

Mechanical alignment in TKR

What are important targets and how do we best achieve it

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LYON KNEE
SCHOOL of SURGERY



UNIVERSITY TEACHING CENTER



Hospices Civils de Lyon

Conflicts of interest

- ***Consultant :***

Heraeus

Tornier

Amplitude

Lepine

Smith and Nephew

- ***Scientific societies:***

ISAKOS : Deputy Chair Arthroplasty
Committee

EKS : Travelling fellowship
Committee

- ***Editorial board:***

KSSTA

OTSR

Maitrise Orthopédique

Mechanical alignment

1. Definition ?
2. Important targets ?
3. How do we best achieve it ?

Understand Our Patients' Anatomy



The Chitranjan Ranawat Award

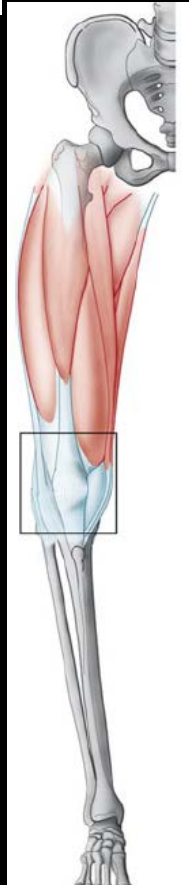
Is Neutral Mechanical Alignment Normal for All Patients?

The Concept of Constitutional Varus

Clin Orthop Relat Res (2012) 470:45–53

Johan Bellemans MD, PhD, William Colyn MD,
Hilde Vandenuecker MD, Jan Victor MD, PhD

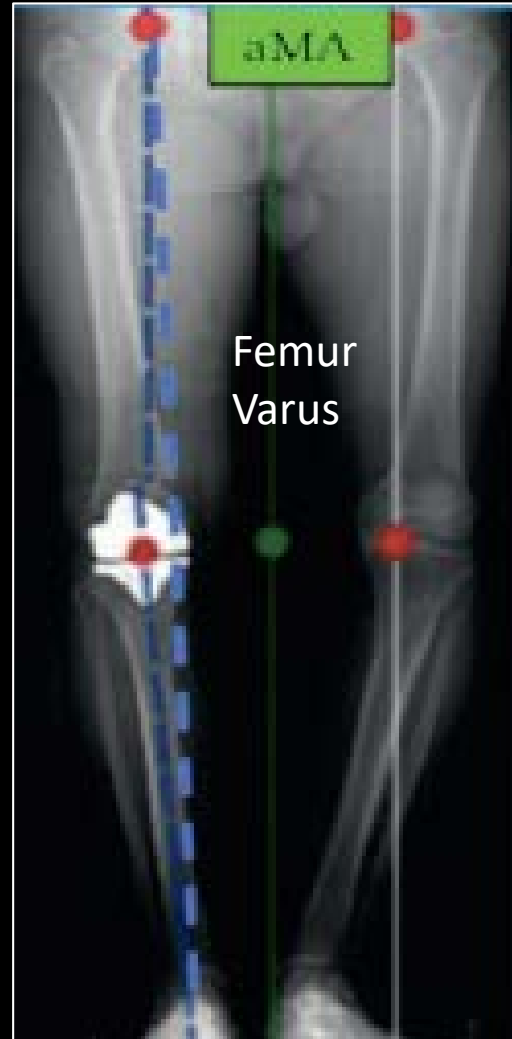
- 250 asymptomatic patients (20 -27 years)
- All patients had full-length standing x-rays
- **Results**
 - 32% of males $> 3^\circ$ constitutional varus
 - 17% of women $> 3^\circ$ constitutional varus



KINEMATIC ALIGNMENT



« HYBRID » ALIGNMENT



« MECHANICAL » Alignment

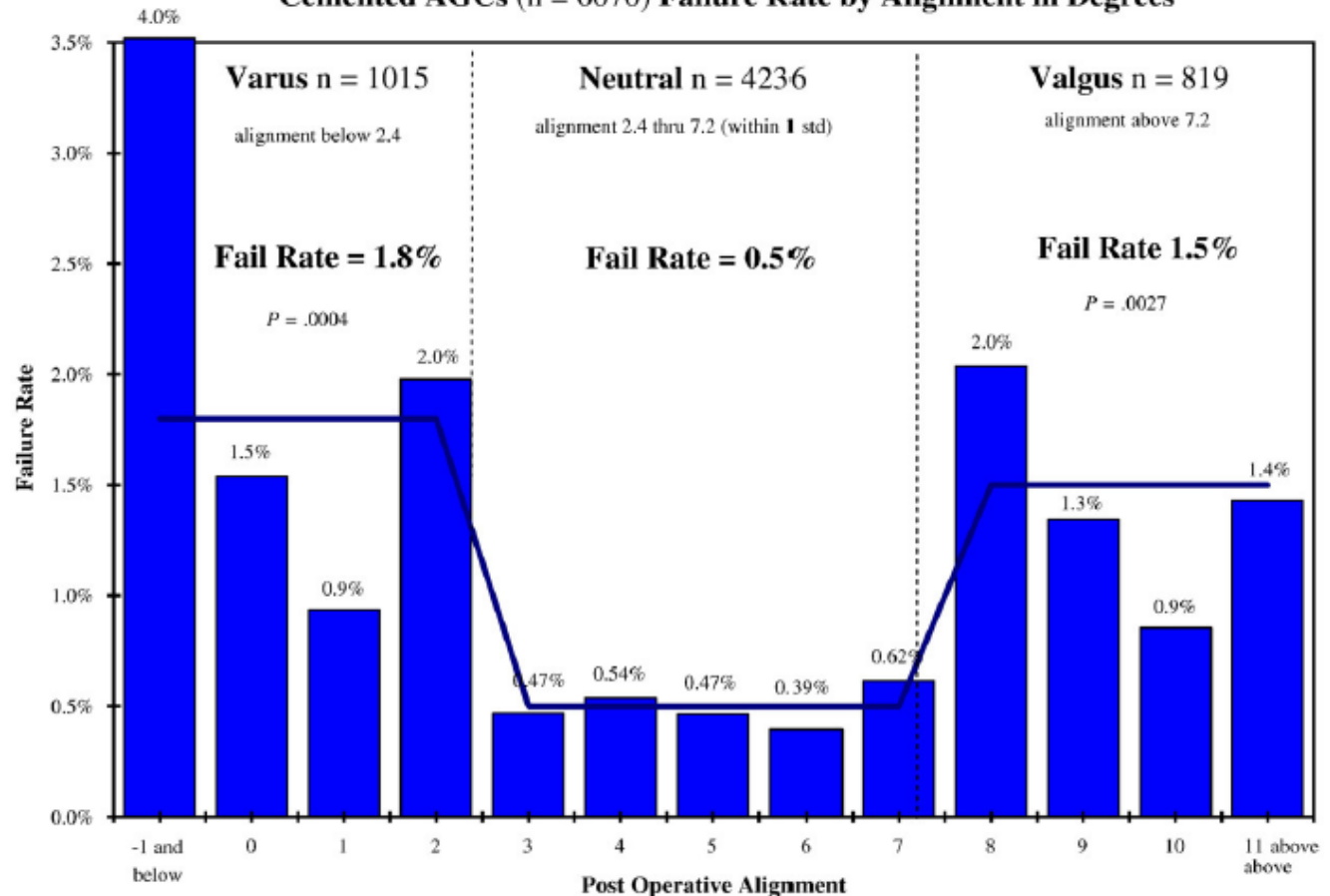


Coronal Alignment in Total Knee Arthroplasty

Just How Important is it?

