

PATIENT SPECIFIC
INSTRUMENTATION – When
to TRUST them & When to
DITCH them?

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What Drives Human Innovation?



I don't think necessity is the mother of invention - invention, in my opinion, arises directly from idleness, possibly also from laziness. To save oneself trouble.

Agatha Christie (1890 - 1976), *An Autobiography, 1977*

THE WISH LIST

- **SURGEON:** M THE BEST, HAVE THE BEST RESULTS, QUICK IN AND QUICK OUT WITHOUT COMPROMISING.
- **HOSPITAL/ STAFF:** LESS INVENTORY, QUICK TURN AROUND TIME.
- **PATIENT:** OPERATION TO LAST LIFETIME!; good pain relief, excellent Function!



CONVENTIONAL Instruments

- Each company has its own set of instrumentation – overload hospital inventory, hospital sterilisation dept, nurses learning curve, OR turn around time -> adds to the cost.
- Issue with use of IM alignment rod: Fat embolism, bleeding, fractures, infection.
- Repeated use of conventional Jigs -> theoretical risk of contamination

Computer NAVIGATION

- Not what computers are meant to do: Decrease time, cut cost and inventory!
- Still require the use of conventional instruments – and to it adds some more inventory making it more complex.
- prolonged operative time
- Complications assoc with pin insertion.
- Requires continuous line of sight – can be annoying!
- Sizing also based on avg bone geometry & is ?

Pro vs Anti: Time 2 move on?

International Orthopaedics (SICOT) (2011) 35:331–339
DOI 10.1007/s00254-010-1008-6

ORIGINAL PAPER

Imageless computer assisted versus conventional total knee replacement. A Bayesian meta-analysis of 23 comparative studies

Yaron S. Brin · Vassilios S. Nikolaou ·
Lawrence Joseph · David J. Zukor · John Antoniou

ARTICLE IN PRESS

The Journal of Arthroplasty Vol. 00 No. 0 2011

Morbidity of Navigated Vs Conventional Total Knee Arthroplasty

A Retrospective Review of 327 Cases

David J.C. Graham, MBBS,
Paul Harvie, BEng(Hons), MBChB, MRCS(Eng), FRCS(Tr & Orth), MD,
Karen Sloan, MSc, and Richard J. Beaver, FRACS

The Journal of Arthroplasty Vol. 22 No. 6 Suppl. 2 2007

Internet Promotion of Minimally Invasive Surgery and Computer-Assisted Orthopedic Surgery in Total Knee Arthroplasty by Members of American Association of Hip and Knee Surgeons

Lucian C. Warth, BS,* John J. Callaghan, MD,* Steve S. Liu, MD,*
Gregg R. Klein, MD,† and William J. Hozack, MD‡

The Journal of Arthroplasty Vol. 21 No. 4 Suppl. 1 2006

Computer-Assisted Surgery: A Wine Before its Time

In Opposition

Bernard N. Stulberg, MD, and Jayson D. Zadzilka, MS

Knee Surg Sports Traumatol Arthrosc (2009) 17:1141–1142
DOI 10.1007/s00167-009-0897-7

