المركز العالمي للركبة والمفاصل
International Knee & Joint Centre

European Knee Society

IML
Institut du Mouvement et de l'appareil Locomoteur

Technology in Total Knee Arthroplasty ?

Pr Sebastien Parratte, MD, PhD

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Charles Brown
Xavier Flecher
Matthieu Ollivier
Jean-Noel Argenson

Disclosures

- Royalties :
  - ZimmerBiomet
  - Newclip Technics
- Consultant
  - ZimmerBiomet
- Board member
  - European Knee Society Tresasurer

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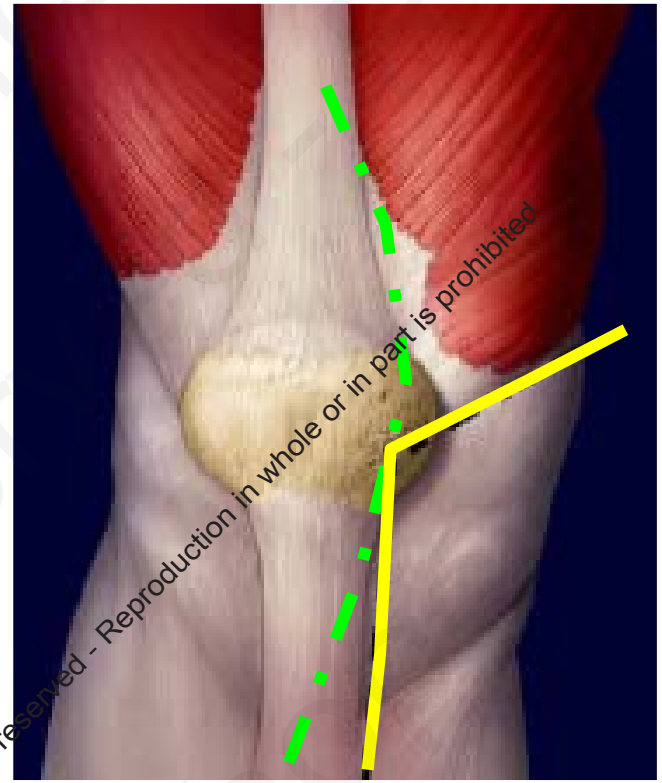
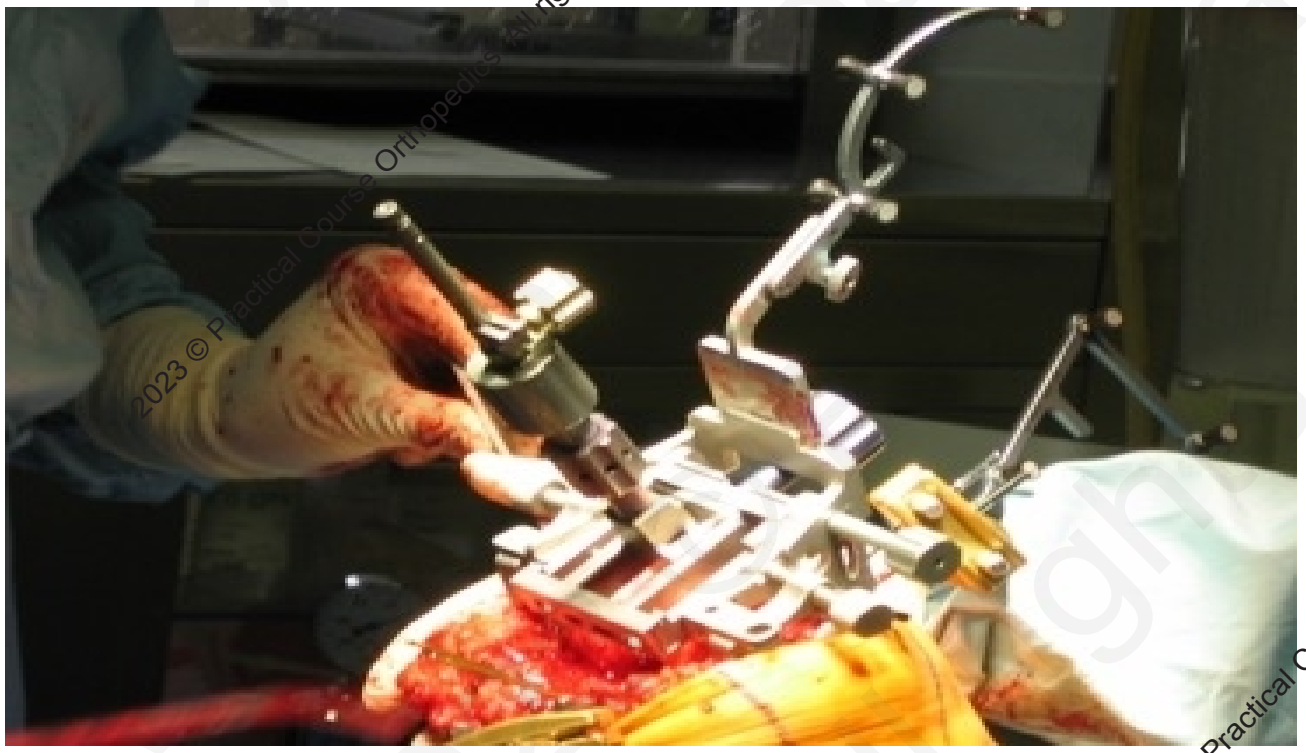
Technology in TKA ?

1. 2 decades of technology in TKA
2. What did we learn ?
3. Where are we heading ?

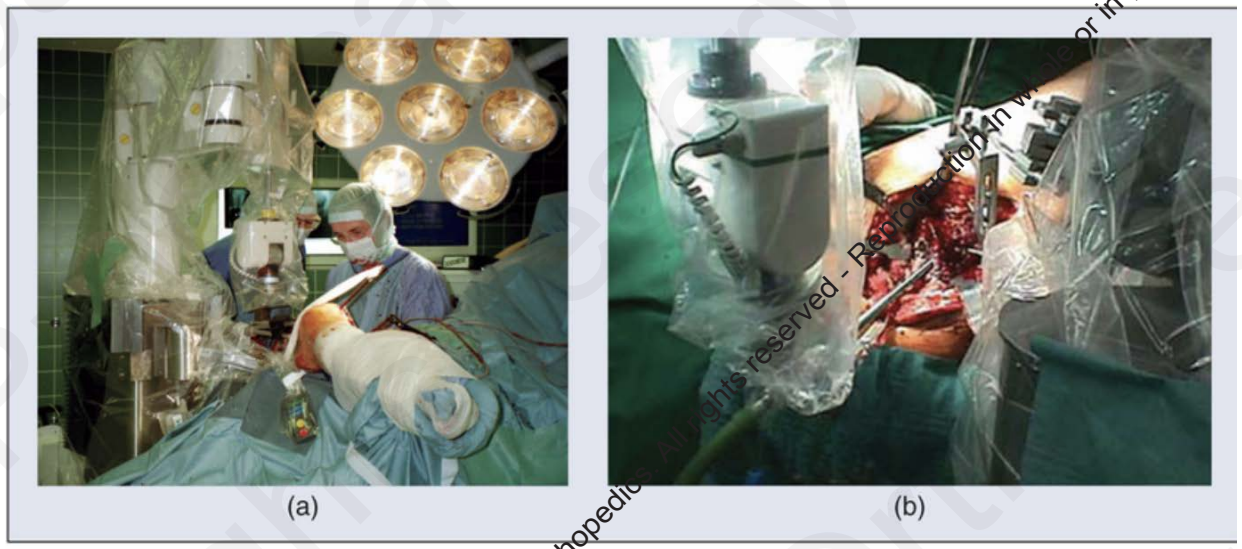
2000 to 2005
Minimally Invasive Revolution



Decade Computer-assisted Surgery
2000 to 2010
Big consoles
Image-based or imageless



The first generation of orthopeadic robots



The modern Era of Robotics in Orthopaedics

PAGING "DR. BUSH": Dr. Martin Roche, left, chief of orthopedics at Holy Cross Hospital in Fort Lauderdale, lets Gov. Jeb Bush operate the robotic system while MAKO President and CEO Maurice R. Ferré looks on at MAKO Surgical Corp. in Davie. **Staff photos/Lou Toman**

A company's robot installs implants while a monitor positions them during …

HIGH-TECH 3-D KNEE SURGERY

14 May 2008
Fort Lauderdale
Martin Roche

« Time of the Smart tools » 2010 to 2015

PSI

Patient Specific Intstrumentation

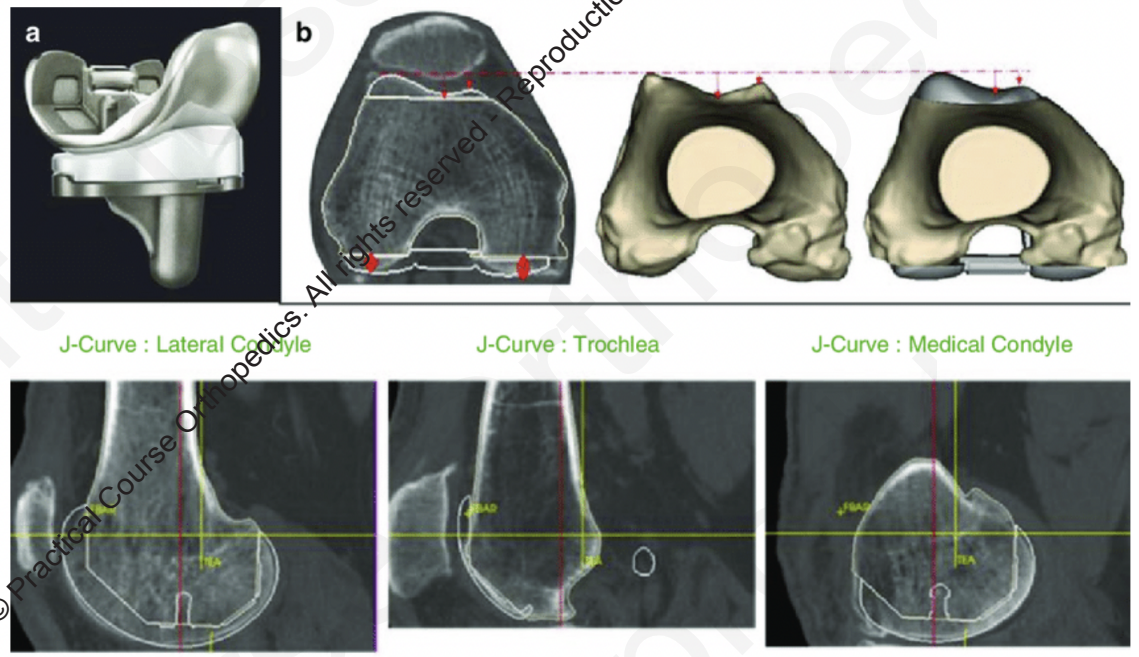
Clin Orthop Relat Res. 2019 Feb 27. doi: 10.1097/CORR.0000000000000660. [Epub ahead of print]

Does Accelerometer-based Navigation Have Any Clinical Benefit Compared with Conventional TKA? A Systematic Review.