David M. Fang, MD,* Merrill A. Ritter, MD,† and Kenneth E. Davis, MS†

Cemented AGCs (n = 6070) Failure Rate by Alignment in Degrees



n = 6070 PTG

Post operative Mal alignment

- Deviation of more than two or three degrees from this alignment, particularly in varus, has been associated increased rates of **aseptic loosening and failure**

Bergen et al, CORR, 1983

Berend et al, CORR, 2004

Fang et al, J Arthroplasty, 2009

Insall et al, CORR, 1985

Jeffery et al, JBJS-Br, 1991

Lewallen et al, JBJS-Am, 1984

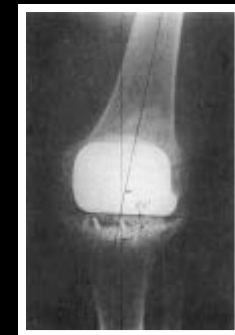
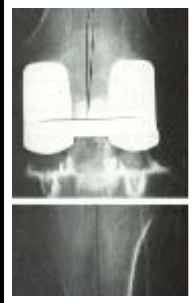
Moreland JR, CORR, 1988

Ritter et al, CORR, 1994

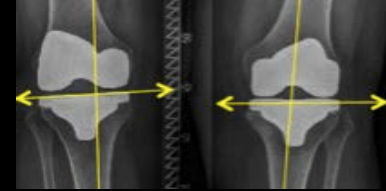
Tew and Waugh, JBJS-Br, 1985

Historical Background

- *Lotke PA and Ecker ML, JBJS Am 1977: Short X-rays*
- *Hvid I and Nielsen S, Acta Orthop Scand, 1984: Short X-rays*
- *Rand JA and Coventry MB, Clin Orthop, 1988: Short X-rays*
- *Bargren JH et al., CORR, 1983: Short X-rays*
- *Moreland J, CORR, 1988: Review*
- *Berend ME et al., CORR, 1988: Short X-rays*
- *Jeffery RS et al., JBJS Br, 1991: Full-length X-rays*



Tibial loading ?



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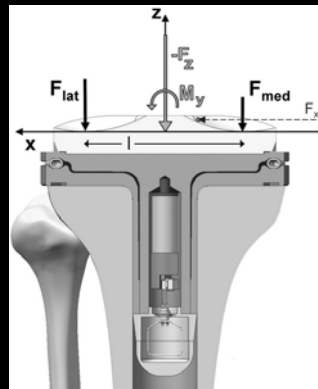
Influence of Limb Alignment on Mediolateral Loading in Total Knee Replacement

In Vivo Measurements in Five Patients

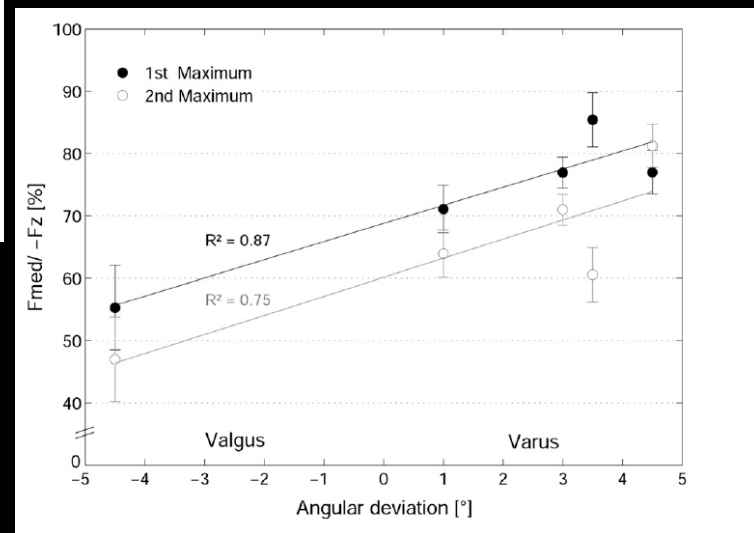
Andreas Halder, MD, PhD, Ines Kutzner, Friedmar Graichen, PhD, Bernd Heinlein, Prof., Alexander Beier, MD, and Georg Bergmann, Prof.

Investigation performed at Klinik für Endoprothetik Sommerfeld, Sommerfeld, Germany

5 instrumented
TKA



1° varus
= 5% loading



Predicting the Effect of Tray Malalignment on Risk for Bone Damage and Implant Subsidence after Total Knee Arthroplasty

Jowene Wong,¹ Nikolai Steklov,¹ Shantanu Patil,¹ Cesar Flores-Hernandez,¹ Mark Kester,² Clifford W. Colwell Jr.,¹ and Darryl D. D'Lima¹

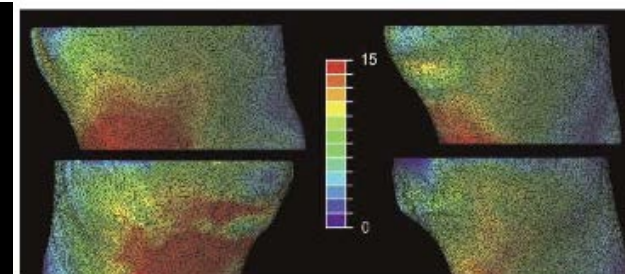
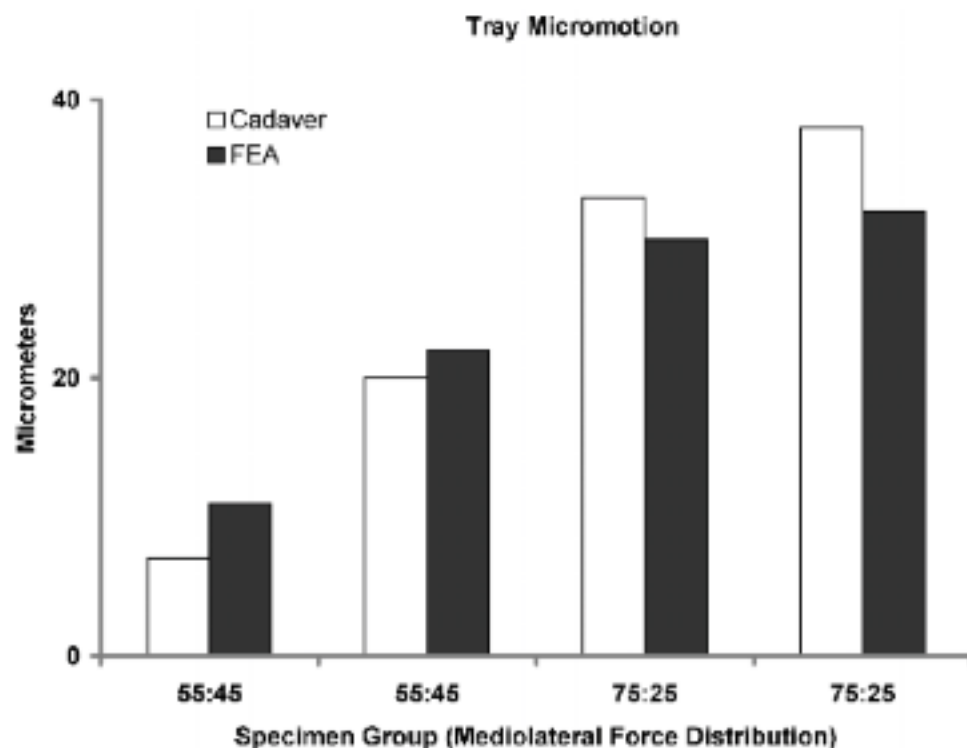


Figure 5. Contour map of von Mises distribution (MPa) in proximal tibia in specimen-specific models. (Left) Two specimens were tested under mediolateral distribution of 75:25; (right) Two specimens were tested under mediolateral distribution of 55:45.

