New Technology in TKR :

Is The Latest Always The Greatest ?

NICOLAAS C. BUDHIPARAMA Jr., MD., PhD (LUMC, NL), PhD (UGM, ID), Prof

Faculty of Medicine Airlangga University – Indonesia
Leiden University Medical Centre - The Netherlands
Nicolaas Institute of Constructive Orthopaedics
Research & Education Foundation for Arthroplasty & Sports Medicine Indonesia - The Netherlands

According to Prof Sebastian Lustig, all total knee replacement has to be performed with robotics

Technology in TKA

Robotics will make us better :

- **More accurate**
- **More precise**
- **More consistent**
- **It will make obtaining a good result easier !**

Robotics Improve
Accuracy & Precision

Functional alignment with robotic-arm assisted total knee arthroplasty demonstrated better patient-reported outcomes than mechanical alignment with manual total knee arthroplasty

Byung Sun Choi [1], Sung Eun Kim [1], Myungho Yang [1], Du Hyun Ro [1], Hyuk-Soo Han [2 3]

KSSTA, 2023

D. G. Deckey,
C. S. Rosenow,
J. T. Verhey,
J. C. Brinkman,
C. K. Mayfield,
H. D. Clarke,
J. S. Bingham

THE BONE & JOINT JOURNAL EST. 1948

■ THE KNEE SOCIETY

Robotic-assisted total knee arthroplasty improves accuracy and precision compared to conventional techniques

BJJ, 2021

Improved Component Placement Accuracy with Robotic-Arm Assisted Total Knee Arthroplasty

Ormonde Mahoney, MD[1] Tracey Kinsey, RN, BSN[1] Nipun Sodhi, MD[2] Michael A. Mont, MD[3]
Antonia F. Chen, MD[4] Fabio Orozco, MD[4] William Hozack, MD[4]

J Knee Surg, 2022

Does robotic technology successfully restore the joint line after total knee arthroplasty? A retrospective analysis

Varun O. Agrawal[1,2*], Anup P. Gadekar[2] and Narendra Vaidya[1,2]

Arthroplasty, 2022

Conclusion

At min F.U. time of 2 years, **RA-TKA is significantly more accurate and precise** in planning both component positioning and final polyethylene insert thickness

The Mechanical Axis May be **the Wrong Target in CAS / Robotics TKR**

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

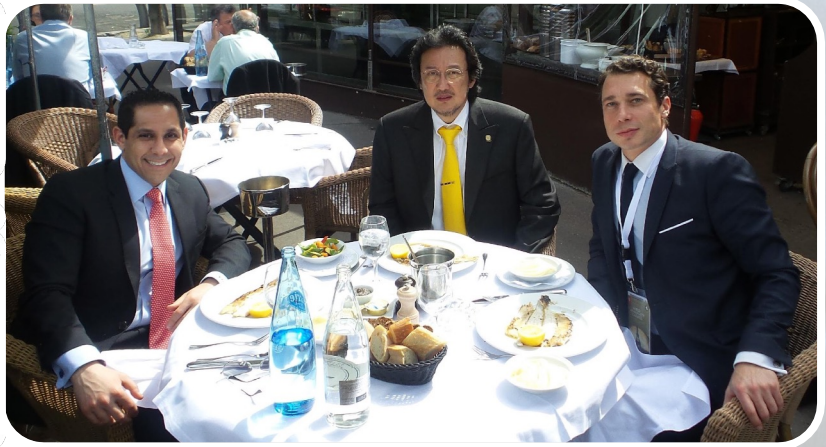
By Sebastien Parratte, MD, PhD, Mark W. Pagnano, MD, Robert T. Trousdale, MD, and Daniel J. Berry, MD

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



"Outliers had somewhat better 15 - 20 year survival"

"Wrong Target"

Success Rate of Mechanical Alignment

	AOANJR	UK NJR	SVK
5 year	96.5%	97.35%	97.5%
10 year	94.8%	95.66%	98%
15 year	92.7%	93.64%	
19 year	91%		

Although up **1/5 (20%)** patients who undergo TKA are **dissatisfied in the short and mid-term, implant survival** remains **greater than 82% at 25 years**