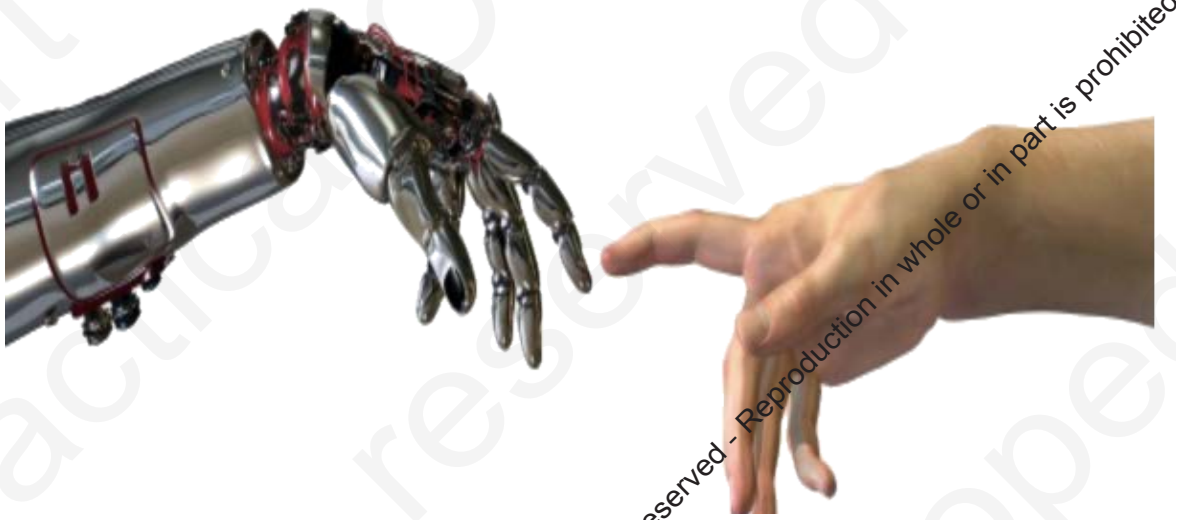
Budhiparama NC[1], Lumban-Gaol I, Ifran NN, Parratte S, Nelissen R.

From PSI to Custom knee arthroplasties

The Knee in a box



Since a few years: the rise of the machines



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NOVEMBER 27, 2019 | 3:00 AM EST
INDUSTRY REPORT

RJ Robotics Symposium Indicates That The Train Has Left The Station, And There Is No Turning Back

Every orthopaedic company has a robot

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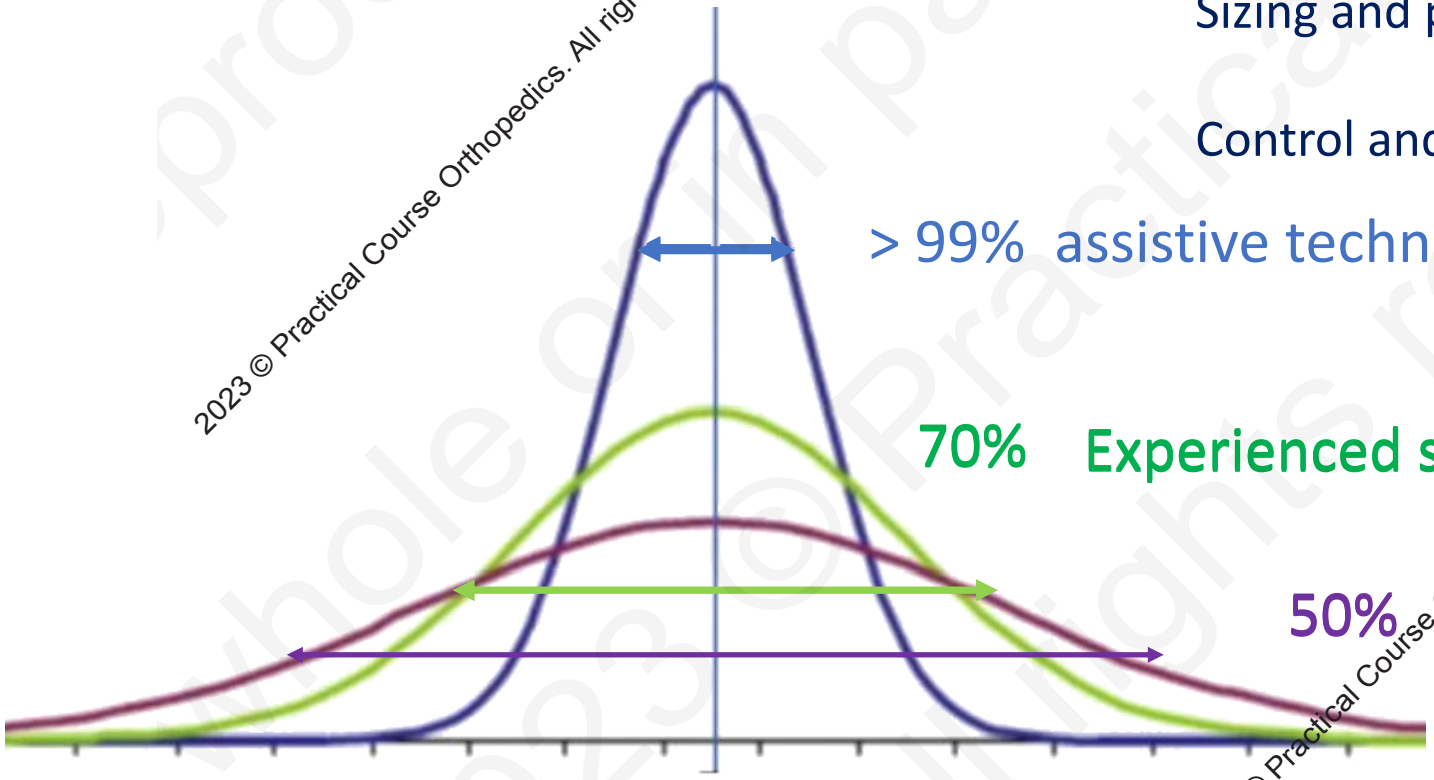
Accuracy of the assitive technology
To reach a define target

Tibial cut

Distal femoral cut

Sizing and positioning the femur

Control and improve ligament balance



> 99% assistive technologies

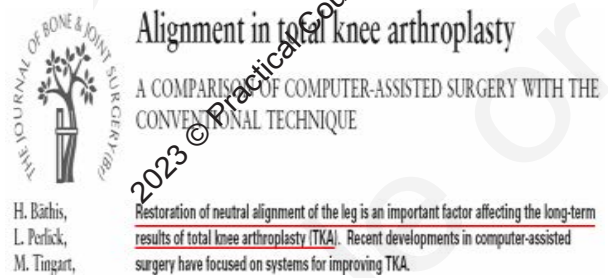
70% Experienced surgeon

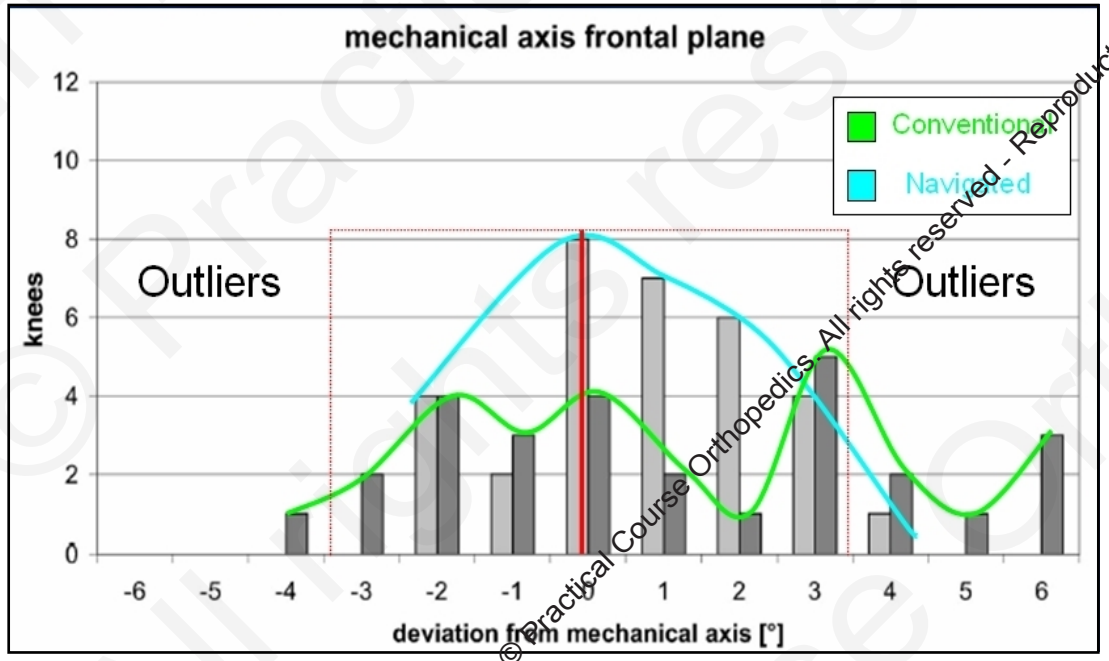
50% Not yet experienced surgeon

During years : Basic hypothesis rely on a neutral mechanical axis for everybody

TKA

CAOS → **Neutral Mechanical Alignment** → Increased Survivorship





G. Matziolis et al. JBJS Am, 2007
K Bauwens et al. JBJS Am, 2007

No functional difference!

Clin Orthop Relat Res. 2019 Feb 27. doi: 10.1097/CORR.0000000000000660. [Epub ahead of print]

Does Accelerometer-based Navigation Have Any Clinical Benefit Compared with Conventional TKA? A Systematic Review.

Budhiparama NC[1], Lumban-Gaol I, Ifran NN, Parratte S, Nelissen R.