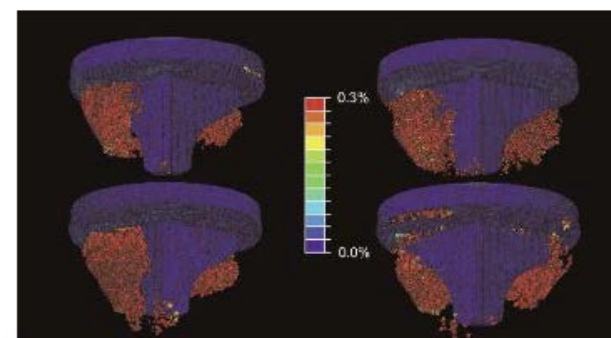
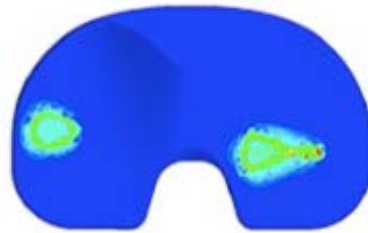


Figure 7. A greater volume of cancellous bone in the medial tibia was at risk for fatigue damage in specimens tested under mediolateral distribution of 75:25 (left) than those tested under mediolateral distribution of 55:45 (right). Unit for contour map = % strain.

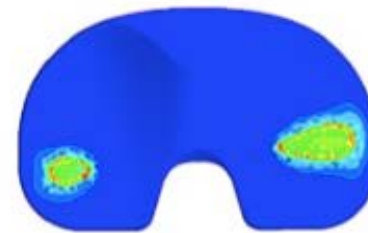
The effects of kinematically aligned total knee arthroplasty on stress at the medial tibia

A CASE STUDY FOR VARUS KNEE

Severe
varus



42.7 MPa



60.4 MPa

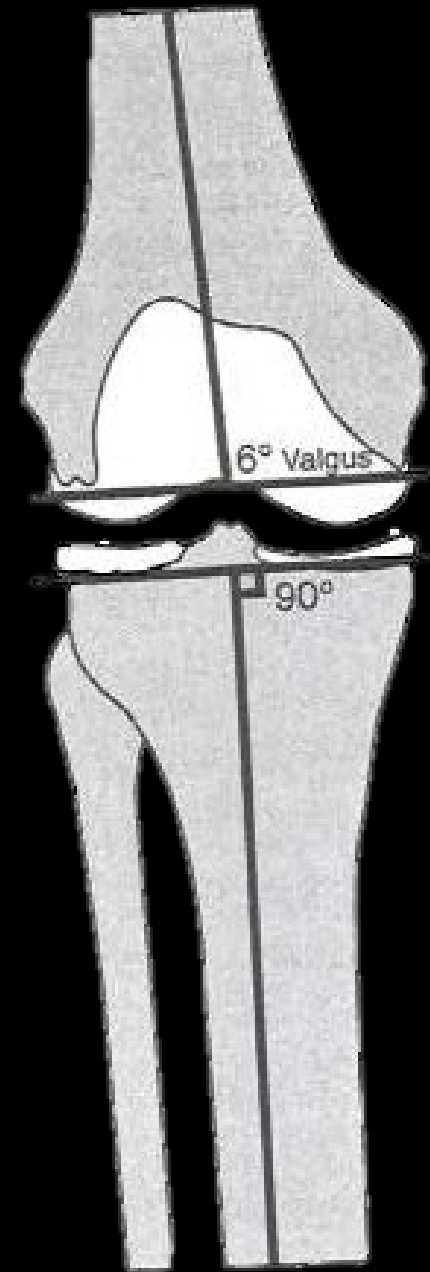
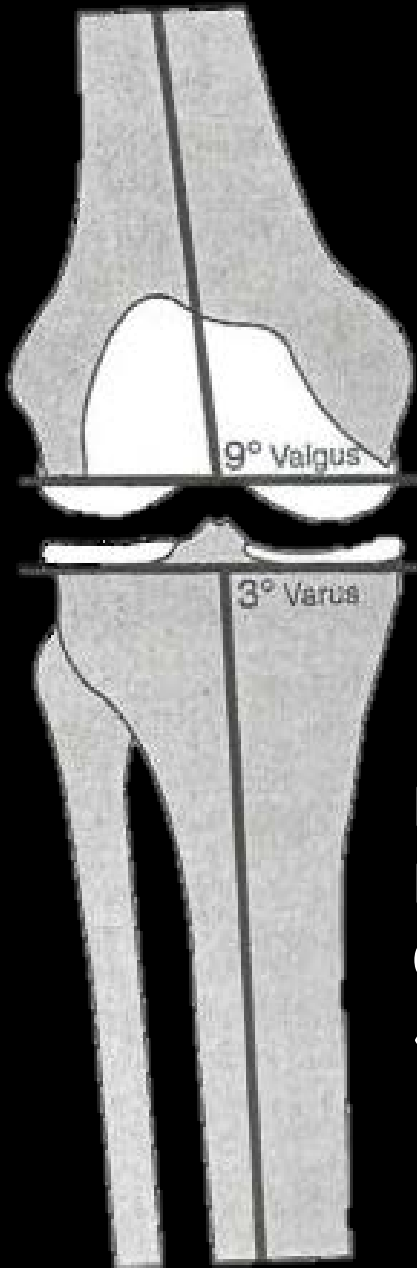
S. Nakamura,*
Y. Tian,*
Y. Tanaka,
S. Kuriyama,
H. Ito,
M. Furu,
S. Matsuda

« ... » However, KA TKA increased the contact force, stress and bone strain at the medial side for moderate and severe varus knee models. The application of KA TKA for severe varus knees may be inadequate. « ... »