David C. Landy, CORR 2020

10-year survivorship free from any reoperation was 99% and 100% in the aligned and outlier groups respectively

Abdel et al, J Clinical Medicine, 2021

Dissatisfaction Declines **from 20% to 10%**

Systematic Review and Meta-Analysis

Are 20% of Patients Actually Dissatisfied Following Total Knee Arthroplasty? A Systematic Review of the Literature

Michael J. DeFrance, DO *, Giles R. Scuderi, MD

Northwell Health Orthopaedic Institute, New York, New York

J Arthroplasty, 2023

Based on the review, **the average rate of patient dissatisfaction following TKA is 10%, without complications the rate is 7.3%**

Patient **Expectation**

Patient dissatisfaction after TKA is **multifactorial, surgical technical factors are probably less important than psychosocial factors, surgical indications, and expectations**

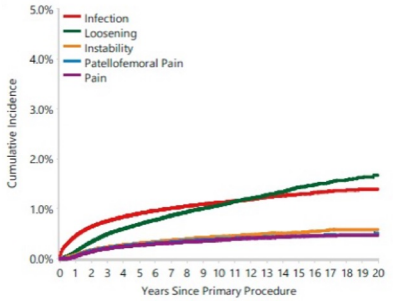
Robotic Technology in TKA
Is It Necessary?

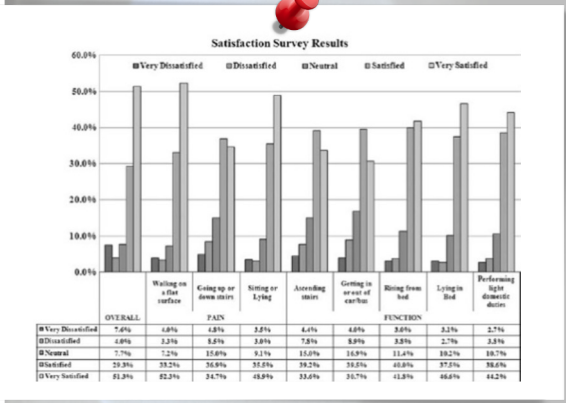
What problem are we trying to solve ?

- Malalignment
- Instability
- Patient satisfaction
- Surgeon wellness
- Cost-effective care

Table KT11 Primary Total Knee Replacement by Reason for Revision (Primary Diagnosis OA)

Reason for Revision	Number	Percent
Infection	6055	26.4
Loosening	5194	22.7
Instability	2170	9.5
Patellofemoral Pain	1931	8.4
Pain	1846	8.1
Patella Erosion	1451	6.3
Arthrofibrosis	879	3.8
Fracture	789	3.4
Malalignment	532	2.3
Lysis	304	1.3
Wear Tibial Insert	294	1.3
Incorrect Sizing	244	1.1