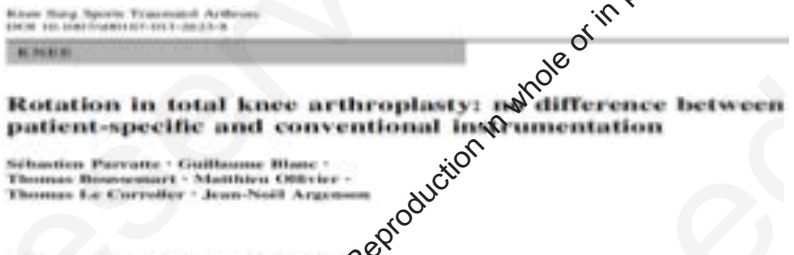

Clin Orthop Relat Res
DOI 10.1007/s11999-014-3944-7

Clinical Orthopaedics and Related Research

CLINICAL RESEARCH

No Benefit of Patient-specific Instrumentation in TKA on Functional and Gait Outcomes: A Randomized Clinical Trial

Matthew P. Abdel MD, Sébastien Parratte MD, PhD, Guillaume Blanc MD, Matthieu Ollivier MD, Vincent Pomero PhD, Elke Vielweger MD, PhD, MHA, Jean-Noël A. Argenson MD, PhD


Knee Surg Sports Traumatol Arthrosc
DOI 10.1007/s00167-013-2513-8

KNEE

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

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

Received: 12 July 2013 / Accepted: 3 August 2013
© Springer-Verlag Berlin Heidelberg 2013


Clin Orthop Relat Res
DOI 10.1007/s11999-014-3944-7

Clinical Orthopaedics and Related Research

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And no improved survivorship

Clin Orthop Relat Res (2018) 476:126-134
DOI 10.1007/s11999.0000000000000021

Clinical Orthopaedics and Related Research®

2017 Knee Society Proceedings

Published online 21 December 2017

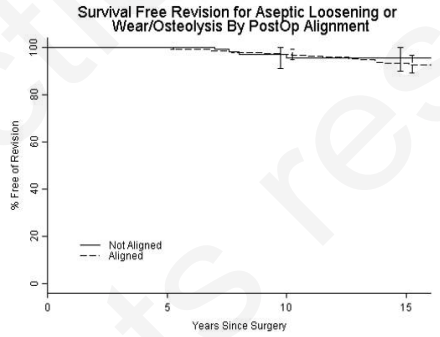
No Benefit of Computer-assisted TKA: 10-year Results of a Prospective Randomized Study

Matthieu Ollivier MD, PhD, Sébastien Parratte MD, PhD, Ludovic Lino MD, Xavier Flecher MD, PhD, Sébastien Pesenti MD, Jean-Noël Argenson MD, PhD

Effect of Postoperative Mechanical Axis Alignment on the Fifteen-Year Survival of Modern, Cemented Total Knee Replacements

By Sebastien Parratte, MD, PhD, Mark W. Pagnano, MD, Robert T. Trousdale, MD, and Daniel J. Berry, MD

Investigation performed at the Mayo Clinic, Rochester, Minnesota



A commentary by Jaques Toshio Ninomiya, MD, MS, is linked to the online version of this article at jbjs.org.

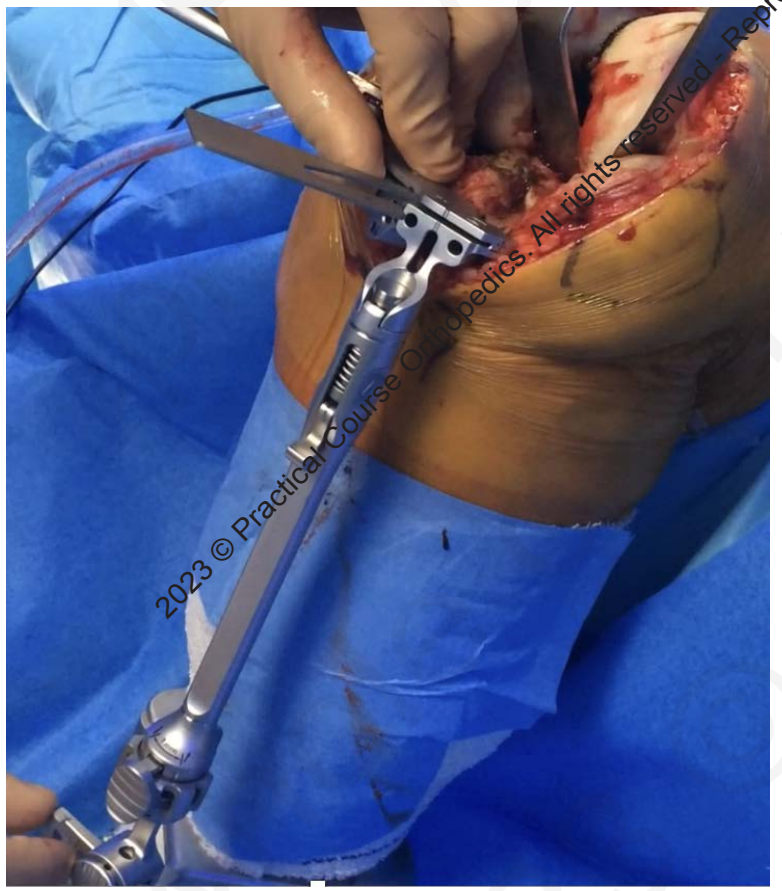
Effect of Postoperative Mechanical Axis Alignment on Survival and Functional Outcomes of Modern Total Knee Arthroplasties with Cement

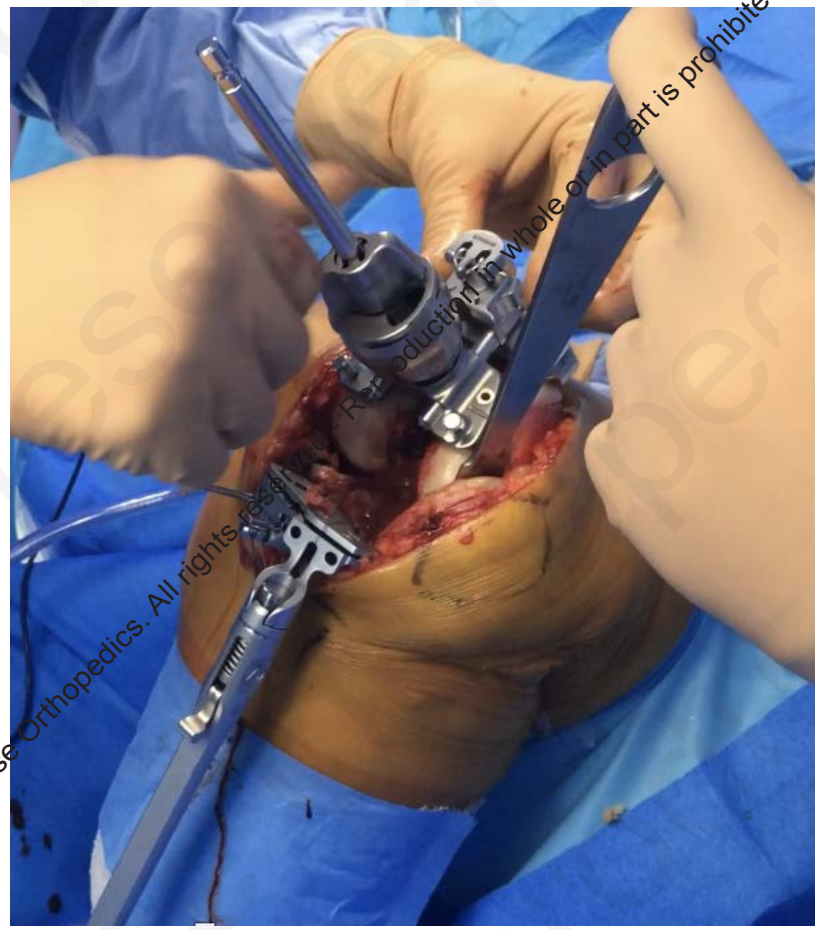
A Concise Follow-up at 20 Years*

Matthew P. Abdel, MD, Matthieu Ollivier, MD, Sebastien Parratte, MD, PhD, Robert T. Trousdale, MD, Daniel J. Berry, MD, and Mark W. Pagnano, MD

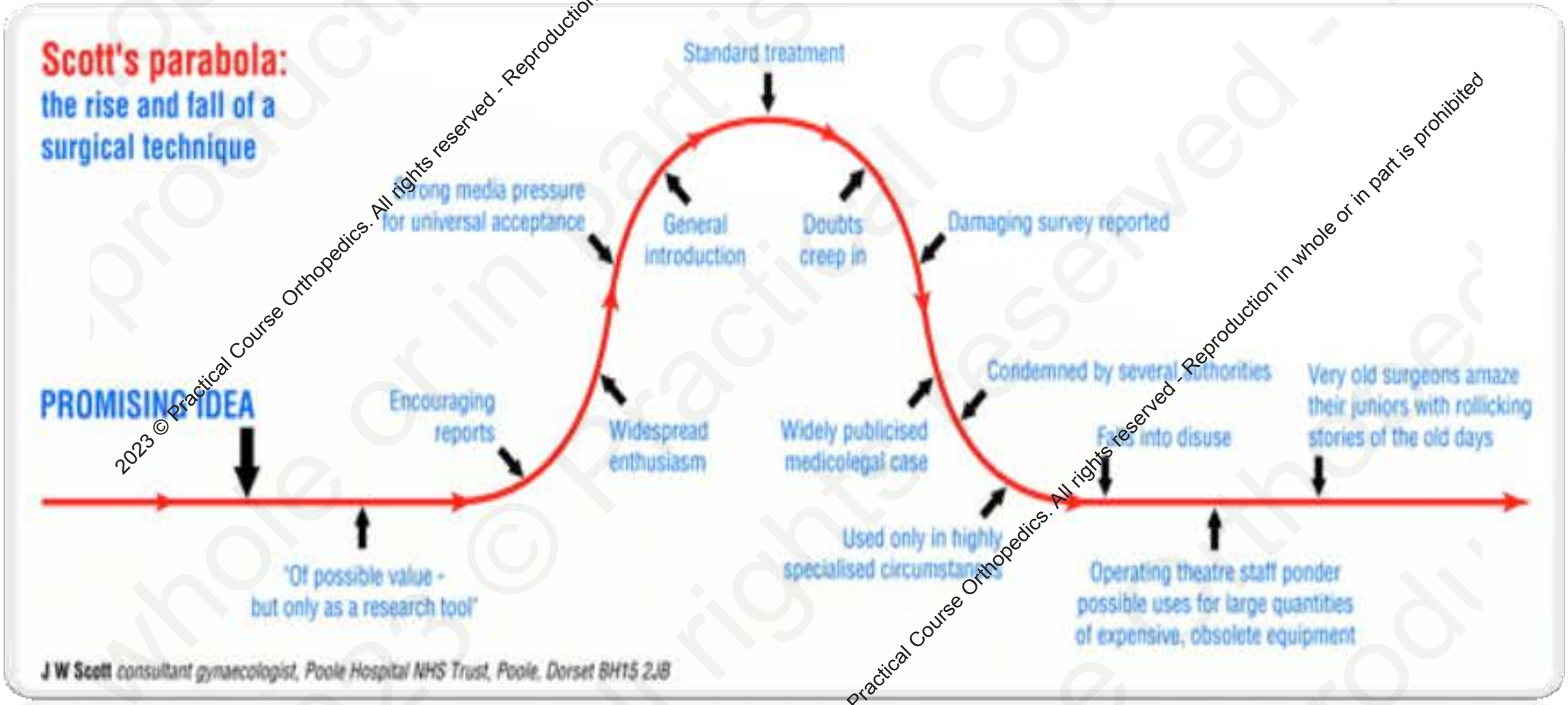
Investigation performed at the Mayo Clinic, Rochester, Minnesota

“ Conventional instrumentation remains the gold standard ”





We always have the same comments : it’s not here to stay !



