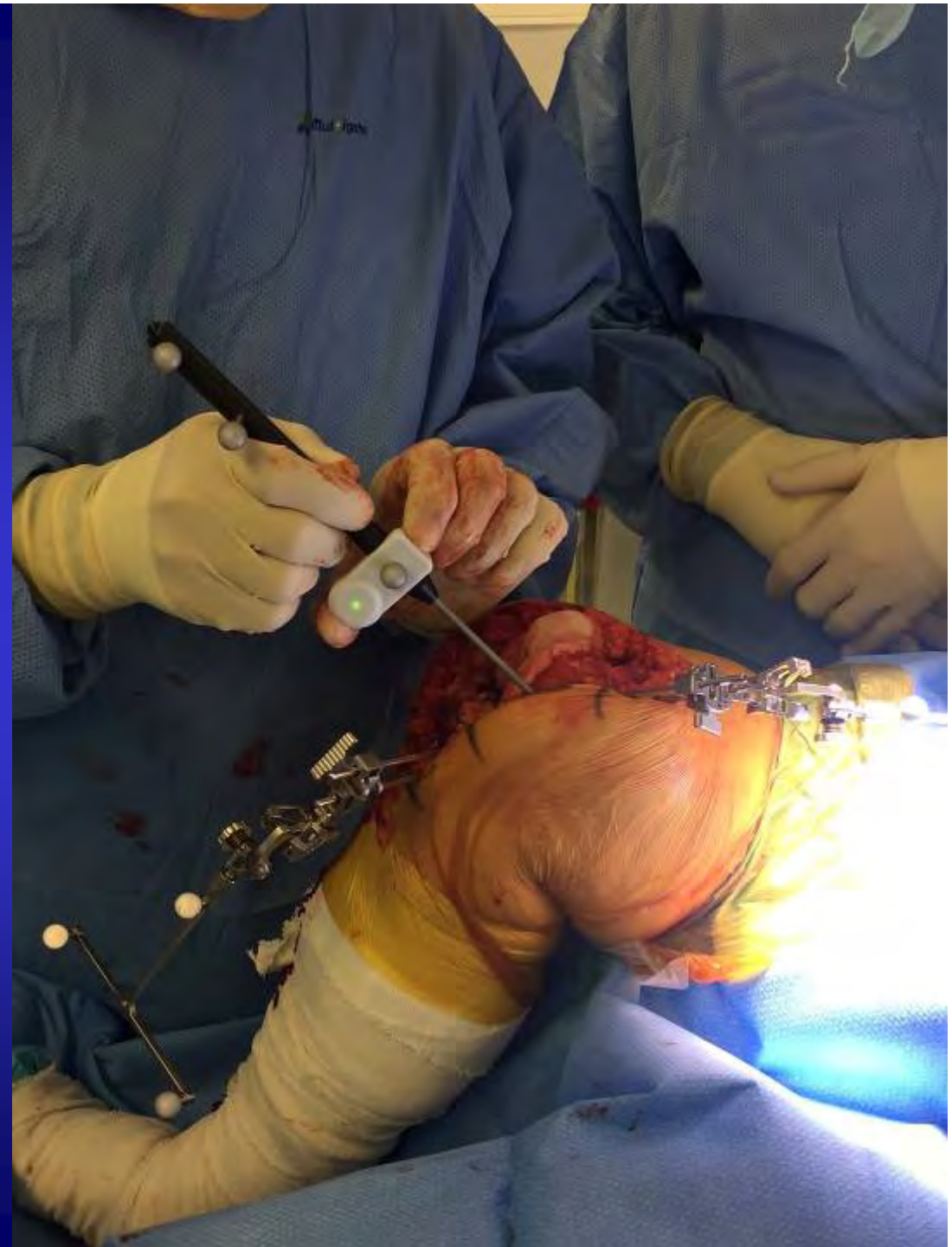
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Tibial and Femoral Infra-red Markers