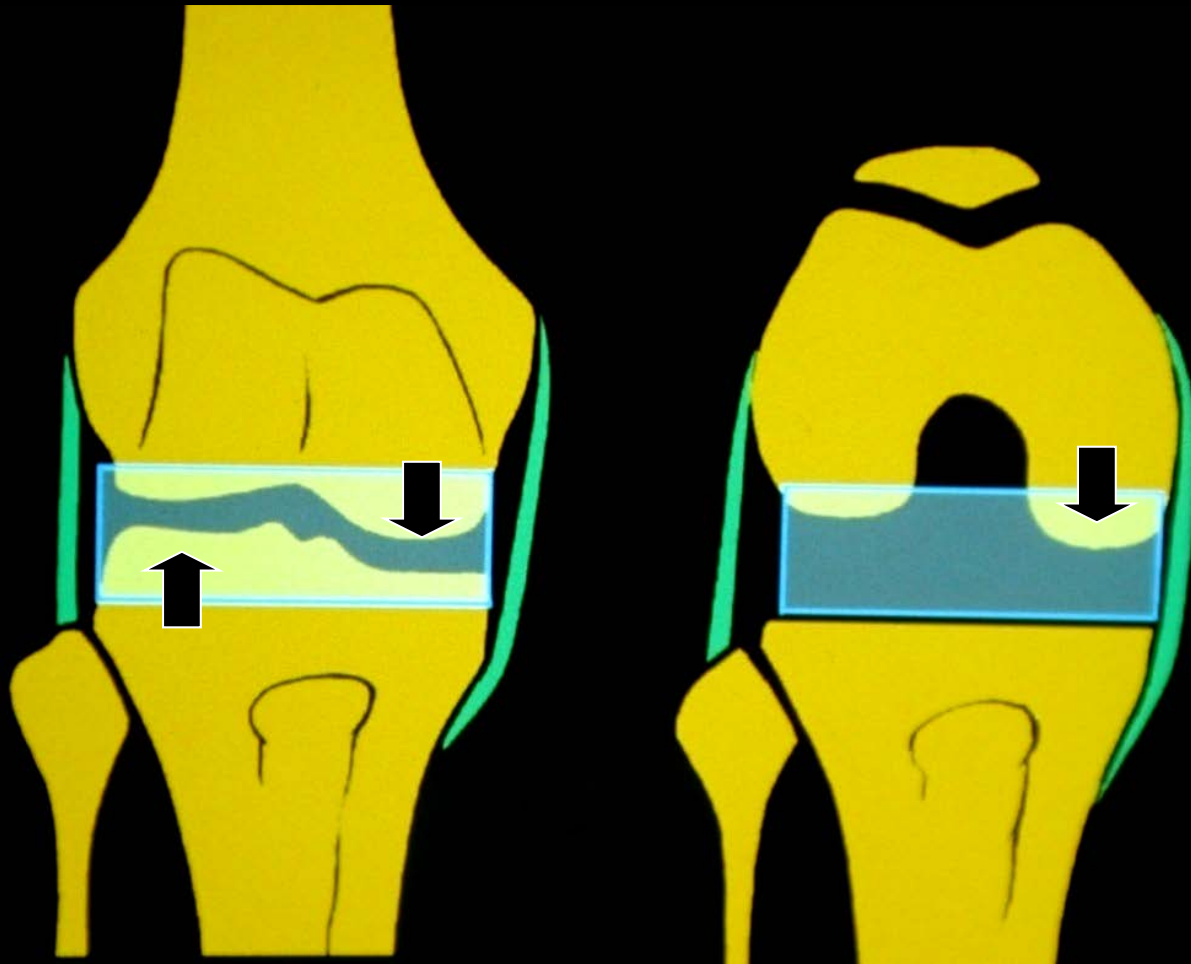
Mechanical alignment

1. *Definition ?*
2. *Important targets ?*
3. *How do we best achieve it ?*

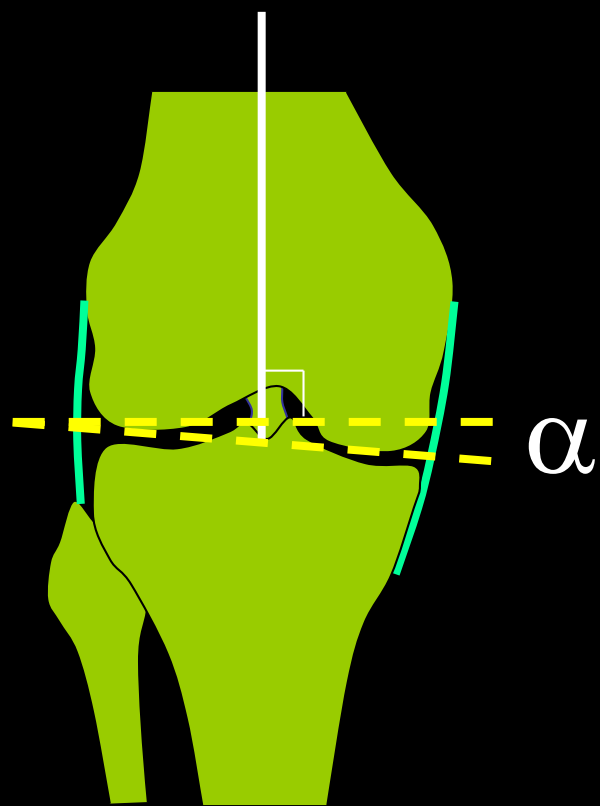
TKA Dogma



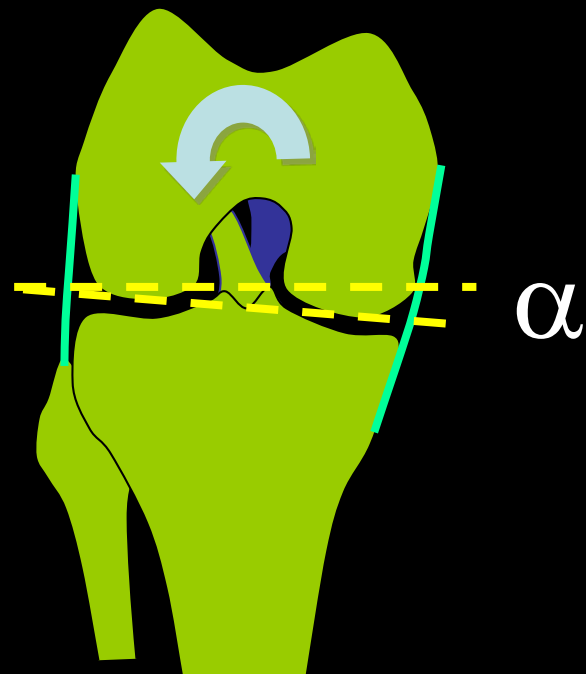
Remove Varus in the tibia
Remove some valgus in the femur
Change the joint line
«Balance the ligaments »



Gap: Extension - Flexion



Distal cut



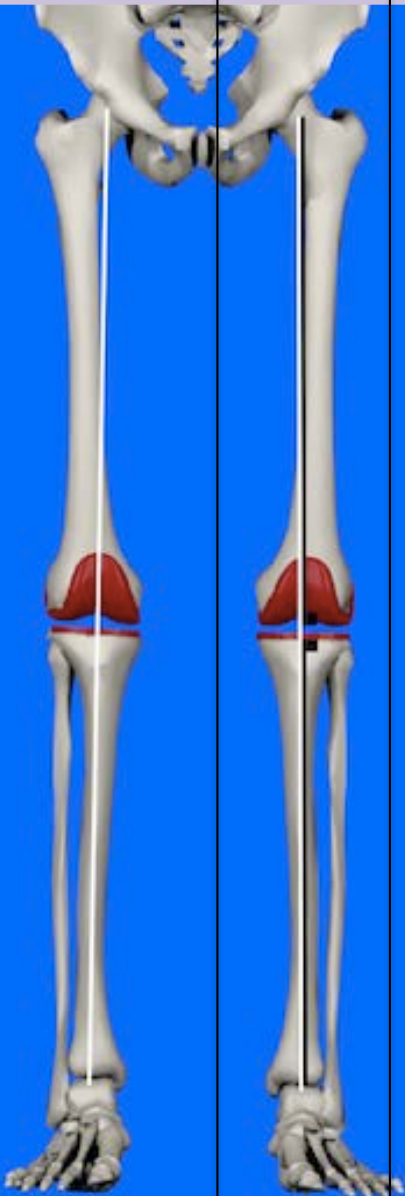
Femur Rotation

Systematic

Alignment techniques

AA

MA



	MA technique “systematic approach”
F flexion	similar
F distal cut	perpendicular to femoral mechanical axis
F posterior cut	- external rotation/PCL - measured resect° or gap balancing
T frontal cut	perpendicular mechanical axis of tibia
T slope	2 to 7° posterior slope
T rotation	towards ATT