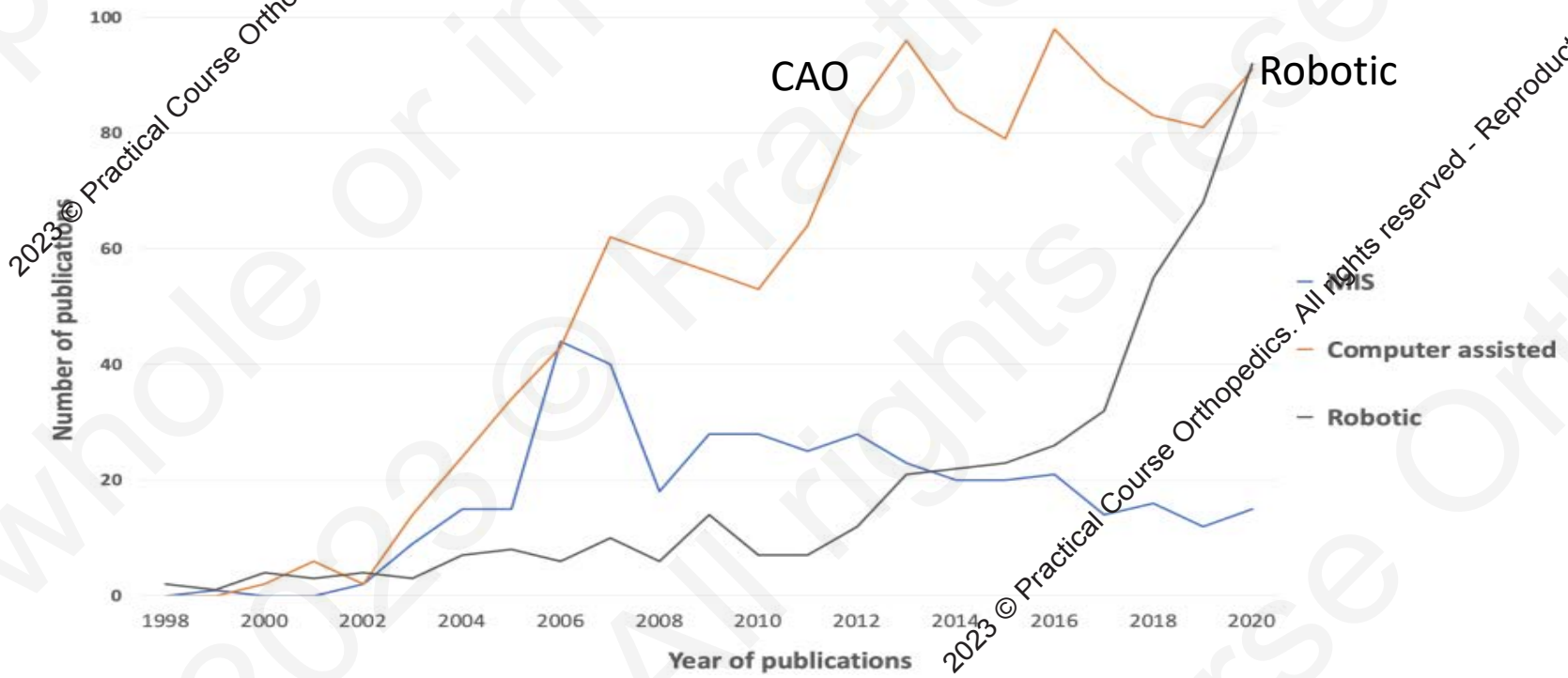
The realistic vision

Knee Arthroplasty | Published: 14 July 2021

Assistive technologies in knee arthroplasty: fashion or evolution? Rate of publications and national registries prove the Scott Parabola wrong

Cécile Batailler & Sébastien Parratte

Archives of Orthopaedic and Trauma Surgery (2021) | Cite this article



Technology in TKA ?

1.2 decades of technology in TKA

2.What did we learn ?

3.Where are we heading ?

1. No obvious clinical benefit ?

A lot of positive studies and others

Clin Orthop Relat Res (2020) 478:266-275
DOI 10.1097/CORR.0000000000000916

Clinical Orthopaedics and Related Research®
A Publication of The Association of Bone and Joint Surgeons®

Clinical Research

Does Robotic-assisted TKA Result in Better Outcome Scores or Long-Term Survivorship Than Conventional TKA? A Randomized, Controlled Trial

Young-Hoo Kim MD, Sung-Hwan Yoon MD, Jang-Won Park MD

At a minimum follow-up of 10 years, we found no differences between robotic-assisted TKA and conventional TKA in terms of functional outcome scores, aseptic loosening, overall survivorship, and complications. Although we observed a small improvement in the proportion of knees with ± 3° deviation from a neutral mechanical axis in the robotic TKA group, there was no such difference if the definition of an outlier was taken to be ± 5° as is commonly done [27], and, importantly, there was no

Knee Surgery, Sports Traumatology, Arthroscopy (2023) 31:736–750
https://doi.org/10.1007/s00167-022-07031-1

REVIEW PAPER

Complications and downsides of the robotic total knee arthroplasty: a systematic review

Christian Nogalo[1,2] · Amit Meena[1,2] · Elisabeth Abermann[1,2] · Christian Fink[1,2]

Received: 14 February 2022 / Accepted: 23 May 2022 / Published online: 2 June 2022

Abstract

Purpose The purpose of this systematic review is to describe the complications and downsides of robotic systems in total knee arthroplasty (TKA).

Methods A comprehensive search according to the PRISMA guidelines was performed across PubMed, MEDLINE, Cochrane Central Register of Controlled Trials, Scopus, and Google Scholar from inception until December 2021. All articles of any study design directly reporting on complications and downsides of the robotic system in TKA were considered for inclusion. Risk of bias assessment was performed for all included studies using the Cochrane risk of bias and MINORS score.

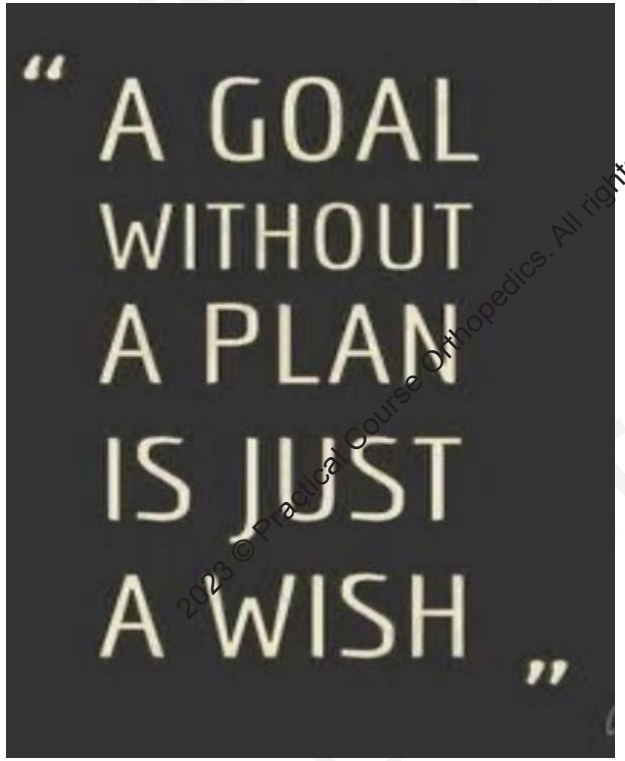
Results A total of 21 studies were included, consisting of 4 randomized controlled trials, 7 prospective studies and 10 retrospective studies. Complications of the robotic system were pin-hole fracture, pin-related infection, iatrogenic soft tissue and bony injury, and excessive blood loss. While, downsides were longer operative duration, higher intraoperative cost, learning curve and aborting a robotic TKA due to different reasons. Iatrogenic injuries were more common in the active robotic system and abortion of the robotic TKA was reported only with active robotic TKA.

Conclusion Robotic TKA is associated with certain advantages and disadvantages. Therefore, surgeons need to be familiar with the system to use it effectively. Widespread adoption of the robotic system should always be evidence-based.

Level of evidence IV

Keywords Total knee arthroplasty · Total knee replacement · Robotic · Complications · Disadvantage · Downside

2. No clear definition of the targets

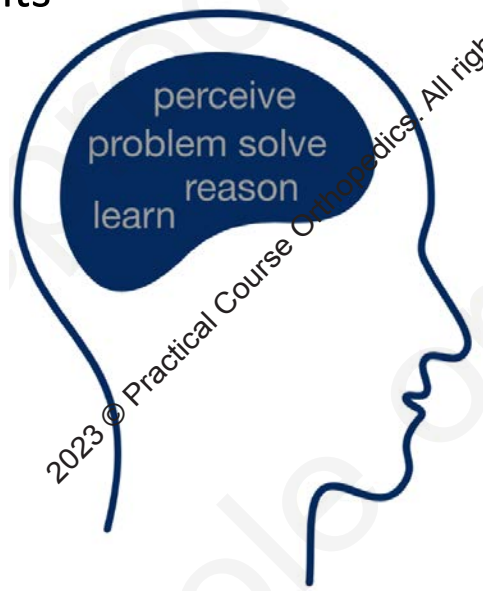


In TKA, I wish
I could have a goal
to make my plan !