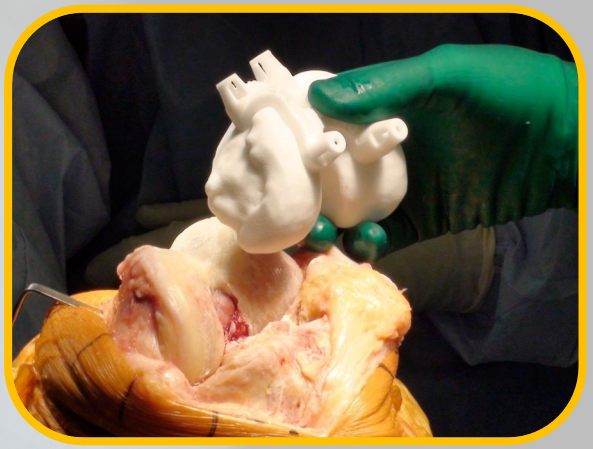
Courtesy of David Liu

CAS

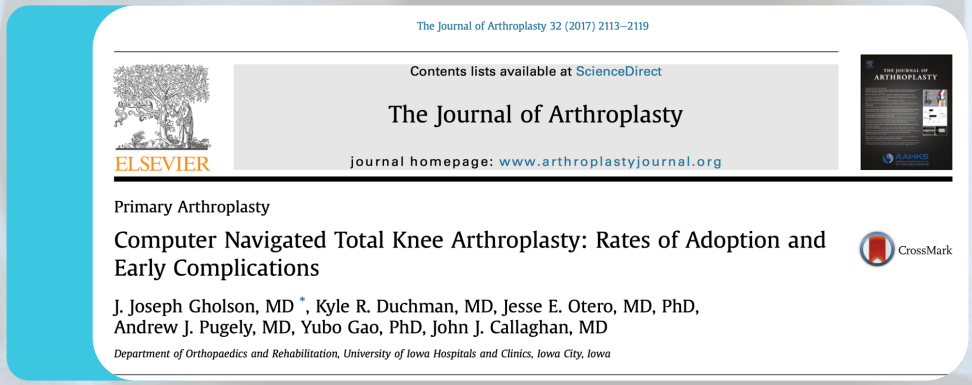
PSI

ROBOTIC

Achieve 100% Success Rate?



CAS: **Is It More Hype Than Hope ?**



The Journal of Arthroplasty 32 (2017) 2113–2119

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Primary Arthroplasty

Computer Navigated Total Knee Arthroplasty: Rates of Adoption and Early Complications

J. Joseph Gholson, MD *, Kyle R. Duchman, MD, Jesse E. Otero, MD, PhD, Andrew J. Pugely, MD, Yubo Gao, PhD, John J. Callaghan, MD

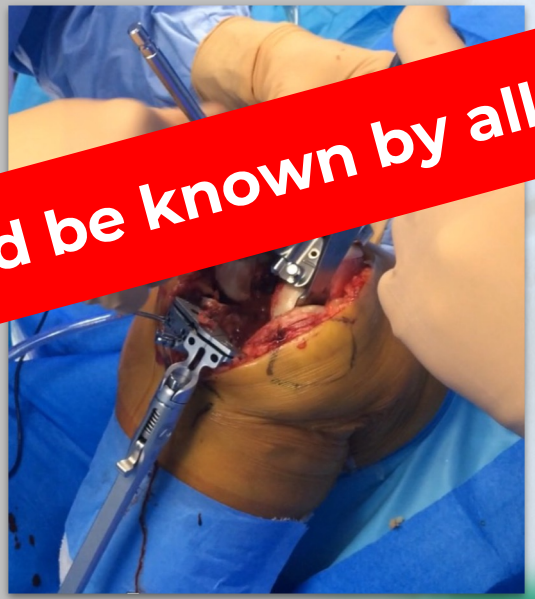
Department of Orthopaedics and Rehabilitation, University of Iowa Hospitals and Clinics, Iowa City, Iowa

- Surgeons should question when to adopt the technology & what their responsibilities are to their patients
- **38.3% decrease in CAS usage for TKA from 2010 - 2014**

The low percentage indicates that the majority of Orthopaedic Surgeons **avoid** using CAS techniques

Robotics Improve
Accuracy & Precision

Are conventional instruments still relevant or outdated in today's world ???



Basic concepts of TKA should be known by all surgeons!

Potential Dangers
for Surgeons

No clinically significant differences in outcomes, quality of life, or complications

EXPERT REVIEW OF MEDICAL DEVICES
2024, VOL. 21, NOS. 1–2, 11–14
https://doi.org/10.1080/17434440.2023.2287576