Systematic

Alignment techniques

AA

MA

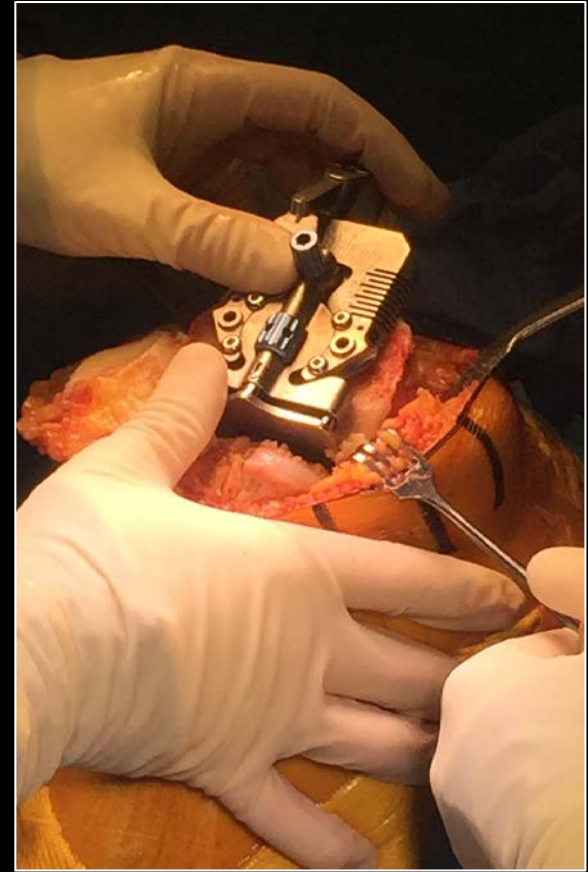
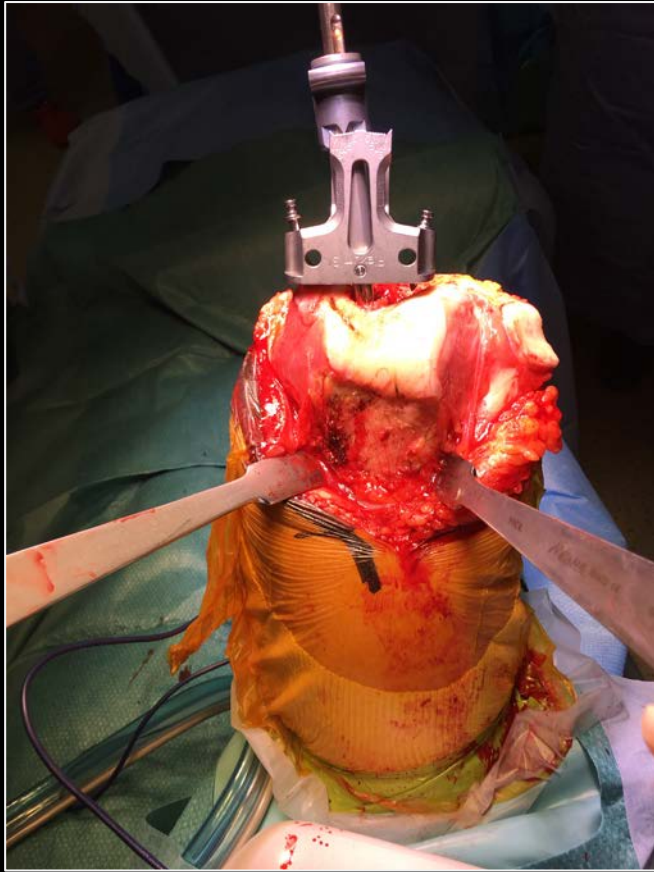


	MA technique "systematic approach"
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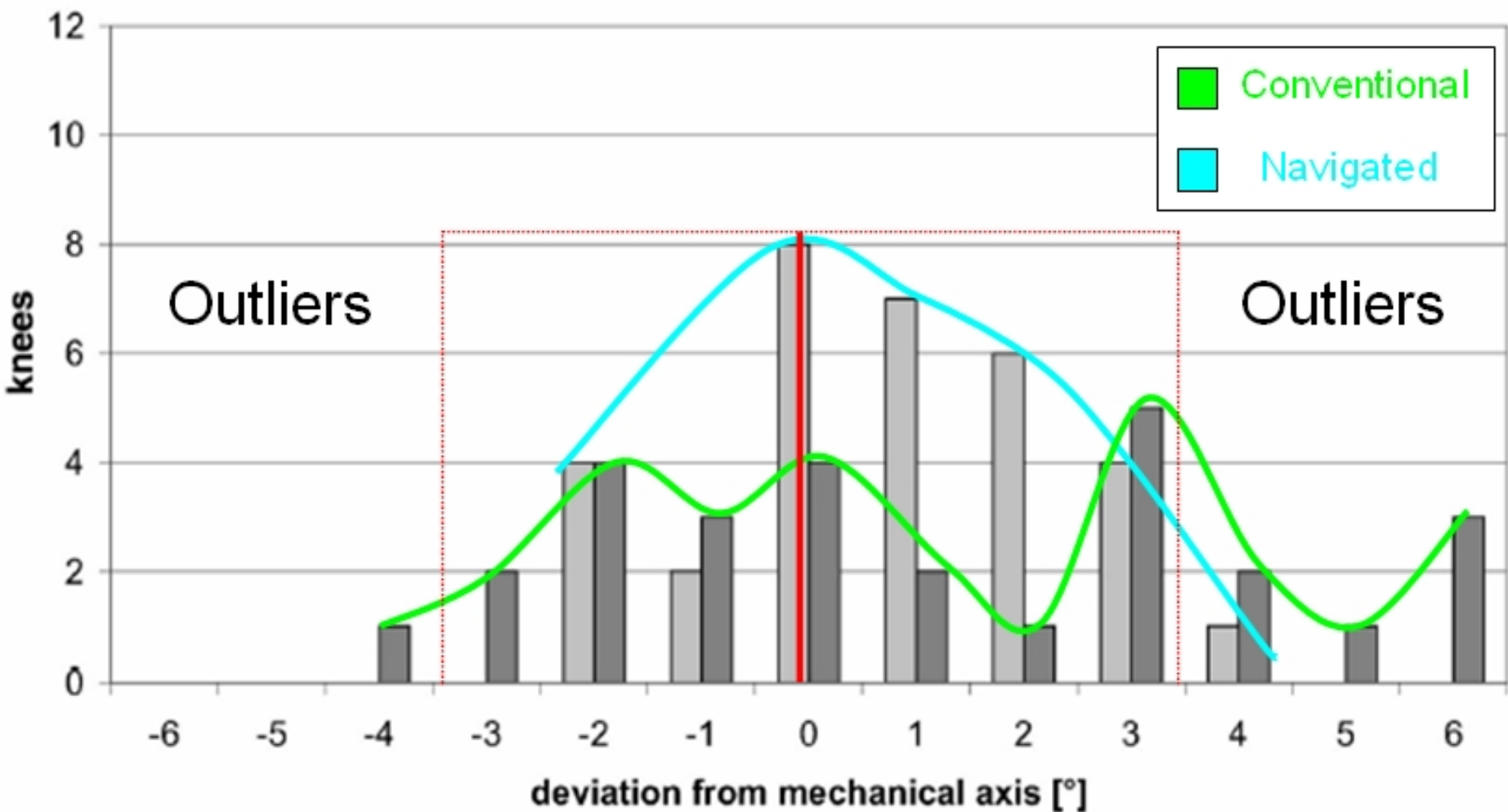
Mechanical alignment

1. *Definition ?*
2. *Important targets ?*
3. *How do we best achieve it ?*

Standard technique ?



mechanical axis frontal plane



Navigation

Knee Surg Sports Traumatol Arthrosc
DOI 10.1007/s00167-011-1588-8

KNEE

Does computer-assisted surgery improve postoperative leg alignment and implant positioning following total knee arthroplasty? A meta-analysis of randomized controlled trials?