The true challenge
in arthroplasties

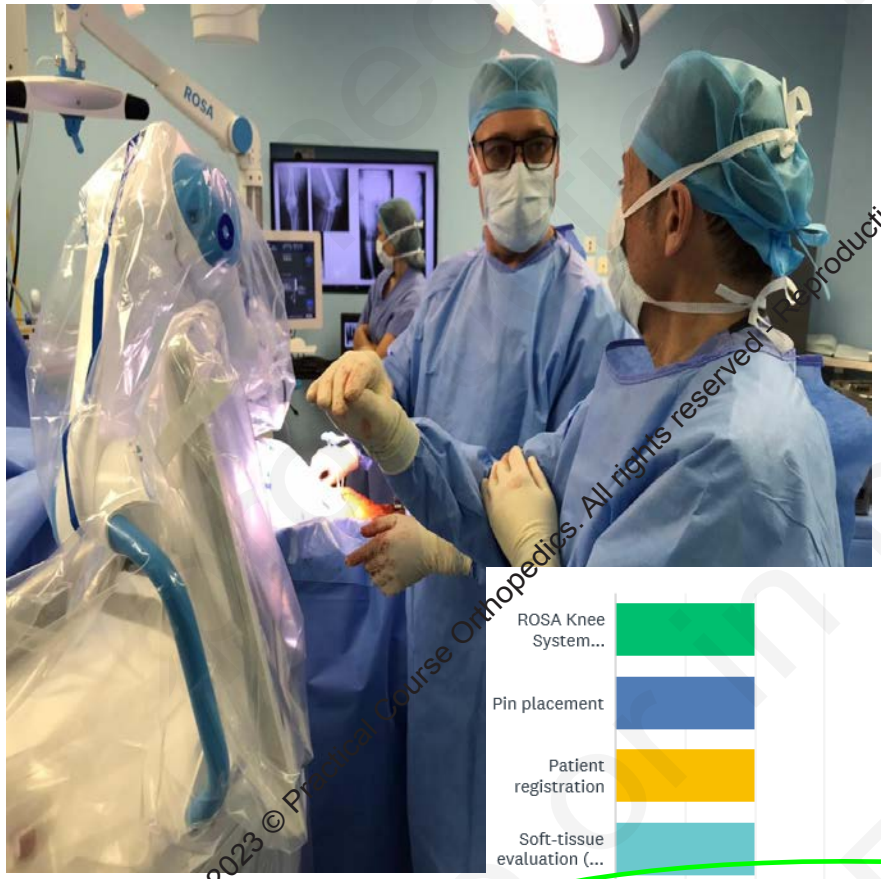
Intra-operatively

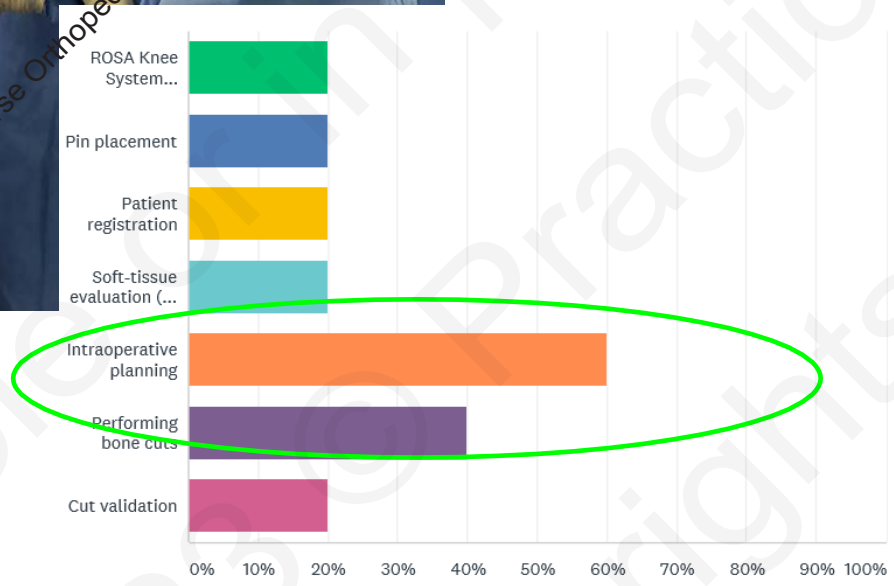
Femur frontal/sagittal/rotation
Tibia: frontal/ sagittal/ rotation
HKA
Patella
Ligaments

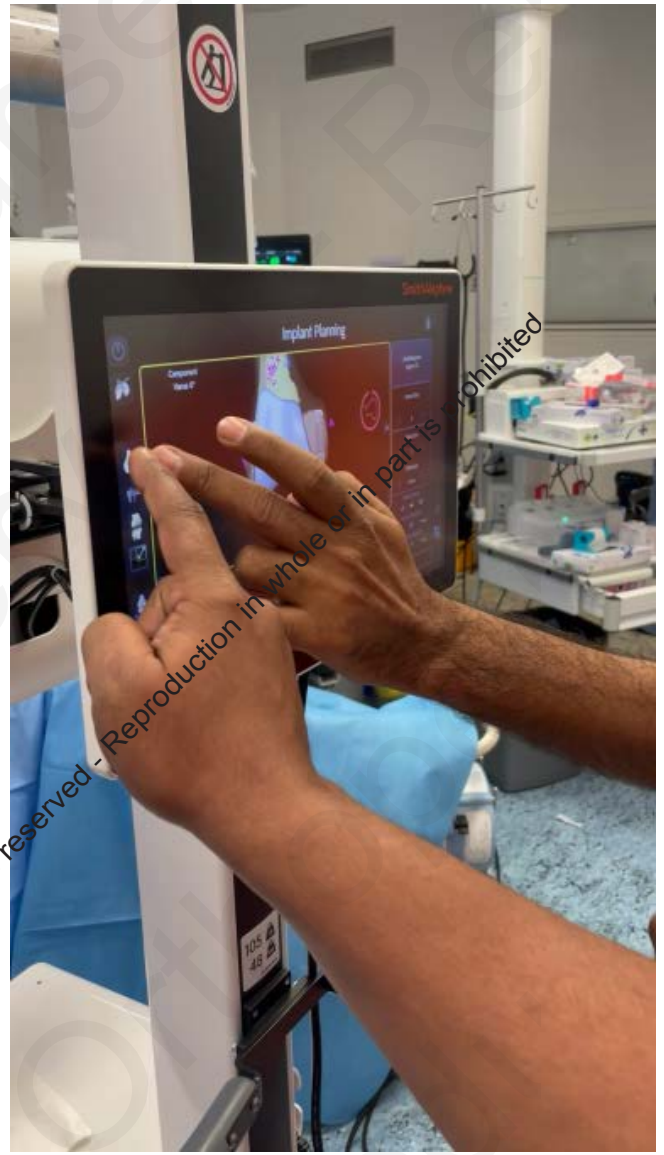


Over a millions of different combinations

Just too many information's for the human brain







3. Hardware remains bulky

Trackers

Screens and Connectivity archaic !

4. The cost is hard to justify

And the buisiness model limits it to surgeons that probably need it the less !

> Knee. 2021 Mar;29:345-352. doi: 10.1016/j.knee.2021.02.004. Epub 2021 Mar 6.

Can robot-assisted total knee arthroplasty be a cost-effective procedure? A Markov decision analysis

H Vermue [1], P Tack [2], F Gryson [3], J Victor [3]

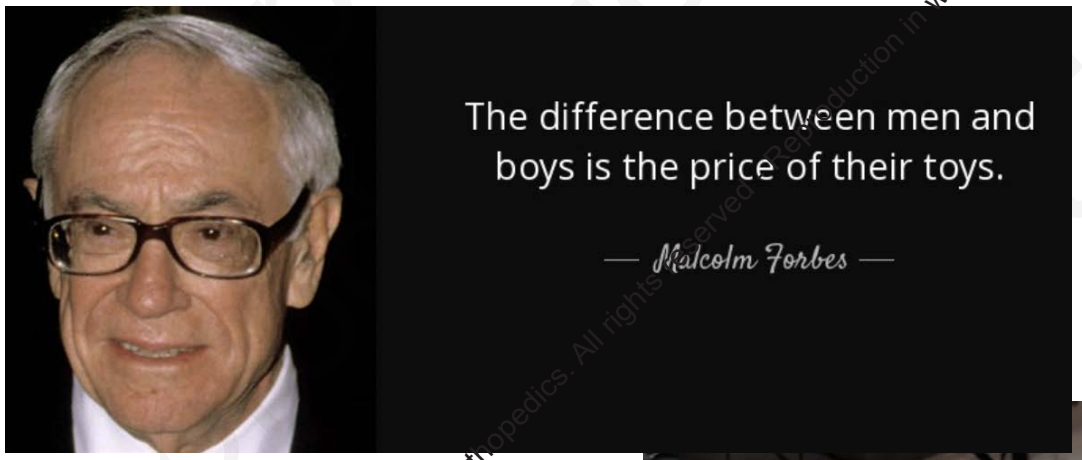
technology. Only 2.18% of the samples yielded from the probabilistic sensitivity analysis proved to be cost-effective (threshold set at $50000/QALY). A calculated surgical volume of at least 253 cases per robot per year is needed to prove cost-effective taking the predetermined parameter values into account.

> Clin Orthop Relat Res. 2023 Jan 1;481(1):157-173. doi: 10.1097/CORR.0000000000002375. Epub 2022 Sep 8.

Can Technology Assistance be Cost Effective in TKA? A Simulation-Based Analysis of a Risk-prioritized, Practice-specific Framework

Matthew D Hickey [1], Bassam A Masri [2], Antony J Hodgson [3]

Industry driven …And the companies know that we love our toys !



5. It's not all about the surgical act

Bleeding
DVT
Skin problem

Fracture
Infection

Instability
Abnormal persistent pain
Stiffness
Early loosening

Classic problems after TKA

Surgeon before
I will save the world with my knife

?