Taylor & Francis
Taylor & Francis Group

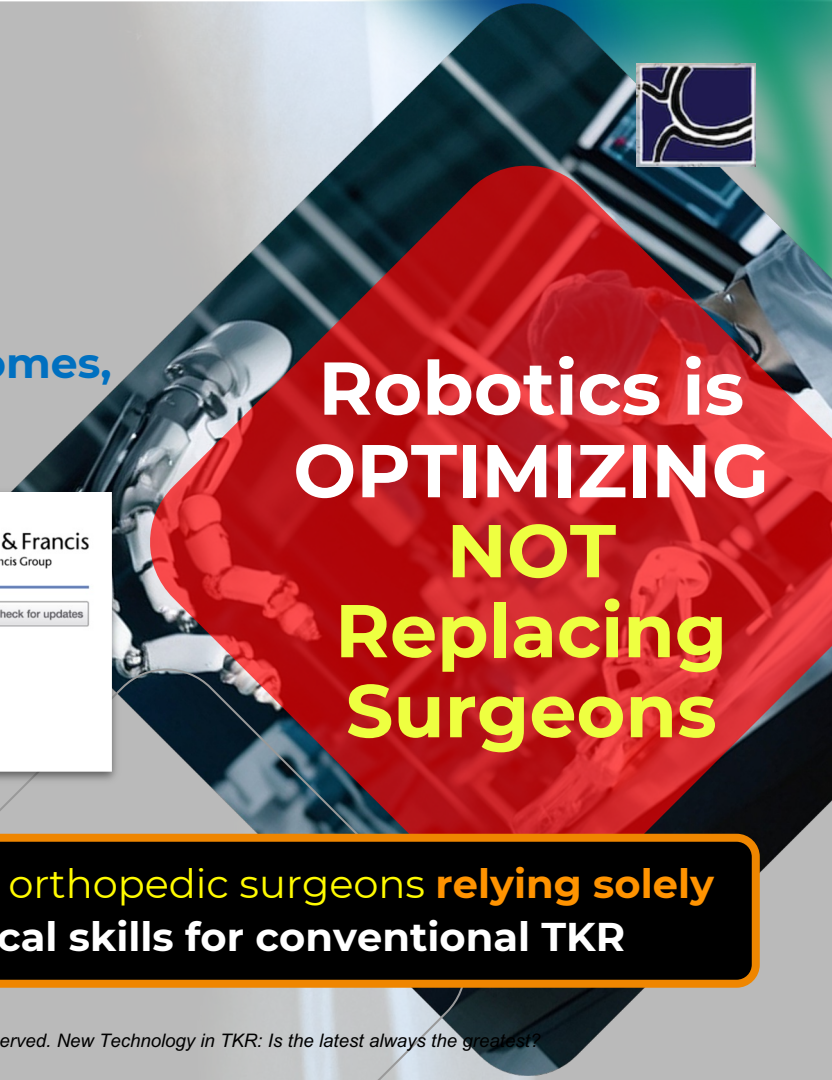
SPECIAL REPORT

OPEN ACCESS Check for updates

Technology assistance in primary total knee replacement: hype or hope?

Bart G. Pijls

Department of Orthopaedics, Leiden University Medical Center, Leiden, The Netherlands



Robotics is OPTIMIZING NOT Replacing Surgeons

As robotic TKR usage increases, there's a risk of orthopedic surgeons **relying solely on robotics,** potentially **diminishing surgical skills for conventional TKR**

Technology in TKA:
Risks of Reliance on Digital Technology

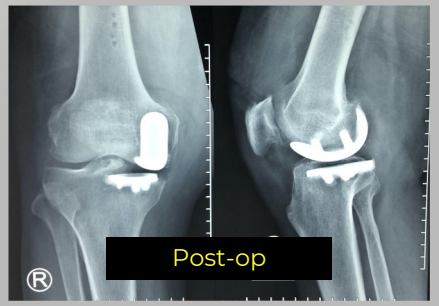
Downsides of Digital Instruments:

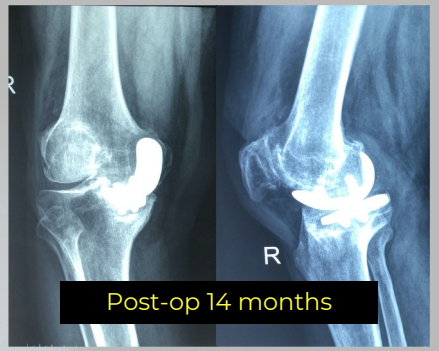
What happens when technology doesn't work?

What is your backup ?

What happens if the tool misguides you?

Will you recognize the problem ?