Tao Cheng · Song Zhao · Xiaochun Peng ·
Xianlong Zhang

The Knee 18 (2011) 15–20

Contents lists available at ScienceDirect

The Knee



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The accuracy of acquisition of an imageless computer-assisted system and its implication for knee arthroplasty

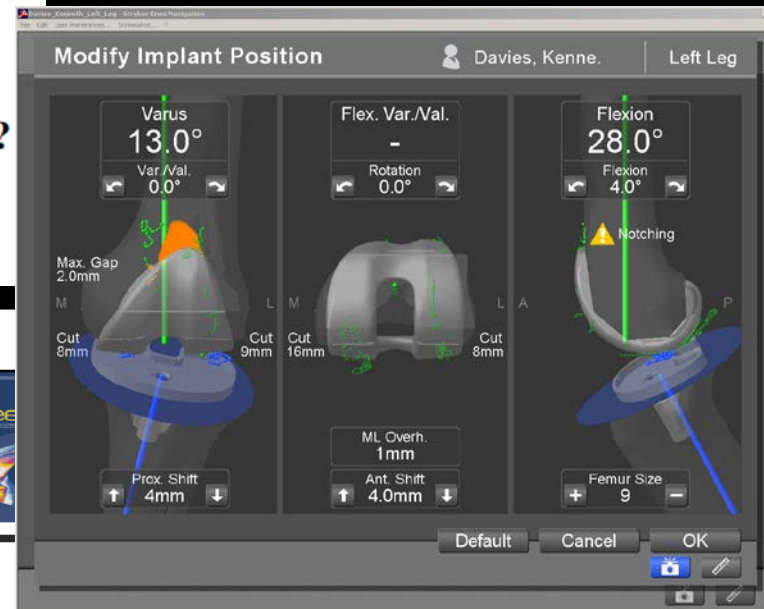
S. Lustig^{a,b,*}, C. Fleury^c, D. Goy^c, P. Neyret^{a,b}, S.T. Donell^d

^a Service de chirurgie orthopédique, Centre Albert Trillat, Hôpital de la Croix Rousse, 8, rue de Margmolles, 69300 Caluire, Lyon, France

^b Université Lyon 1, F-69003, Institut National de Recherche sur les Transports et la Sécurité, Bron, F-69675, Laboratoire de Biomécanique et Mécanique des Chocs, UMR_T 9406, France

^c TORNIER SAS, 161 rue Lavoisier, Montbonnot, 38334, Saint-Ismier, France

^d Norfolk & Norwich University Hospital, Colney Lane, Colney, Norwich NR4 7UY, UK



Prospective Randomized Trials

Conventional Manual Navigation vs. Computer Assisted Optical Tracking Navigation

Sparmann et al.	JBJS	2003
Grifka et al.	Orthopedics	2004
Stockl et al.	Clin Orthop	2004
Haaker et al	Clin Orthop	2005

* All demonstrate statistically significant improvement in alignment parameters between CAS and Manual TKA



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The Knee



Editorial

The bone cuts and ligament balance in total knee arthroplasty: The third way using computer assisted surgery

Lustig et al.

"Clinical studies have demonstrated that CAS reduces the number of outliers in component positioning and leg alignment as reported in the study by Lützen et al. Similar results have also been reported in a meta-analysis of level-I studies. "

" Unfortunately, the total time spent in the operating room and the lack of clinical amelioration has tempered its uniform acceptance by the surgical community. "

Knee Surg Sports Traumatol Arthrosc (2013) 21:2191–2193
DOI 10.1007/s00167-013-2622-9

EDITORIAL

Alignment in total knee arthroplasty, still more questions than answers...

Emmanuel Thienpont · Johan Bellemans ·
Jan Victor · Roland Becker

MEDIOCRITY

IT TAKES A LOT LESS TIME
AND MOST PEOPLE WON'T NOTICE THE DIFFERENCE
UNTIL IT'S TOO LATE.

Saving time ?



Can Patient Specific Instruments Extrapolate CAS Data ?

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The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

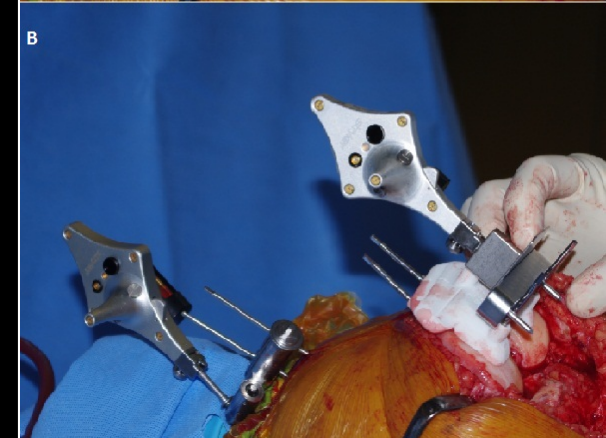
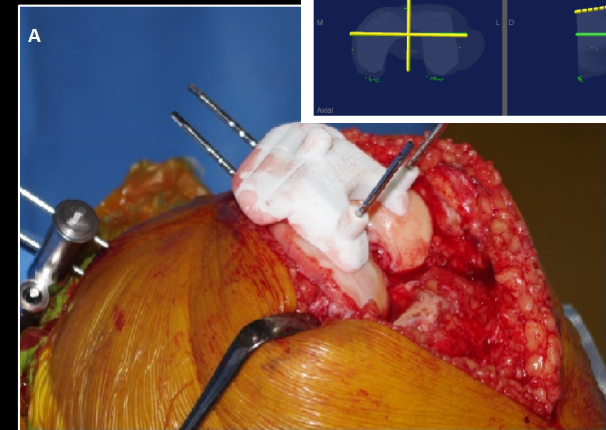
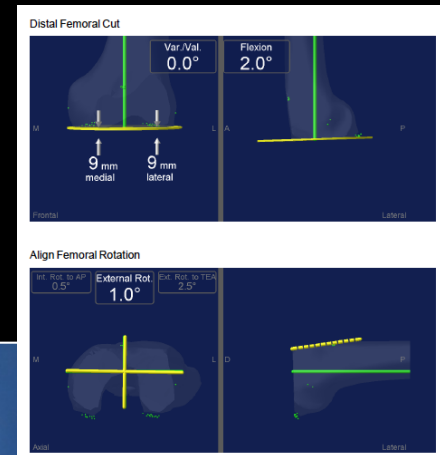
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THE JOURNAL OF Arthroplasty