EDITORIAL

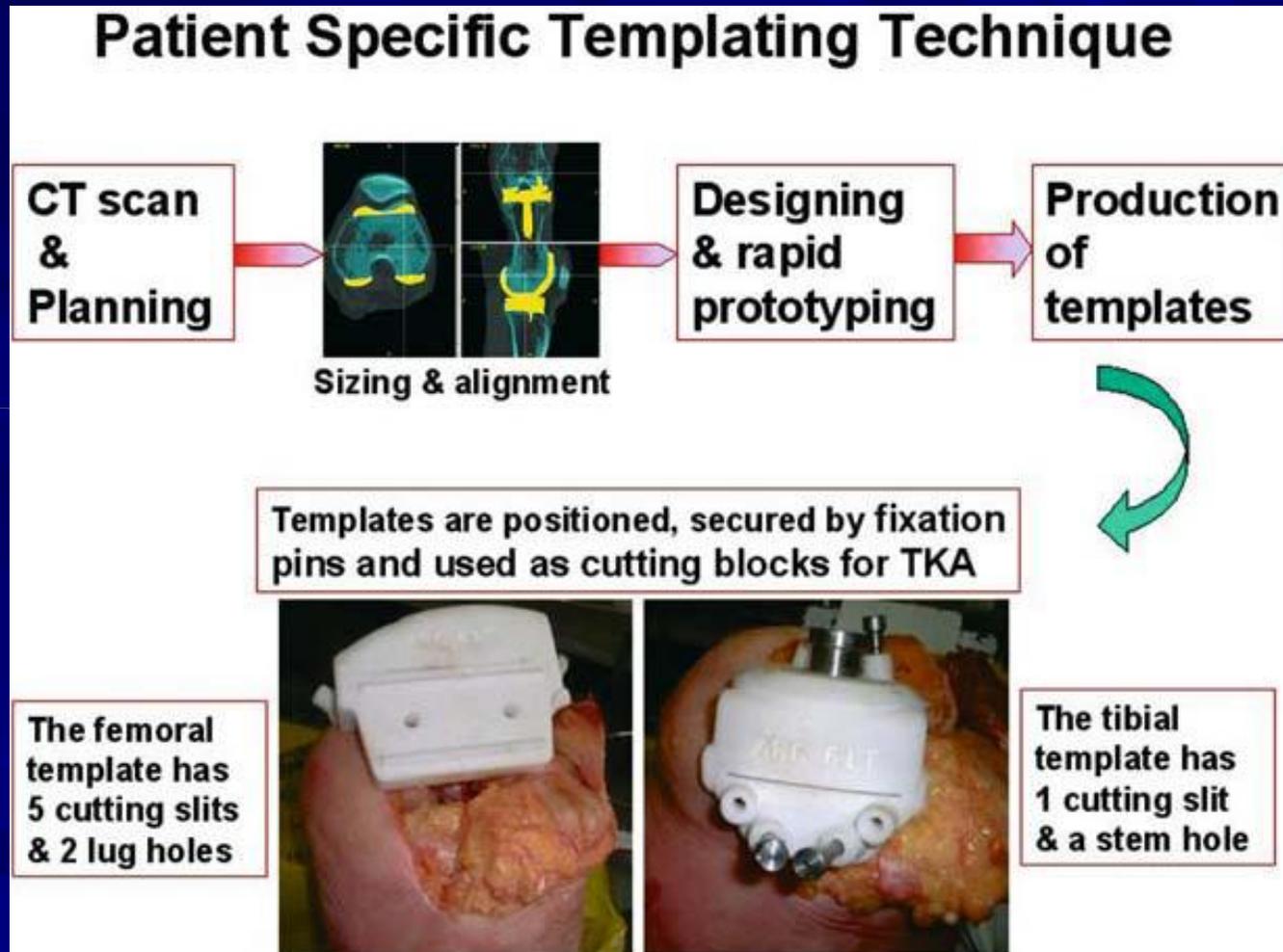
Navigation and CAS: is D-Day approaching?

Johan Bellemans

STEPS IN Designing PSI

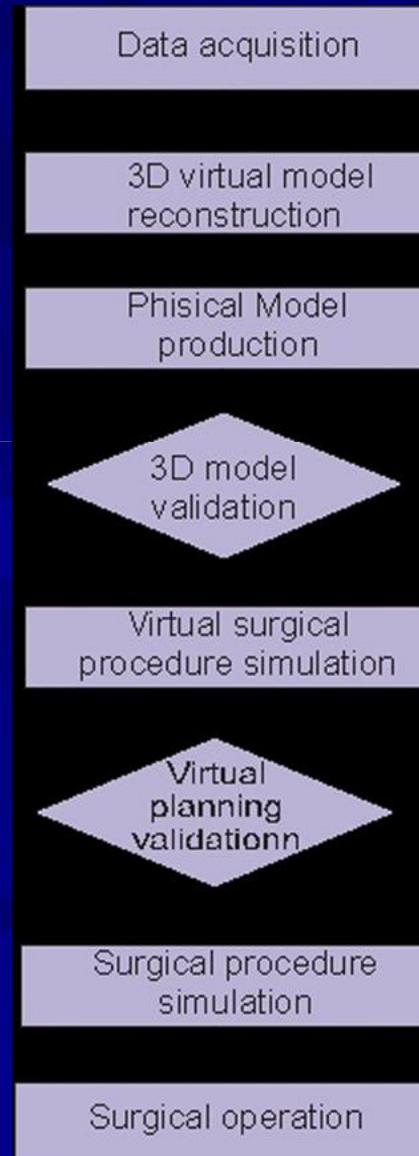
- 3-D reconstruction of CT/MRI scan data.
- Surgical Simulation
- Sizing & Alignment of the prosthesis.
- Creation of templates using CAD software.
- Using Rapid prototyping technology – virtual templates are converted to physical templates or jigs.