Evidence Based **Literature**

The Journal of Arthroplasty 38 (2023) S232–S237

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Proceedings of The Knee Society 2022

Image-Free Robotic-Assisted Total Knee Arthroplasty Results in Quicker Recovery but Equivalent One-Year Outcomes Compared to Conventional Total Knee Arthroplasty

Irfan A. Khan, ATC [a], John R. Vaile, BS [a], Cristian A. DeSimone, BS [a], Douglas E. Parsell, PhD [b], Jared D. Heinze, MPH [c], Alexandra Alessi, BS [c], Winnie Xu, BA [d], Roshan P. Shah, MD [d], Trevor Pickering, MD [b], Nathan L. Cafferky, MD [c], Jess H. Lonner, MD [a,*]

[a] Rothman Orthopaedic Institute at Thomas Jefferson University, Philadelphia, Pennsylvania
[b] Mississippi Sports Medicine and Orthopaedic Center, Jackson, Mississippi
[c] Vail-Summit Orthopaedics and Neurosurgery Research and Education Foundation, Vail, Colorado
[d] Columbia University Medical Center Department of Orthopaedic Surgery, New York, New York

Knee Surgery, Sports Traumatology, Arthroscopy (2023) 31:4680–4691
https://doi.org/10.1007/s00167-023-07458-0

KNEE

Robotic-assisted mechanically aligned total knee arthroplasty does not lead to better clinical and radiological outcomes when compared to conventional TKA: a systematic review and meta-analysis of randomized controlled trials

Alessandro Bensa[1] · Alessandro Sangiorgio[1] · Luca Deabate[1] · Andrea Illuminati[2] · Benedetta Pompa[1] · Giuseppe Filardo[1,3]

Received: 10 February 2023 / Accepted: 13 May 2023 / Published online: 3 June 2023

Knee Surgery, Sports Traumatology, Arthroscopy (2023) 31:5453–5462
https://doi.org/10.1007/s00167-023-07578-7

KNEE

Robotic-arm assisted total knee arthroplasty is associated with comparable functional outcomes but improved forgotten joint scores compared with conventional manual total knee arthroplasty at five-year follow-up

Babar Kayani[1] · Andreas Fontalis[1] · Isabella Catrina Haddad[1] · Christian Donovan[1] · Vishal Rajput[1,2] · Fares Sami Haddad[1,2]

Received: 26 July 2023 / Accepted: 4 September 2023 / Published online: 7 October 2023

Sometimes Progress **Leads Us Nowhere !!**

This was largely the case with “minimally invasive surgery” and many “navigation” platforms

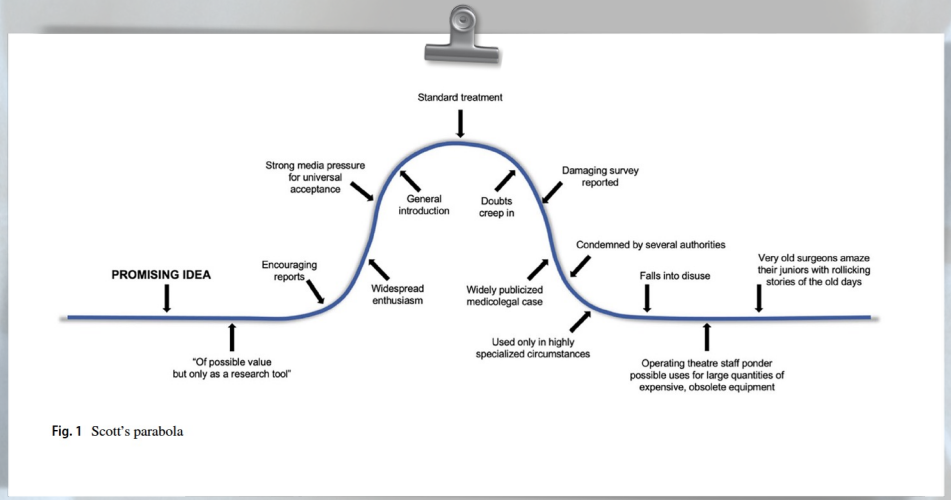


Fig. 1 Scott’s parabola

Krueger et al, J Arthroplasty, 2020
Abdel et al, J Arthroplasty, 2015

They seemed promising at the start, but when the literature did not show their superiority, their usage waned