Register points

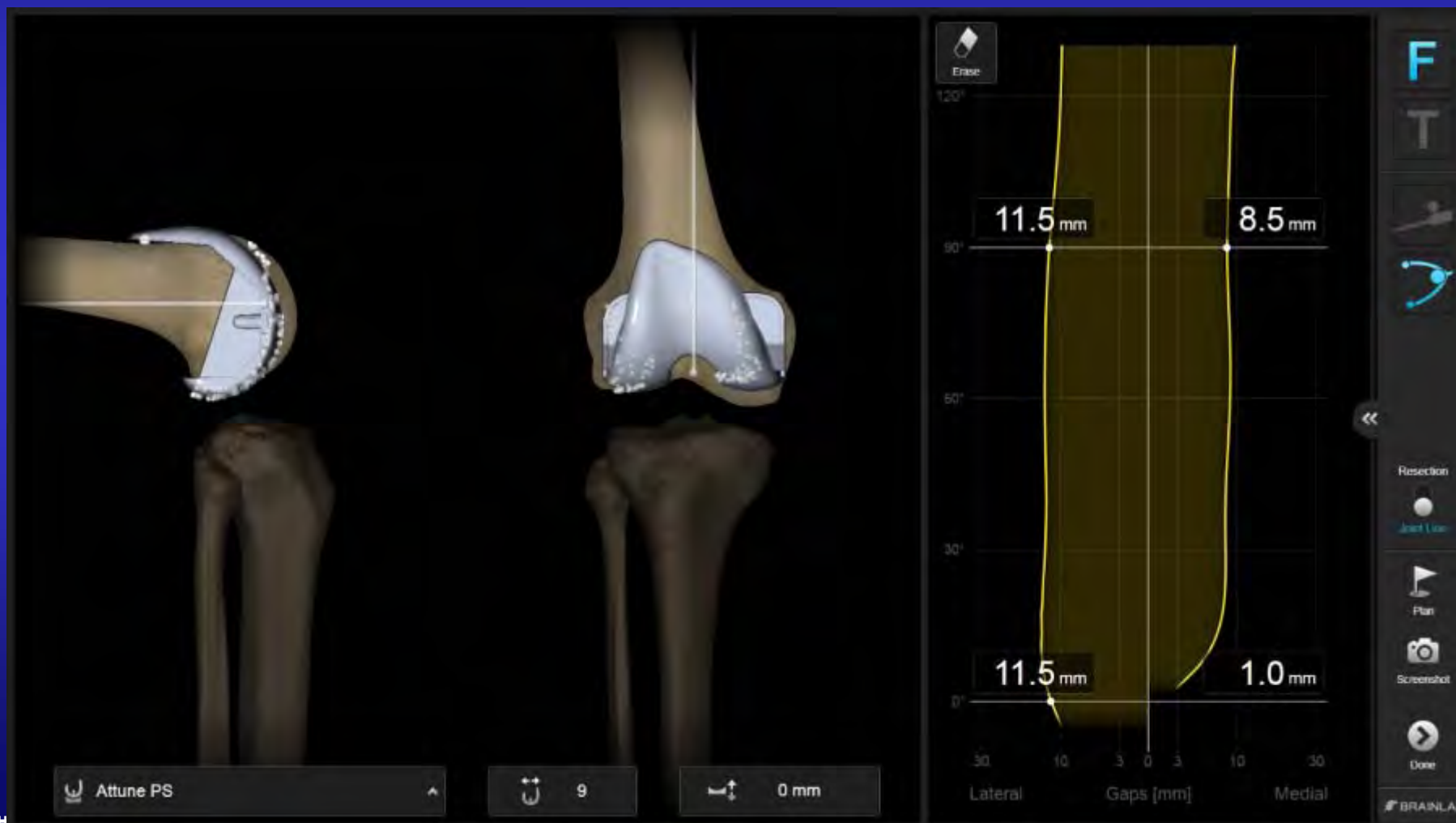


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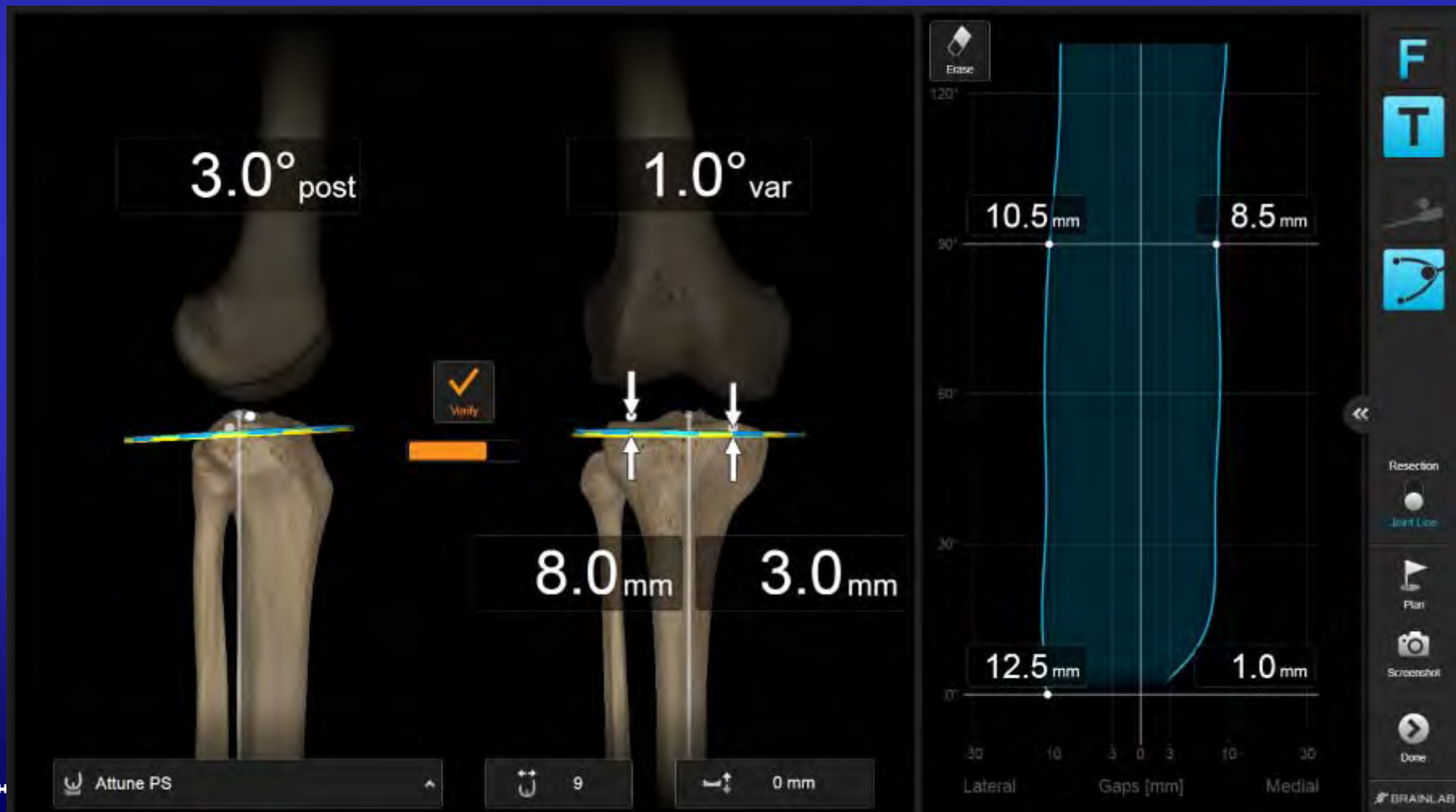
KNEE 3 - Initial Alignment

Initially registered 12° varus (extension screenshot missing) with deformity apparent in stability graph – in particular medial side