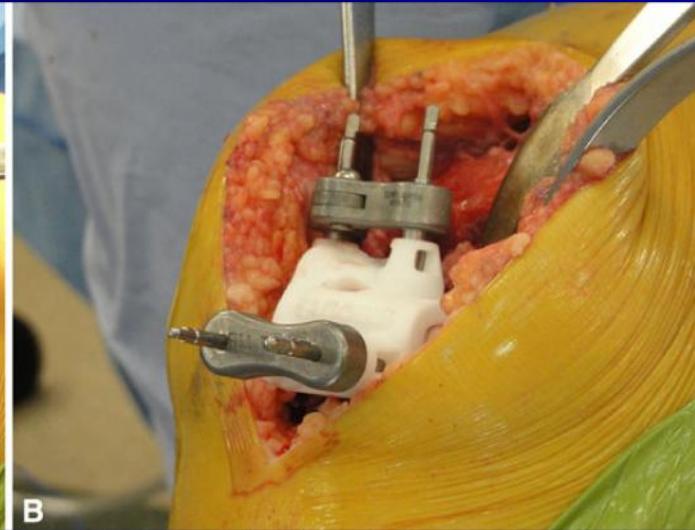
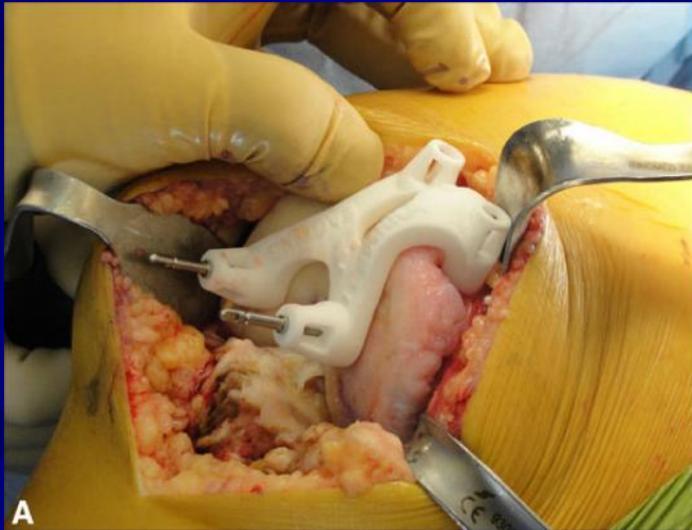
Technical steps in designing PSI



Hafez et al: Computer-Assisted Total Knee Arthroplasty Using Patient-Specific Templates

CAD & RAPID PROTOTYPING





Other uses of Rapid Prototyping

G Model
EURR-5004: No. of Pages 7

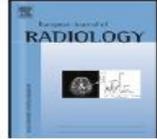
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European Journal of Radiology xxx (2011) xxx–xxx

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad



Use of rapid prototyping and three-dimensional reconstruction modeling in the management of complex fractures

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Abhay Kuthe^d, Bhawan K. Paunipagar^c

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^d Mechanical Engineering Department, VNIT, India

The Journal of Bone & Joint Surgery, Volume 85, Issue suppl 4

Scientific Articles | November 01, 2003

Rapid Prototyping: The Future of Trauma Surgery?

George A. Brown, MS, MD; Keikhosrow Firoozbakhsh, PhD; Thomas A. DeCoster, MD; José R. Reyna Jr., MD; Moheb Moneim, MD

[View Disclosures and Other Information](#)

J Bone Joint Surg Am. 2003; 85:49-55

COMMERCIAL AVAILABILITY

- SIGNATURE: Biomet
- VISIONAIRE: Smith & Nephew
- TRU MATCH: Depuy
- PSI: Zimmer
- ConforMIS: Patient specific implants.