Data Registry : American

United States

790.000 TKA /year

Robotic Surgery in Total Joint Arthroplasty: A Survey of the AAHKS Membership to Understand the Utilization, Motivations, and Perceptions of Total Joint Surgeons

William F. Sherman, MD, MBA, Victor J. Wu, MD *

Department of Orthopaedic Surgery, Tulane University School of Medicine, New Orleans, LA

J Arthroplasty, 2020

Robotic assistance has increased over 6-fold in the last 6 years, representing 13.4%

Study findings:
(735 of 2281 AAHKS members)

33.3% AAHKS members use robot arm assistance for TKA

Data Registry : European

A Multi-Source Data Collection of European Registries

Europe (+UK)

639.000 TKA /year

OECD Health Statistics 2023
NJR Annual Report 2023 - United Kingdom
Dutch Arthroplasty Register (LROI) 2022 – the Netherlands

What are the perceived benefits and barriers to the use of robot-assisted total knee arthroplasty? A survey of members of the European Knee Society

Saffarini et al, Int Orthop, 2022

Study findings:

(83 of 123 EKS members)

54% perform **conventional TKA**

27% perform **RA-TKA**

Asia-Pacific Leads
in Robotic TKA Advancements

Holding Multiple Asia Pacific Presidencies Simultaneously

APKS President
2019-2022

APAS President
2020-2022

ASIA President
2019-2022

Over 1.4 million cases per year

- **AUSTRALIA** - **57,264** per year - **30.6%** robotic assistant — *AOAJR - Chris Vertullo*
- **NEW ZEALAND** - **9,833** per year - **18.6%** robotic use — *Mark Clatsworthy, NZ - JR*
- **CHINA** - **700,000** cases per year - **8%** robotic use — *Courtesy of Cao Li & Yixin Zhou*
- **INDIA** - **325,000** cases per year - **7.6%** robotic — *Courtesy of Ashok Rajgopal*
- **JAPAN** - **120,000** es per year - **5.46%** robotic use — *Courtesy of Shuichi Matsuda - Yukihide Minoda*
- **KOREA** - **100,000** cases per year - less than **5%** robotic use — *Courtesy of Kang-il Kim*

What's Next in **Knee Arthroplasty?**

Artificial Intelligence

Evolution of robotic procedures & implant designs

Smart implants

Outpatient surgery and centers of excellence

Digital **Transformation**

We live in a dynamic digital era, with changes occurring every day

What about the changes in our professional environment?

CURRENT CONCEPTS

Digital Transformation: Do We Already Benefit from This in Orthopaedics?

Nanne P. Kort, MD, PhD
CortoClinics
Nederweert, NETHERLANDS

Peter Pilot, PhD
IMUKA
Roosteren, NETHERLANDS

Nicolaas C. Budhiparama, MD, PhD, FICS, Prof.
Nicolaas Institute of Constructive Orthopaedic Research & Education Foundation
Jakarta, INDONESIA

Digital technology has changed many aspects of our lives. We live in a dynamic digital era, with changes occurring every day. But what about the changes in our professional environment? Is the orthopaedic world changing at the same pace as other aspects of our lives? Traditionally, health care has been lacking when it comes to technological innovation. If we look around, we see a range of developments, from small technological innovations such as health care apps to major innovations such as robotic arm-assisted surgery. The big question is: are these developments innovations, or are they just hype? Many articles have been devoted to this topic of "hope or hype." With previous topics, such as minimally invasive hip and knee arthroplasty, metal-on-metal hips, and navigation still fresh in our memories, we might place current developments into the same category: hype. But maybe this is a reaction of our reptile brain? Is it fair to see the surgical robot as an expensive motorized sawing machine, or should we see it more as a data-driven dynamic solution with multiple aspects that are just underdeveloped?

Classical evidence-based medicine has toughened us to look back and build on the past. And to be honest, this model has brought us a lot! But in 2015, after 250 years, the world entered the fourth phase of the industrial revolution. In the current era, we must not forget to look further ahead and see new possibilities.