Surgical Act

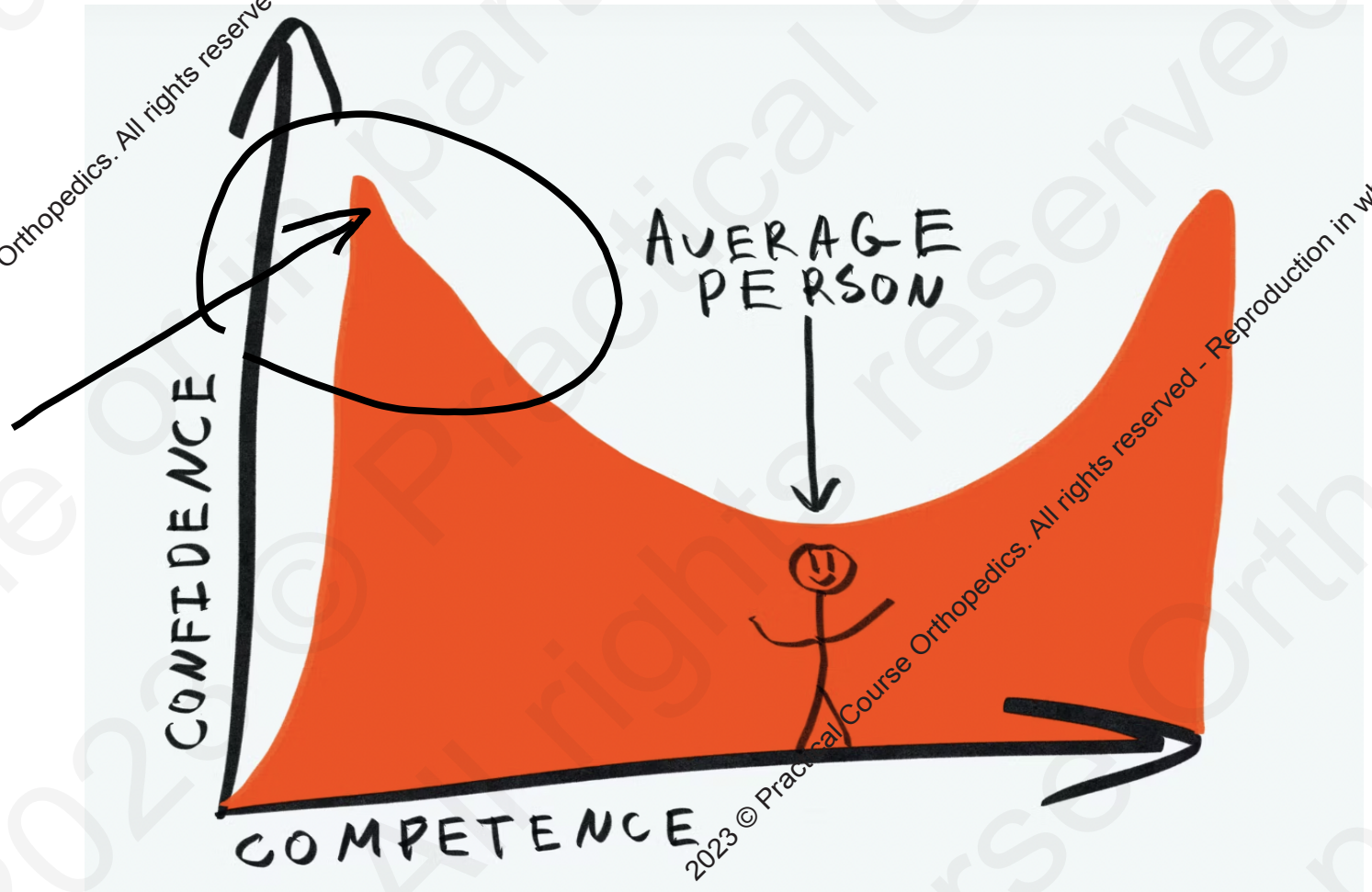
?

The end of this ?

There are only 2 techniques in surgery:
The bad one done by the others
And mine !

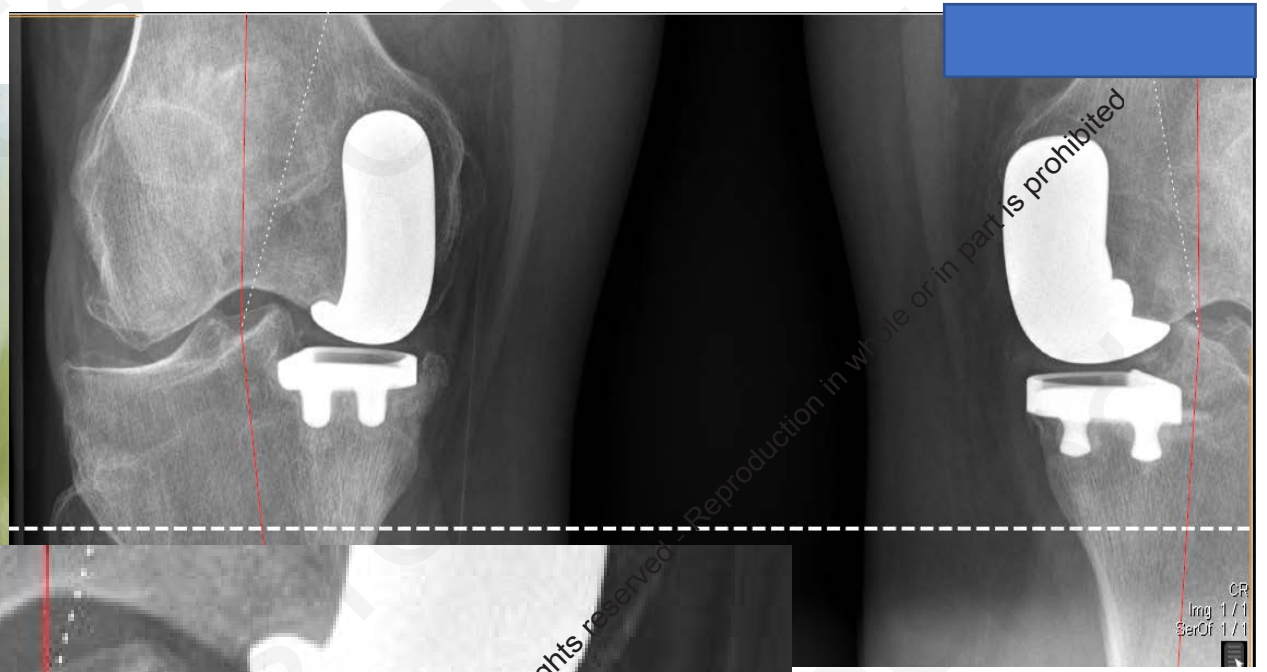
6. The real problem is sometimes the surgeon

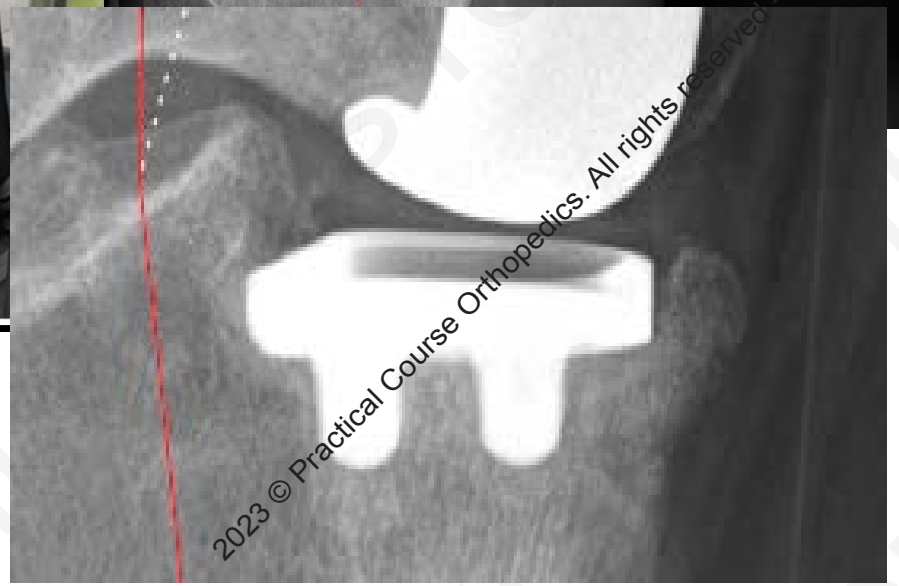
Dunning-Kruger Effect



No expert surgeon
With a robot !

Chat GPT





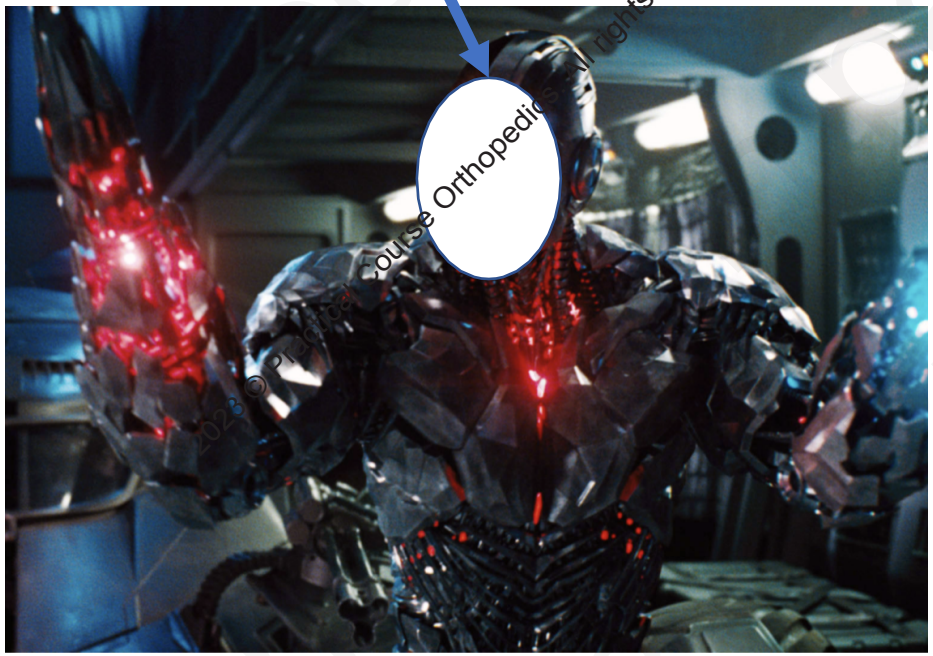
Technology in TKA ?