AAOHS

Unsatisfactory Accuracy as Determined by Computer Navigation of VISIONAIRE Patient-Specific Instrumentation for Total Knee Arthroplasty

Sébastien Lustig MD, PhD ^{a,b}, Corey J. Scholes PhD ^a, Sam I. Oussedik FRCS ^a, Vera Kinzel FRACS ^a, Myles R.J. Coolican FRACS ^a, David A. Parker FRACS ^a



20% mismatch $> 3^\circ$ for all parameters

35% mismatch $> 3^\circ$ for sagittal positioning of the femur

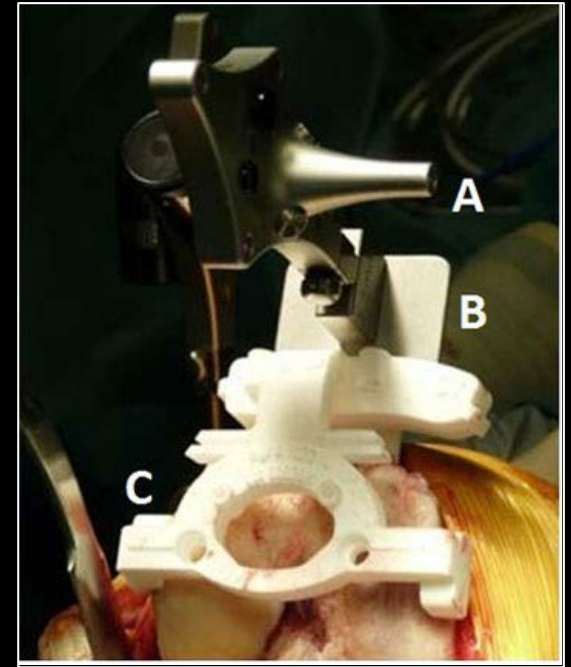
« Mistakes » up to 8° for the frontal plane and 13° for the sagittal plane

Intra- and post-operative accuracy assessments of two different patient-specific instrumentation systems for total knee replacement

Andrea Ensini · Antonio Timoncini · Francesco Cenni ·
Claudio Belvedere · Francesca Fusai · Alberto Leardini ·
Sandro Giannini

“(...)Despite good coronal alignments of the single prosthetic components, the lower limb mechanical axis was not restored correctly in a number of patients. (...)”

n= 50



Patient-specific instrumentation for total knee arthroplasty does not match the pre-operative plan as assessed by intra-operative computer-assisted navigation

Corey Scholes · Varun Sahni · Sebastien Lustig ·
David A. Parker · Myles R. J. Coolican

n=30

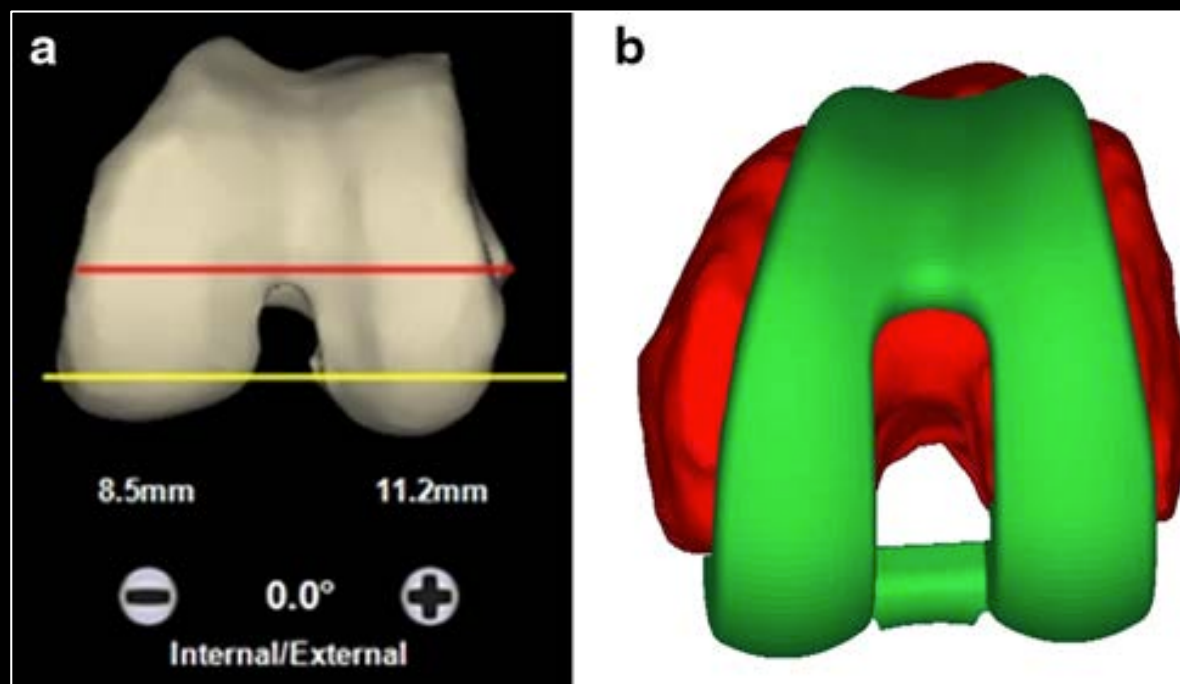


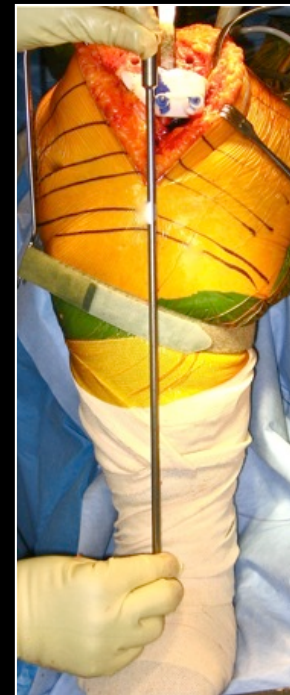
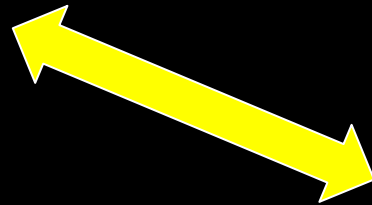
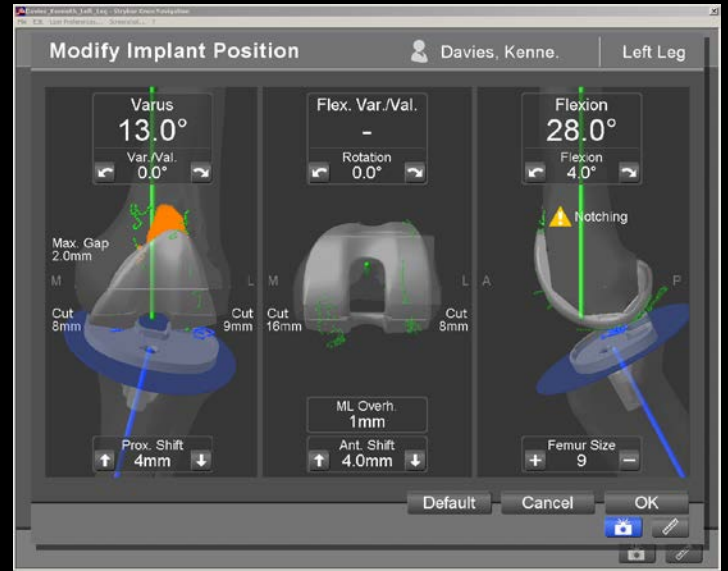
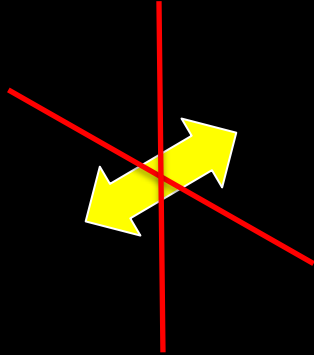
“(...) the error for total coronal alignment exceeded 3° for 27 % of the sample (...)”