Perhaps this fast-changing world will also require us to develop new skills and methods. Evidence-based medicine should be upgraded to evidence-based medicine 2.0, in which we combine evidence and data. In this setting, causality has a new friend: associative data. Associative data are used in many other industries, so why not use them more frequently in health care? Instead of using only data from clinical trials, we have the possibility to use real-world data. We also have access to digital tools to collect patient-generated data, providing the opportunity to shift toward personalized medicine. Personalized medicine can allow for higher precision in terms of diagnosis, therapy, and prognosis that can ideally be tailored to the individual patient [Nardini et al, 2021]. On our way to achieving personalized medicine, we can improve ourselves and health care by learning from new data sources that become available. In sports, for example, advanced analytics are commonly used to improve performance. Advanced analytics are used not only in high-tech sports, such as Formula 1 racing, but also in sports such as cycling, golf, and many others that were formerly seen as analog. This brings us back to the questions: How is our orthopaedic world changing? Are we fit for the future? Can we serve our patients in a way that fits into the 2020s?

Let's look at some examples of innovative changes that could change our professional lives. Apps, for example, are relatively simple and cheap innovations with great potential for advanced analytics. The primary function of apps is to educate patients with timely medical information through smartphones or tablets. However, they can also improve patient knowledge; provide insights into medication or treatment adherence, satisfaction, and clinical outcomes; and positively affect health care economics [Timmers, 2020]. An often-overlooked aspect of these tools is the ability to analyze the use of the app (e.g., how often and for what reason), the effectiveness of push-notifications, and communication tiredness. With this information, we can optimize information delivery, learn about the needs of our patients, and maximize the use of clinical resources.

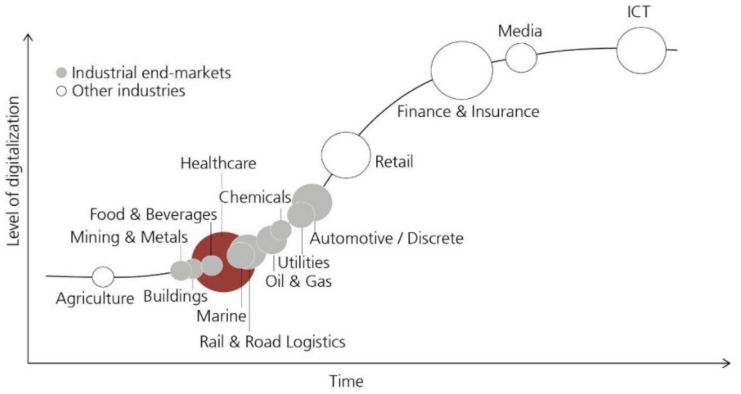
To continue our debate on digital transformation, we all recognize the importance of good surgical instruments in the setting of hip and knee arthroplasty. Therefore, it is a natural evolution that robotic arm-assisted surgery has transformed the instruments into smart instruments. But do we use the "smart" part of the system in a mature fashion? As with smartphones, it will take a few generations before we start to use the smart part of the device to a larger extent that will make it worthwhile. From this perspective, robotic arm-assisted surgery is more than an expensive motorized sawing machine; it is an example of how technology can change a surgical field. We now need to start using the digital nature of the robot and work with the generated performance data to its full potential. Then we will see how these instruments' smart part will help us develop the field.

Digital **Transformation**

Healthcare has always been lacking in technology uptake

Healthcare is one of the least digitalized industries

Level of digitalization by industry



ABB, 2020

Digital **Transformation**

Range of developments:

Small technological innovations

Health care apps

- To educate patients with timely medical information through smartphones or tablets
- Improve patient knowledge