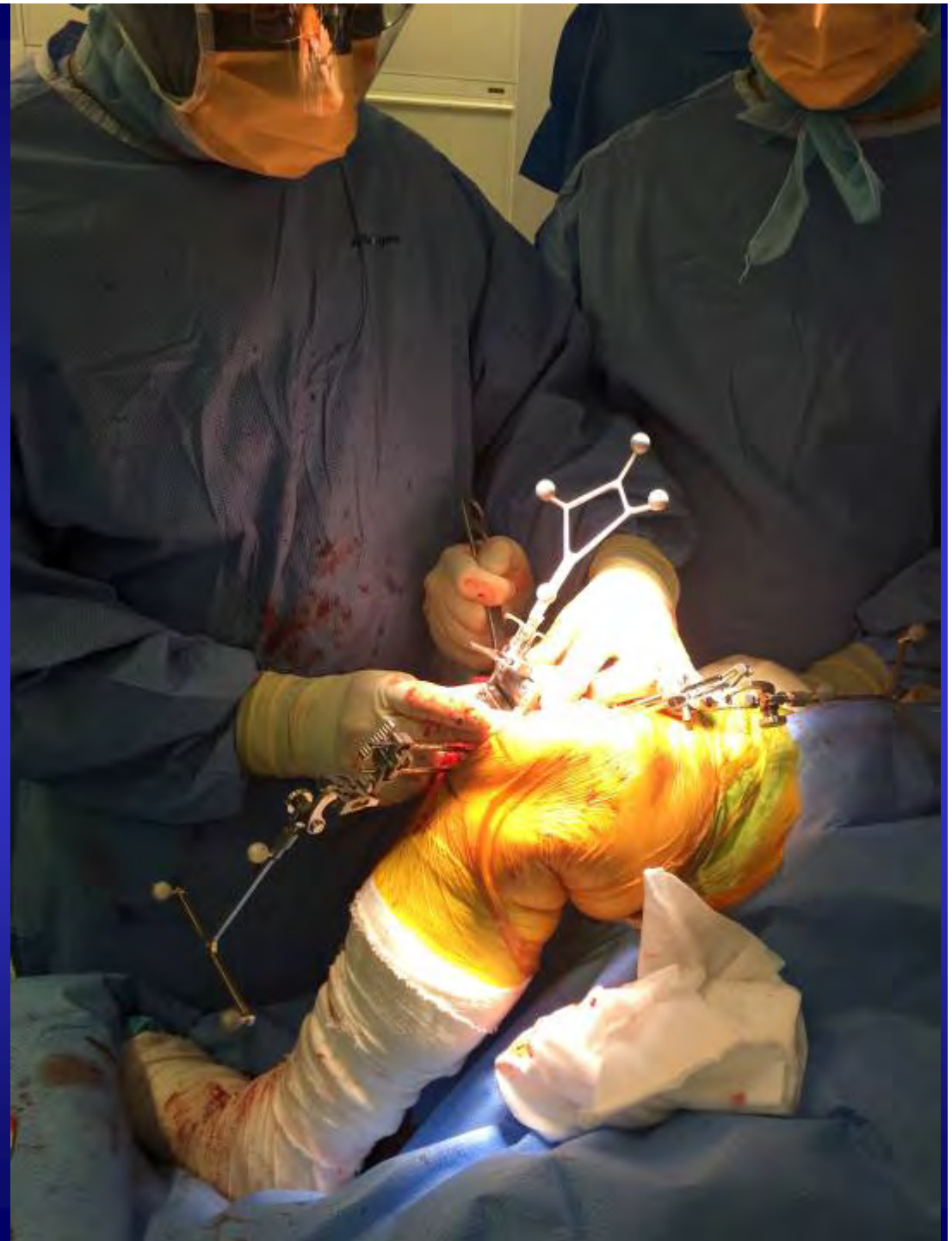


KNEE 3 – Tibial Resection

Standard tibial resection in expectation for a stable knee throughout range of motion