Rotation in total knee arthroplasty: no difference between patient-specific and conventional instrumentation

Sébastien Parratte · Guillaume Blanc ·
Thomas Boussemart · Matthieu Ollivier ·
Thomas Le Corroller · Jean-Noël Argenson

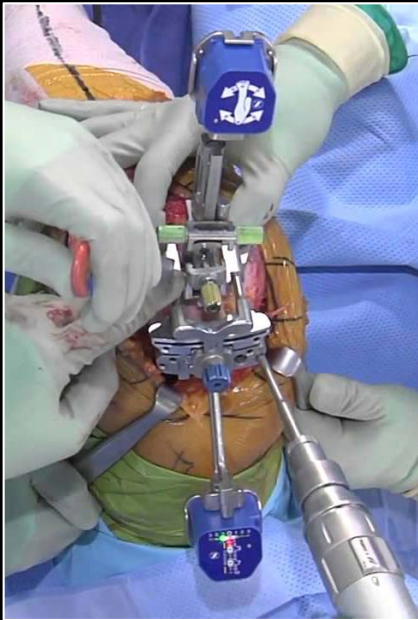
20 vs 20





Smart Instrument

Accelerometer-based, portable navigation



[Orthop J Sports Med.](#) 2016 Feb; 4(2 Suppl): 2325967116S00016.
Published online 2016 Feb 16. doi: [10.1177/2325967116S00016](#)

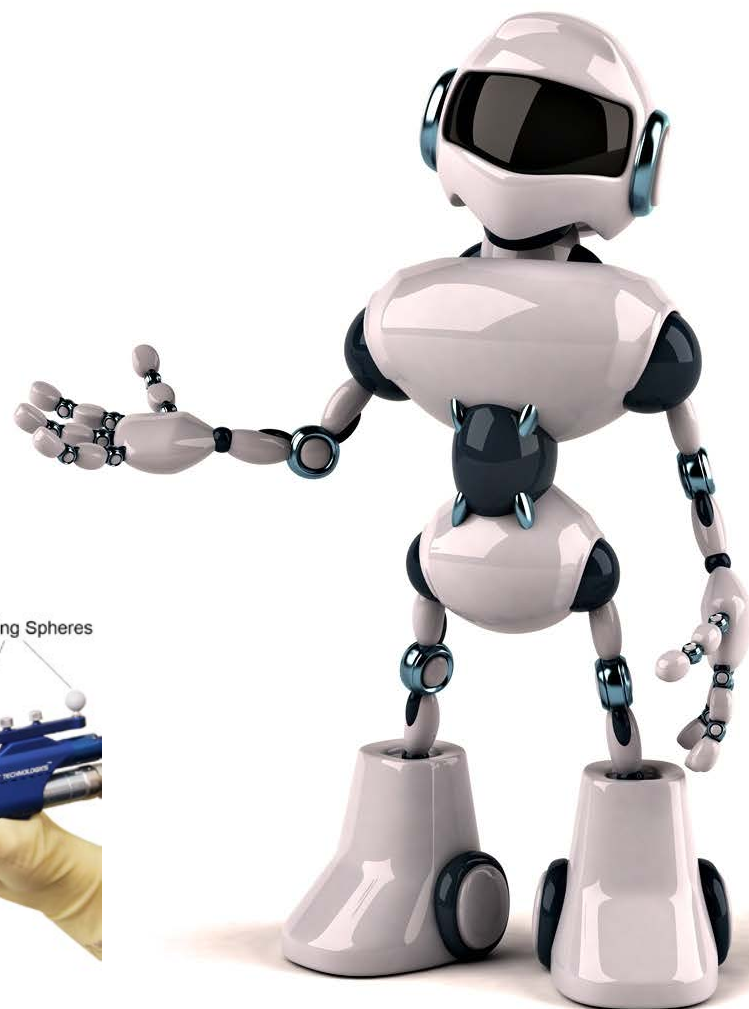
PMCID: PMC4901785

Radiological Outcomes and Operative Time following Total Knee Arthroplasty using Accelerometer-based, Portable Navigation versus Conventional Inter-Medullary Alignment Guides

Samuel MacDessi,¹ GN Solayar,¹ N Thatcher,¹ and Darren B Chen¹

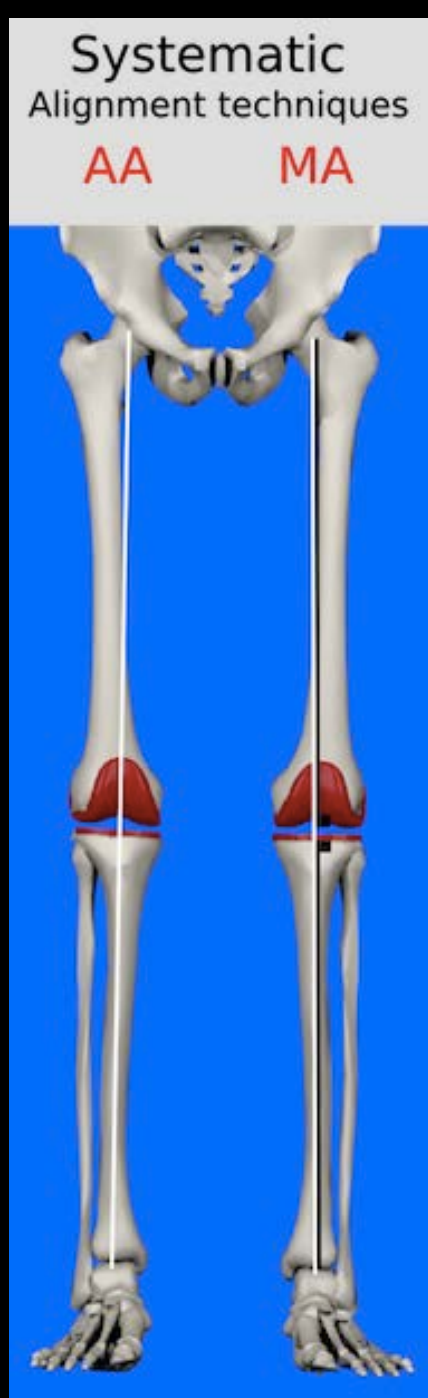
« ... » Accelerometer-based, portable navigation has a **statistically similar outcome in alignment following TKA as IM guides**. It is noted that using the portable navigation device does prolong surgical time compared to conventional IM surgery and this may be due to the learning curve. « ... »

Robotic ?



Take Home Message

- Targets :
 - Femur 90°
 - Tibia 90°
 - External rotation femoral component / compensate asymmetrical distal cut
- Standard technique
- Technology ?
 - Navigation ++





Thank You

sebastien.lustig@gmail.com