Major technological innovations

Robotic arm assisted surgery

SURGICAL ROBOT

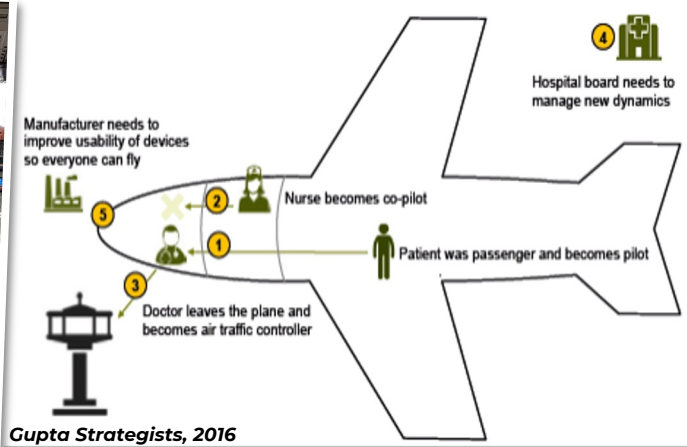
Expensive motorized sawing machine?

or

A data-driven dynamic solution with multiple aspects that are just underdeveloped?

The New Role
of the Surgeon

The roles of the stakeholders change drastically



It must be acknowledged that we are still in the era of needing humans to coexist with machine

Piuzzi et al. BJO, 2022

Demand For
New Technology

PUBLIC PERCEPTION :

Prefer RaTKA
by a low-volume surgeon

than

conventional by high-volume surgeon

even if results were comparable

Pagani et al, JOA, Feb 2021

Contrary to popular belief,
the less or more experienced surgeon do not differ in their willingness to adopt new technology

Sherman et al, JOA, July 2020

Key Findings on **RA-TKA**

- Patients more comfortable in the first **24** hours
- Achieving flexion to 90 degrees in the first **48** hours
- Improved sagittal alignment of femoral and tibial components

Technology in TKA:
Questions to Ask About New Technology

1. How much ***more precise*** and ***advantageous*** is the technology likely to be ***noticed by the patient?***
2. Are there **potential harm** and **added cost** of the technology ?
3. How **complex** is the new technology to use ?
4. As you consider new technology, **think about the ethics!**

Daniel J. Berry

From just doing laps,
to go out and measure

Personalized Alignment
in Robotic Assisted Total Knee Arthroplasty

SICOT-J 2021, 7, 19
© The Authors, published by EDP Sciences, 2021
https://doi.org/10.1051/sicotj/2021021

SICOT-J

Available online at:
www.sicot-j.org

REVIEW ARTICLE OPEN ACCESS

Personalized alignment in total knee arthroplasty: current concepts

Sébastien Lustig[1,2], Elliot Sappey-Marinier[1], Camdon Fary[3,4], Elvire Servien[1,5], Sébastien Parratte[6,7], and Cécile Batailler[1,2,*]

Journal of Joint Surgery and Research 1 (2023) 108–116

Contents lists available at ScienceDirect

Journal of Joint Surgery and Research

journal homepage: www.journals.elsevier.com/journal-of-joint-surgery-and-research

ELSEVIER

Review

Alignment techniques in total knee arthroplasty

Yukihide Minoda *

Department of Orthopaedic Surgery, Osaka Metropolitan University Graduate School of Medicine, 1-4-3 Asahi-machi Abeno-ku Osaka, 545-8585, Japan

Conclusions

Functional alignment TKA aims to restore pre-arthritic alignment and achieve balanced soft tissue tension by manipulating alignment based on surgeon's discretion intraoperatively using robotic technology

My Experience with RA-TKA
Pioneer of RA-TKA

Is Robotic really nothing but marketing?

YES

Long term functional outcome are similar

Long term survival rate has not been proven yet

NO

Quite satisfied with post-operative pain, faster recovery, and short-term functional outcome

In severe varus and valgus cases, robotic assistance helps surgeon determine the precise resection, ensuring optimal alignment

Ultimately, collaboration is key to driving advancements in robotic TKA

Conclusions

- All technologies need **long-term assessment** and **critical appraisal**
- What we need is a **simple robotic system** that will **improve patient's functional outcome, alignment** and **long term satisfaction** at **no additional cost**
- It's important to note that the integration of **AI technologies into medical practice requires rigorous testing, validation, and adherence to regulatory standards**
- **Interpretation of literature is difficult** for a physician trying to decide if and when to implement new technology