Verify cuts

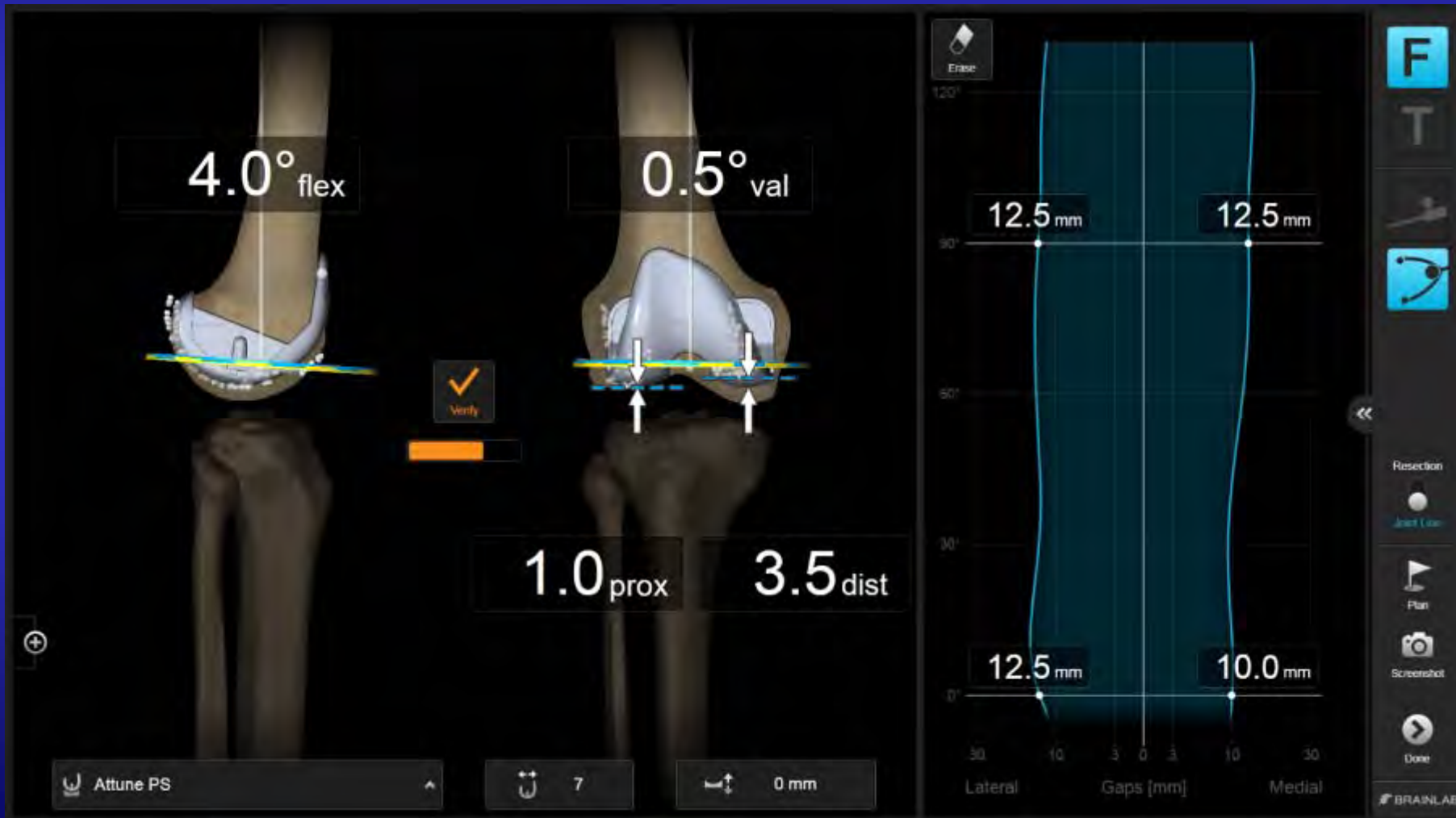


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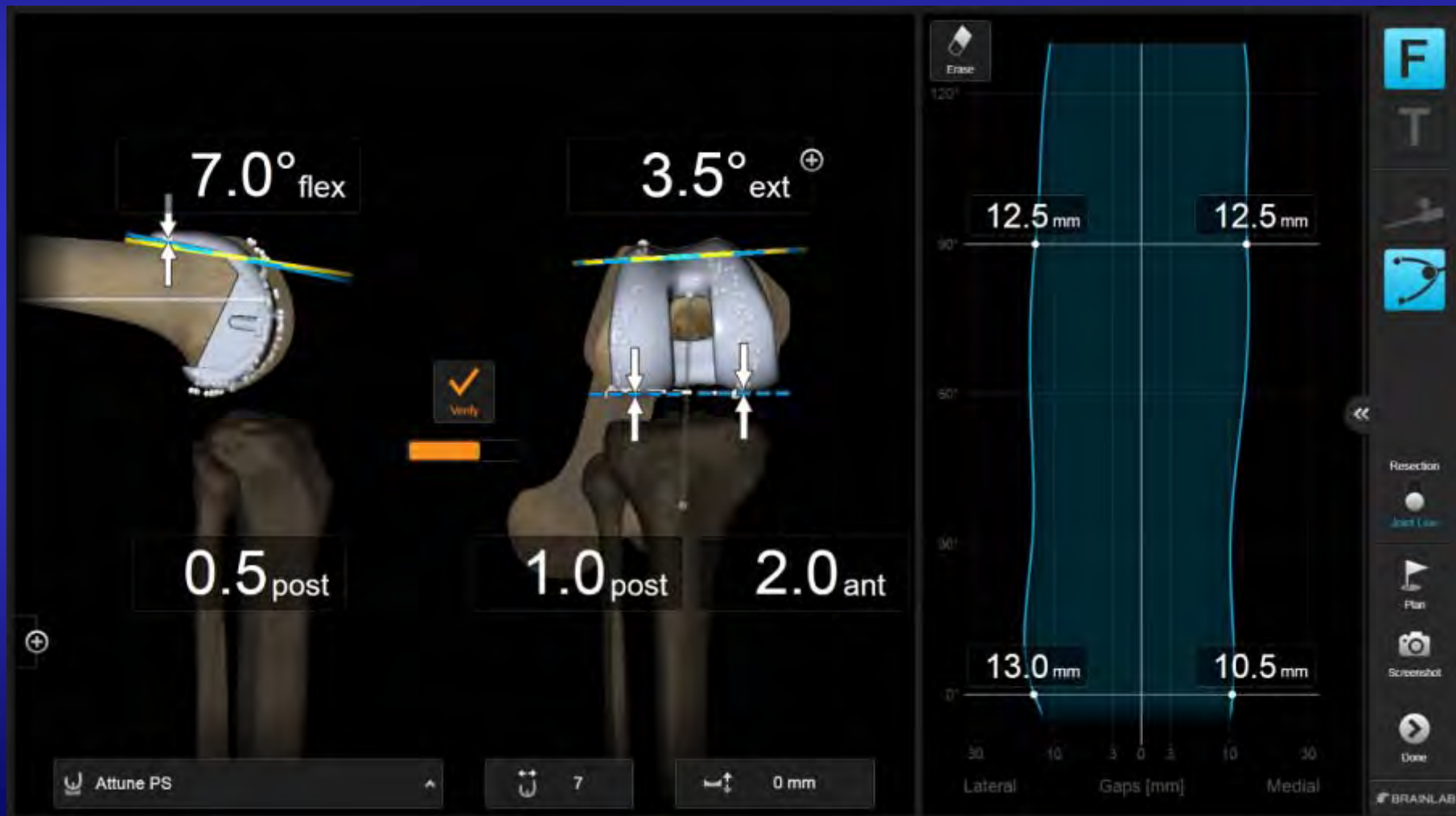
KNEE 3 – DISTAL FEMUR

After tibial resection and removal of posterior osteophytes, full extension is reached.