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

Improved Accuracy of Alignment With Patient-specific Positioning Guides Compared With Manual Instrumentation in TKA

Vincent Y. Ng MD, Jeffrey H. DeClaire MD,
Keith R. Berend MD, Bethany C. Gulick RT (R),
Adolph V. Lombardi Jr MD

ARTICLE IN PRESS

The Journal of Arthroplasty Vol. 00 No. 0 2010

Design and Primary Application of Computer-Assisted, Patient-Specific Navigational Templates in Metal-on-Metal Hip Resurfacing Arthroplasty

Yuan Z. Zhang, MD, PhD,* Sheng Lu, MD, PhD,† Yong Yang,*
Yong Q. Xu, MD, PhD,† Yan B. Li, PhD,‡ and Guo X. Pei, MD, PhD§

[Int J Med Robot.](#) 2008 Sep;4(3):224-31.

Accuracy of MRI vs CT imaging with particular reference to patient specific templates for total knee replacement surgery.

[White D,](#) [Chelule KL,](#) [Seedhom BB.](#)

Division of Bioengineering, Academic Unit of Musculoskeletal Diseases, Leeds Medical School, University of Leeds, UK.
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The study Findings:

- Based on surgical simulation done using the software (MIMICS).
- Team comprised of Orthopaedic Surgeon (2), radiologist and 2 Engineers who routinely did surgical simulation planning and Rapid prototyping.
- Although experienced – the study could be potentially biased and be treated as opinion!

Potential flaws in universal application of PSI



ERROR: SOURCE CODE?

- Plain radiographs: 10 degree flexion & 25 rotation -> significant alteration in axis calculation.(good system use combination of long film xrays & CT/MRI)
- Thickness of Slice of CT scan/ MRI
- Who is doing the surgical simulation.
- How has the programme been validated?

Lonner JH, Laird MT, Stuchin SA (1996) Effect of rotation and knee flexion on radiographic alignment in total knee arthroplasties.
Clin Orthop Relat Res 331: 102–106

ERROR: STATIC

- Treats any deformity as fixed deformity.
- Contrary to well founded principle: 'TKR is a soft tissue surgery'
- Especially inaccurate for large mobile deformities.
- Robs surgeon of opportunity to make the knee tight or slightly loose depending on patient profile.

ERROR: Bone always

- Simulation & Planning is largely based on bony landmarks.
- ER rotation is based on two fixed criteria – an additional info that surgeon often use intra-operatively.
- Mal positioned or externally rotated Tibial Tuberosity significantly reduced accuracy.
- Similarly in the cases where there were large osteophytes which were ossified – the program did not distinguish it from true bone.

Over all

- Accuracy is similar to conventional jigs, not as accurate as CAS.
- Not good- When there were extensive osteophytes.
 - - When tibial torsion was beyond standard.
 - - When the deformities are mobile.
- However relatively accurate when the deformity was extra articular.

So! When to trust them?

Straight forward, simple cases
only. @ the moment!

Why PSI for simple Cases?

- COST -
- Time -> COST (reduces surgical time by upto 20 min, and more vs CAS)
- EASY: cuts 22 surgical step.
- Can be overridden
- Possibly less chance of infection
- Other advantages that navigation has over conventional instruments

When to ditch them?

- Complex intra articular deformities.
- Correctable deformities or significantly lax knees.
- Significant tibial torsion.
- Intra operatively – esp when the external rotation set by jig does not match up with other parameters like parallel to tibial cuts.

In Conclusion

- Non of the three available tech - conventional, CAS, PSI are panacea yet they have their own advantages.
- Surgeons should not be dogmatic about any one of them , rather should have all three in armamentarium.
- Future is out there some where.. And in our view perhaps a combination of all three and also another dimension of Remote surgeries.

COMPARISON

PARAMETERS	ACCURACY	COST	EASE OF USE	TIME
CI	OK	OK	OK	OK
CAS	GOOD	BAD	BAD	BAD
PSI	NOT KNOWN	OK	GOOD	GOOD

Treat Like Driving experience!

- PSI is like having a chauffer driving you around: good for simple chores and most importantly should follow your commands!
- Navigation for complex situations, and for the places where you never have been! But do you really need it to drive home?
- But You would like to keep the steering when you are in deep mess! Or on a racing track! Till the time you find a Schumaker!



Thank You!