1. 2 decades of technology in TKA
2. What did we learn ?
3. **Where are we heading ?**

The super optimistic vision

"The Cyborg of the TKA league"

Place your picture here



Planning

Cutting

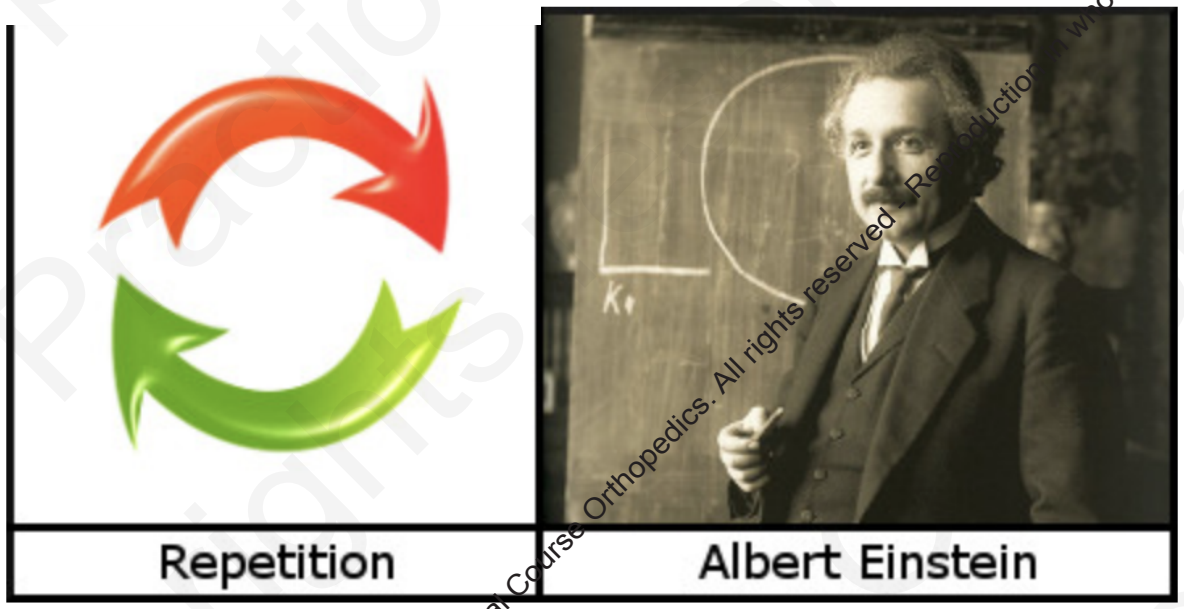
The future of technology in TKA
How are our tools gonna look like ?
Does it really matter ?

From big arms and expensive machine to a “gun” with a pair of Apple

One of the latest out there

We can’t focus only on the effector !

Insanity Is Doing the Same Thing Over and Over Again and Expecting Different Results



What does matter : A simple equation !

Patients → Surgeon ← Healthcare Systems

Better

Faster

For ever

Smarter

Cost-efficient

1. Measure better : Connectivity

Principles of Value-Based Health Care Delivery

$$\text{Value} = \frac{\text{Health outcomes that matter to patients}}{\text{Costs of delivering the outcomes}}$$

?

We as surgeons struggles to collect and provide proper measurments of outcomes that matter to patients

Data collection during the entire episode of care

Day -360
Surgery Scheduled

Day -30

Day -15

SURGERY

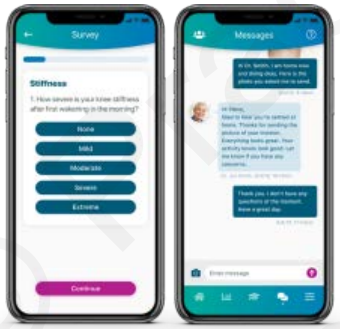
Day 14

Day 30

Day 60

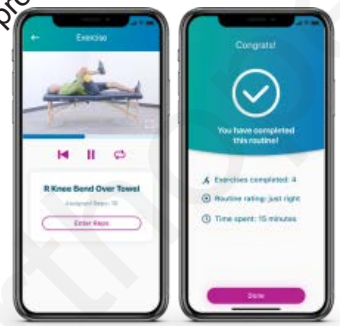
Day 365

Engagement and Education



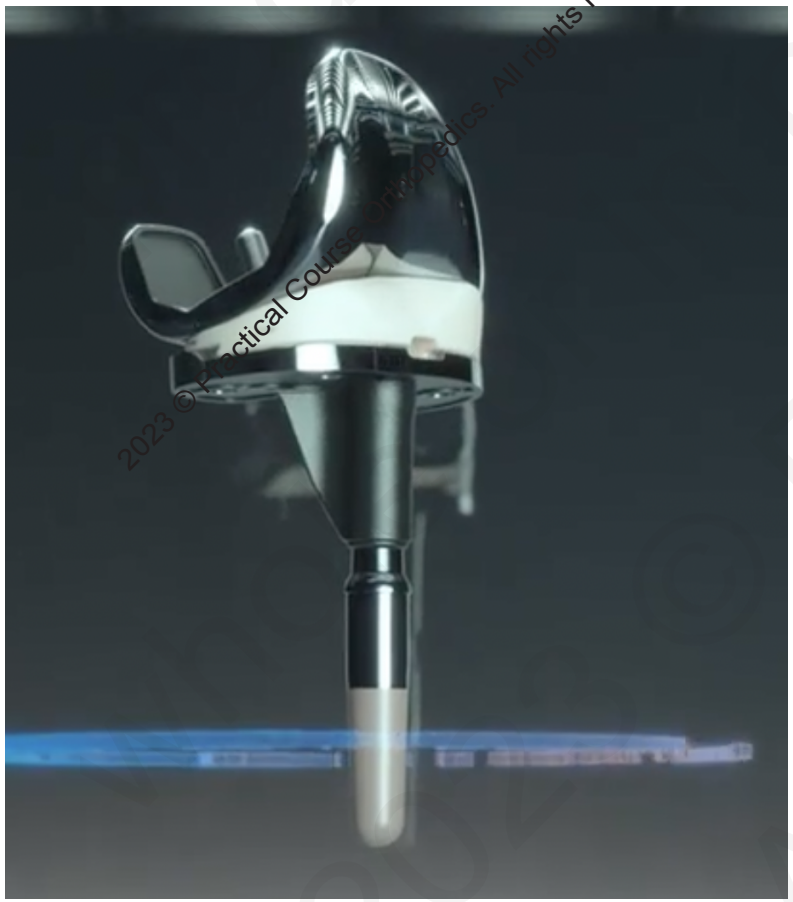
PROMS Collection and Care Team Messaging

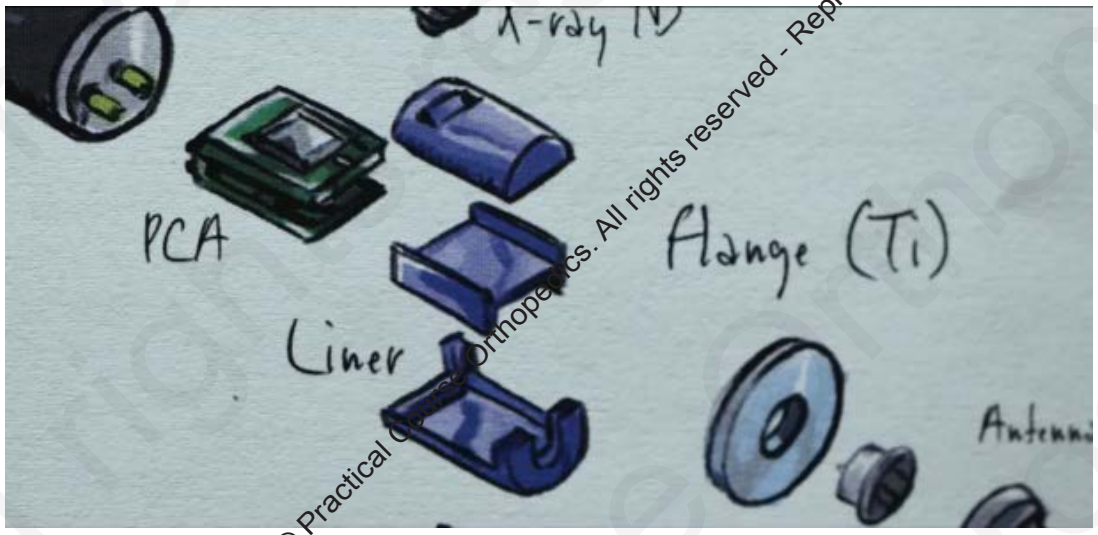
Effortless Activity + Physiologic Tracking



Pre- and Post-operative Exercises Anywhere, Anytime

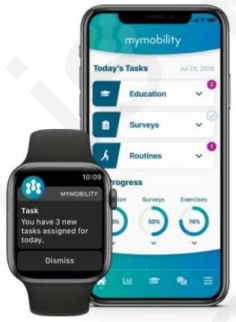
Persona IQ : the first smart implant





Connectivity for data collection

My Mobility



Patient recruitment

Patient Preparation

Surgical Act

Immediate post-op

PT Post-op

Follow-up

Data

Data

Data

Data

Data

Data

Persona IQ

A reality

An orthopedic intelligence application successf
based care management platform and a roboti

Jess H. Lonner, MD[1] (Orcid ID: 0000-0002-1168-1513); Mike B
Redfern, PhD, MPH[2] (Orcid ID 0000-0001-9883-2910); Dave Van
Sebastian Parratte MD PhD[4,5] (Orcid ID: 0000-0002-91

Journal of *Personalized Medicine*

MDPI

Article

Digital Rehabilitation after Knee Arthroplasty: A Multi-Center Prospective Longitudinal Cohort Study

Julien Lebleu [1,*], Andries Pauwels [1], Philippe Anract [2], Sébastien Parratte [3,4], Philippe Van Overschelde [5] and Stefaan Van Onsem [6,7]

OrthoIntel

Powered by ZBEdge™

t Centre, Abu Dhabi, United

ance

Post-operatively

OrthoIntel Orthopedic Intelligence Platform

- Aggregates and analyzes data in three types of reports including Mobility, Outcomes and Intra-operative

> Int Orthop. 2023 Feb;47(2):485-494. doi: 10.1007/s00264-022-05651-3. Epub 2022 Dec 12.