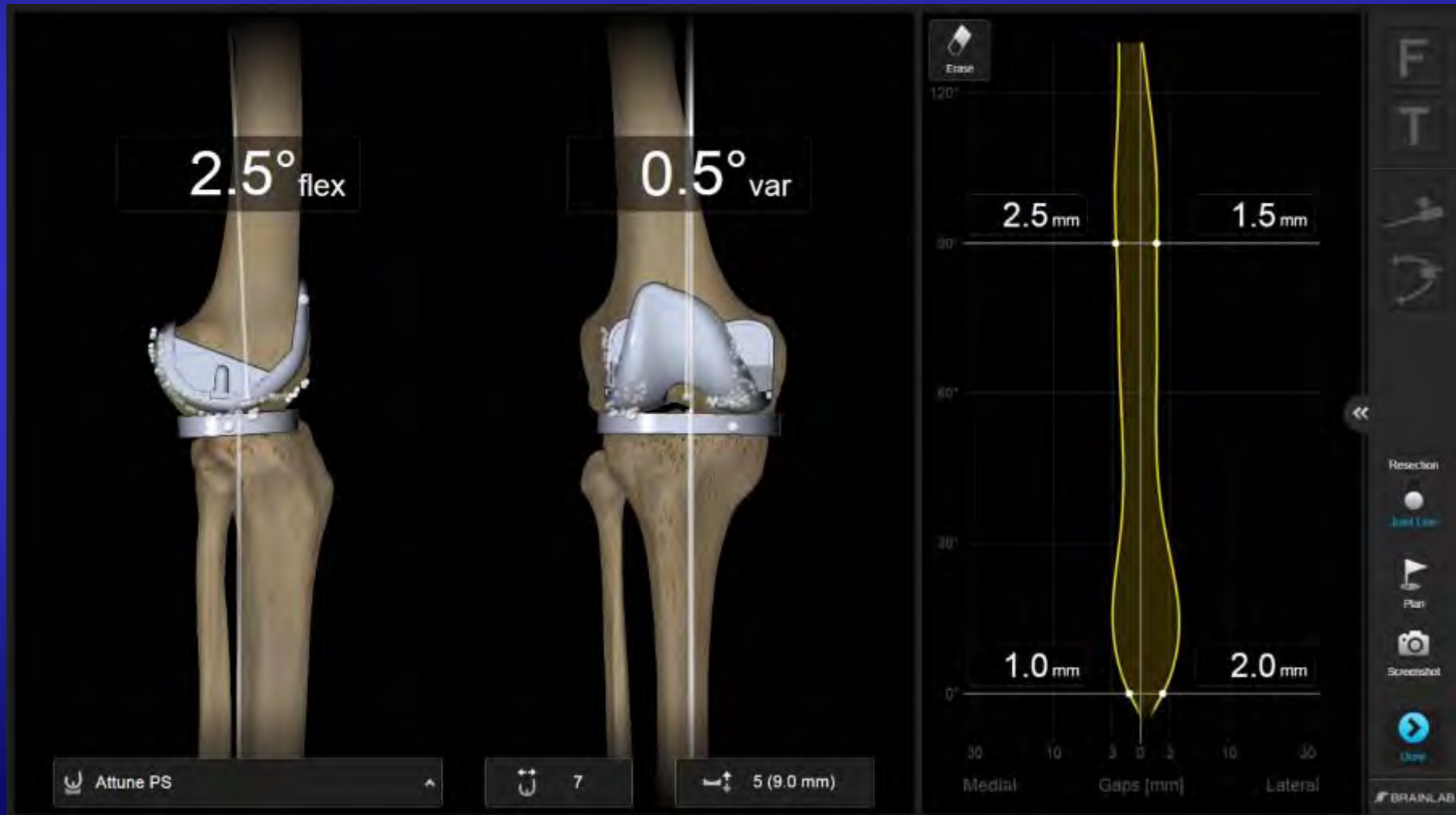
KNEE 3 – FEMORAL ROTATION

Femoral rotation relative to posterior condylar line at 3.5° internal to get flexion gaps rectangular



KNEE 3 – FINAL STABILITY

Final Stability Graph with 9mm tibia (under varus/valgus stress)



Is Navigation worthwhile?

What is the evidence?