An orthopaedic intelligence application successfully integrates data from a smartphone-based care management platform and a robotic knee system using a commercial database

Jess H Lonner [1], Mike B Anderson [2], Roberta E Redfern [2], Dave Van Andel [2], James C Ballard [3], Sébastien Parratte [4 5]

Classic problems after TKA

Bleeding
DVT
Skin problem

Fracture
Infection

Instability
Abnormal persistent pain
Stiffness
Early loosening

Post-operatively

OrthoIntel Orthopedic Intelligence Platform

- Aggregates and analyzes data in three types of reports including Mobility, Outcomes and Intra-operative

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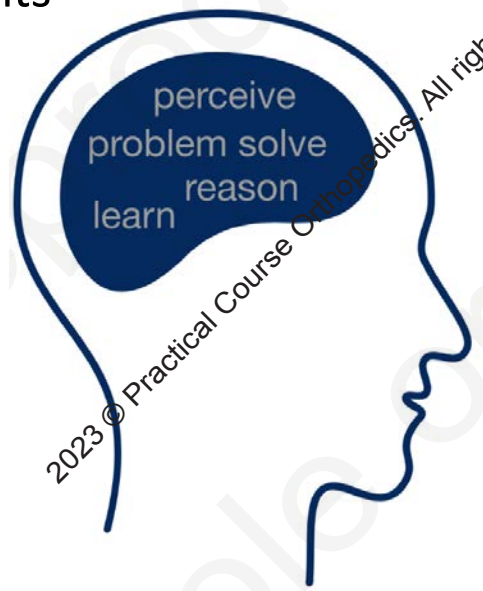
2. Understand better

Patient specific needs

1. Expectations
2. Indication
3. Patient specific surgical and pathway targets

Intra-operatively to pre-operatively

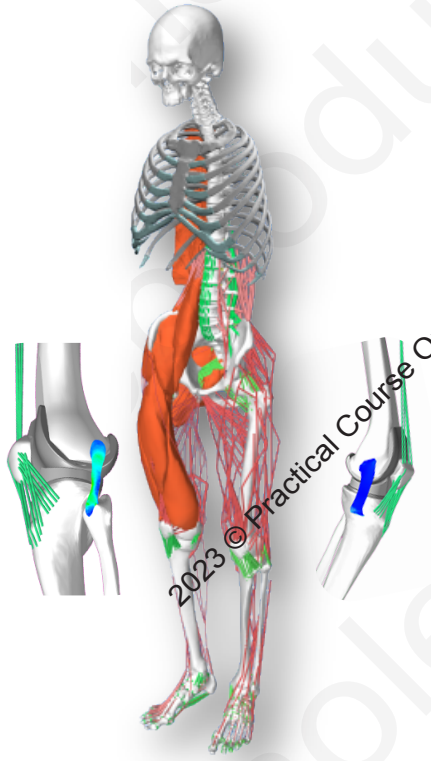
Femur frontal/sagittal/rotation
Tibia: frontal/ sagittal/ rotation
HKA
Patella
Ligaments



Over a millions of different combinations

Just too many information's for the human brain

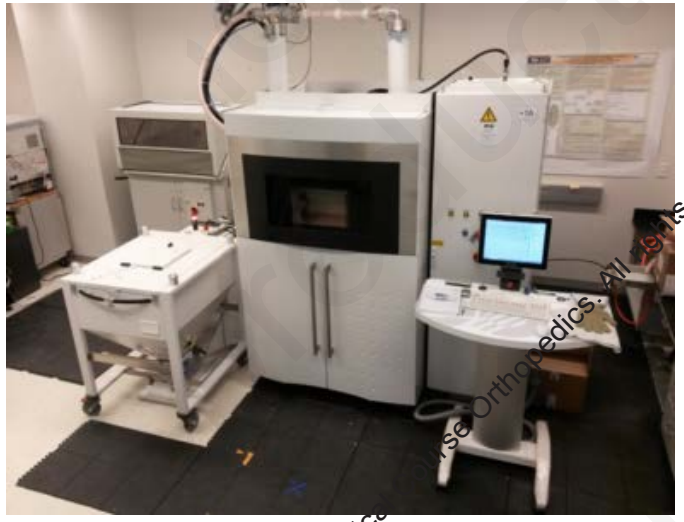
Digital twins in Orthopaedics

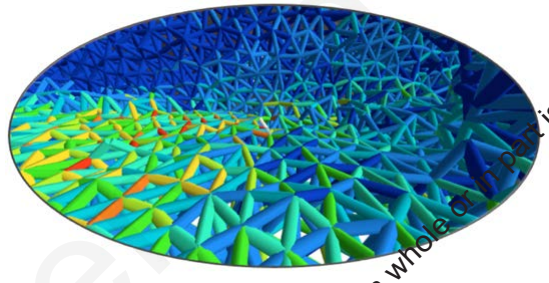


Conventional implants ?
Or 3-D printed patient-specific implant

Effector

3-D Printed smart materials





Based on gyroscopic fractals

Biomechanical properties
Haemostatic
Bone growth
Antibiotic carrier

The concept : find the best equation

Use **technology** to empower surgical excellence in care delivery

Planning

Standart X-rays
Static 3-d CT
Static 3-d MRI

4-D Planning

Implant

Off the Shelf
Semi-custom molded

3-D Printed custom

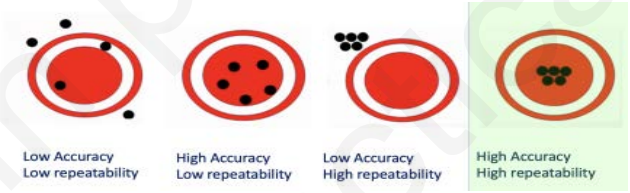
Effector

Conventional
PSI
Robotic
CAOS
AR

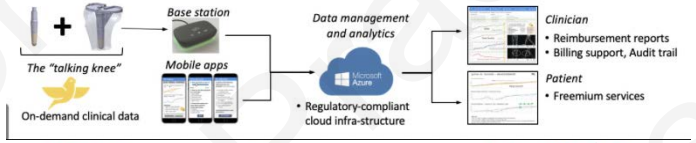
Start an endless 4 steps process

1. Understand
2. Apply
3. Collect
4. Adjust

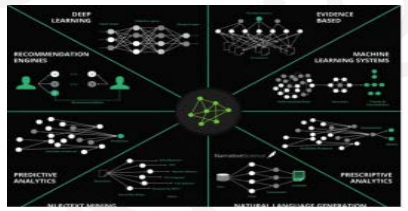
Robotic as an evaluation tool/modelisation



Robotic to exactly execute the plan



Connected tool to create the data set



Collaborative intellingence tools

DO a Better job everyday for every patient

Access: from 5% of the surgeons to 100%

Principles of Value-Based Health Care Delivery

$$\text{Value} = \frac{\text{Health outcomes that matter to patients}}{\text{Costs of delivering the outcomes}}$$

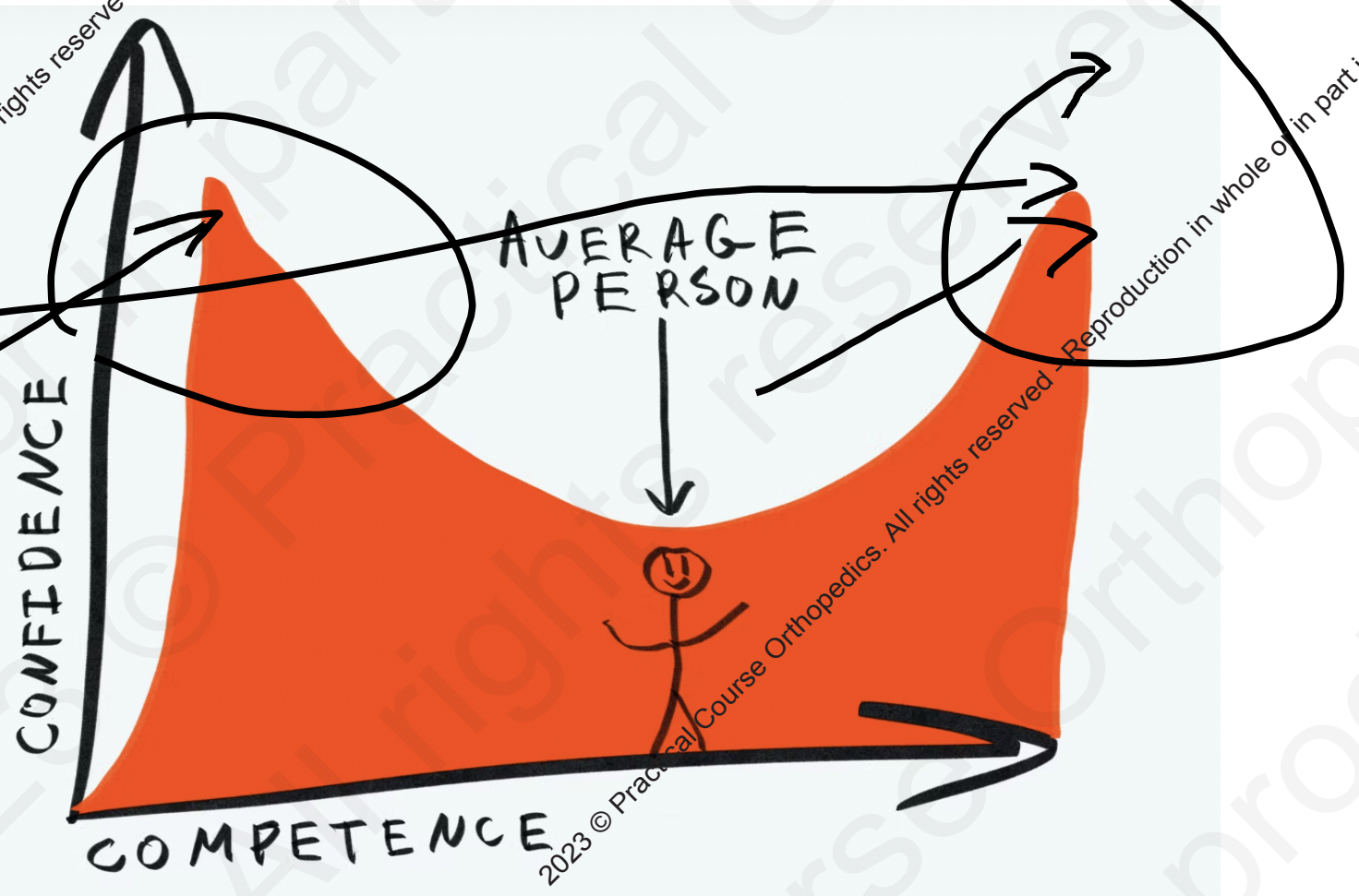
?

We as surgeons struggles to collect and provide proper measurments of outcomes that matter to patients

The goal

Dunning-Kruger Effect → Technology → Consistent performance

Non expert surgeon
With a robot !



Take home message
the future is today !

Technology in TKA

empower us to be an **ACTIVE BETTER** and **SMARTER** surgeon

For a more **PERSONALIZED pre-emptive and predictive approach in TKA**

Using COLLABORATIVE INTELLIGENCE
from modelization, surgical application, data collection to implant manufacturing

Moving forward **ADVANCED TKA**