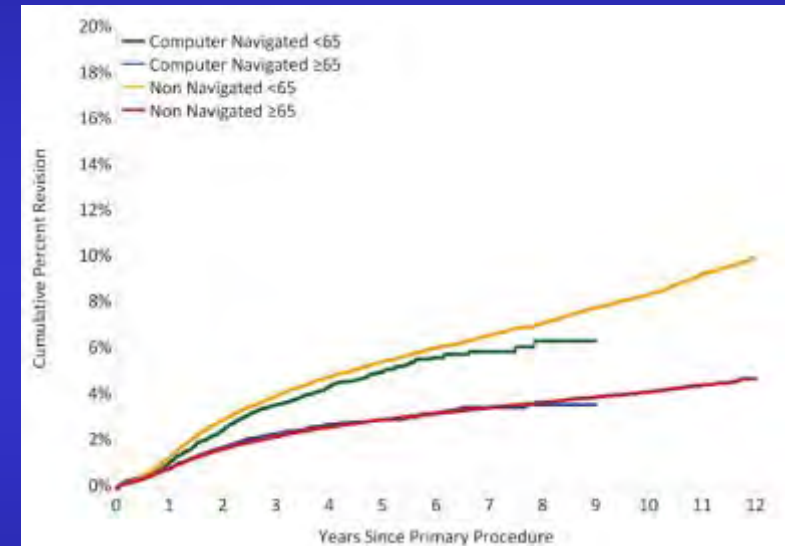
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CLINICAL EVIDENCE

AUSTRALIAN REGISTRY

- 9 year follow up study of 44.000 patients shows a reduced rate of revision for navigated TKA in patients < 65y ¹⁾
- Significant reduction in the rate of revision for navigated TKA for the most common revision diagnosis of loosening/lysis and a reduction in major revisions
- Revision rate was reduced 20% from 7.8% in non-navigated to 6.3% in navigated TKA



1) Richard N De Steiger et al., The Outcome Of Computer Navigation For Primary Knee Arthroplasty, EFORT 2014



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Why make a change?

Can we improve outcomes?

+ Functional Outcome

- CAS facilitates gap balancing method which leads to fewer outliers and improved knee scores.²⁾
- Patients undergoing navigated surgery are more satisfied after 12 months postoperatively.³⁾

2) Pang et al., *Knee Surg Sports Traumatol Arthrosc.* 2011 ;19(9):1496-503

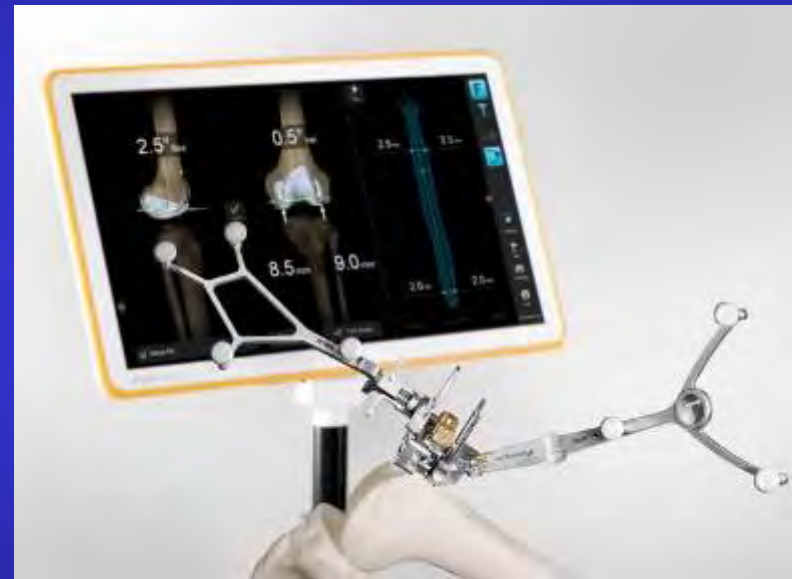
3) Lehnen et al., *Knee Surg Sports Traumatol Arthrosc.* 2011, 19(6):887-92

+ Less Revision

- CAS reduces TKA revision rate by 50% in retrospective analysis.⁴⁾
- CAS reduces TKA revision rate in patients <65 years⁵⁾

4) Schnurr et al., *Int Orthop.* 2012; 36(11)2255-60

5) Richard N De Steiger et al., *The Outcome Of Computer Navigation For Primary Knee Arthroplasty, EFORT 2014*



Evolution

Navigation is not new

Navigation is better

Evolution of software and technique

Improvement of surgical technique

Gap balancing through a full range of motion



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Clinical Results

Patient outcomes are improved
Surgeon satisfaction rate is up



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Thank you



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