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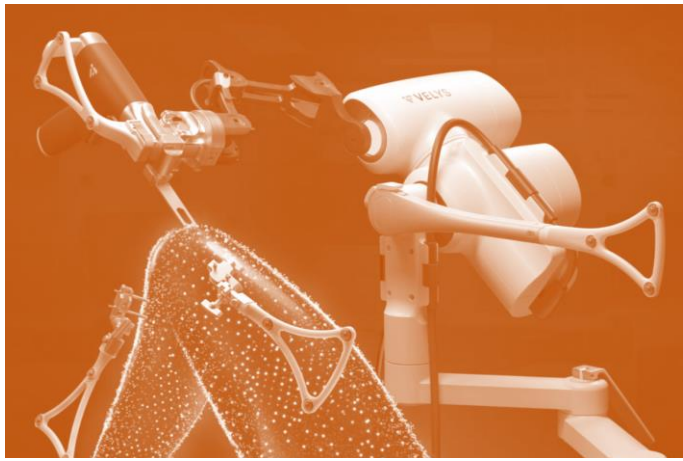
Robotic TKA 101: why robots now? Practical Tips on Implementation and Training Ramification



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UCSF Arthroplasty for the Modern Surgeon
Napa, California
September 2023

Disclosures

- Stocks: Rzzr Medical
- Consultant:
  - Depuy-Synthes
  - Rzzr Medical
- Institutional Education and Research Support
  - OREF Omega Grant
  - The Hoag Foundation
- Own shares in a physician owned hospital

Roadmap

WHY:

Why robotics? Does it make sense today?

HOW:

Learning from my mistakes what can make the transition easier

WHAT:

Personalized Alignment – Stefano Bini

WHEN AND WHERE:

A right time? Right setting? – Keith Fehring

Biases against Adopting Robotics

I don't trust a robot to do my job

I was frustrated with the 2 robotic cases I did and I gave up.

The information the robot gives can be overwhelming and overloads my circuits!

Will the robot do what I need it to do every time?

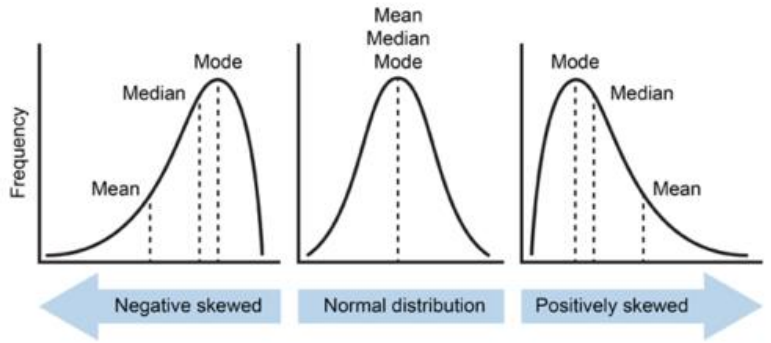
Why do I need a robot? I do a good knee

Robots are fads/gimmicks for surgeons to get patients

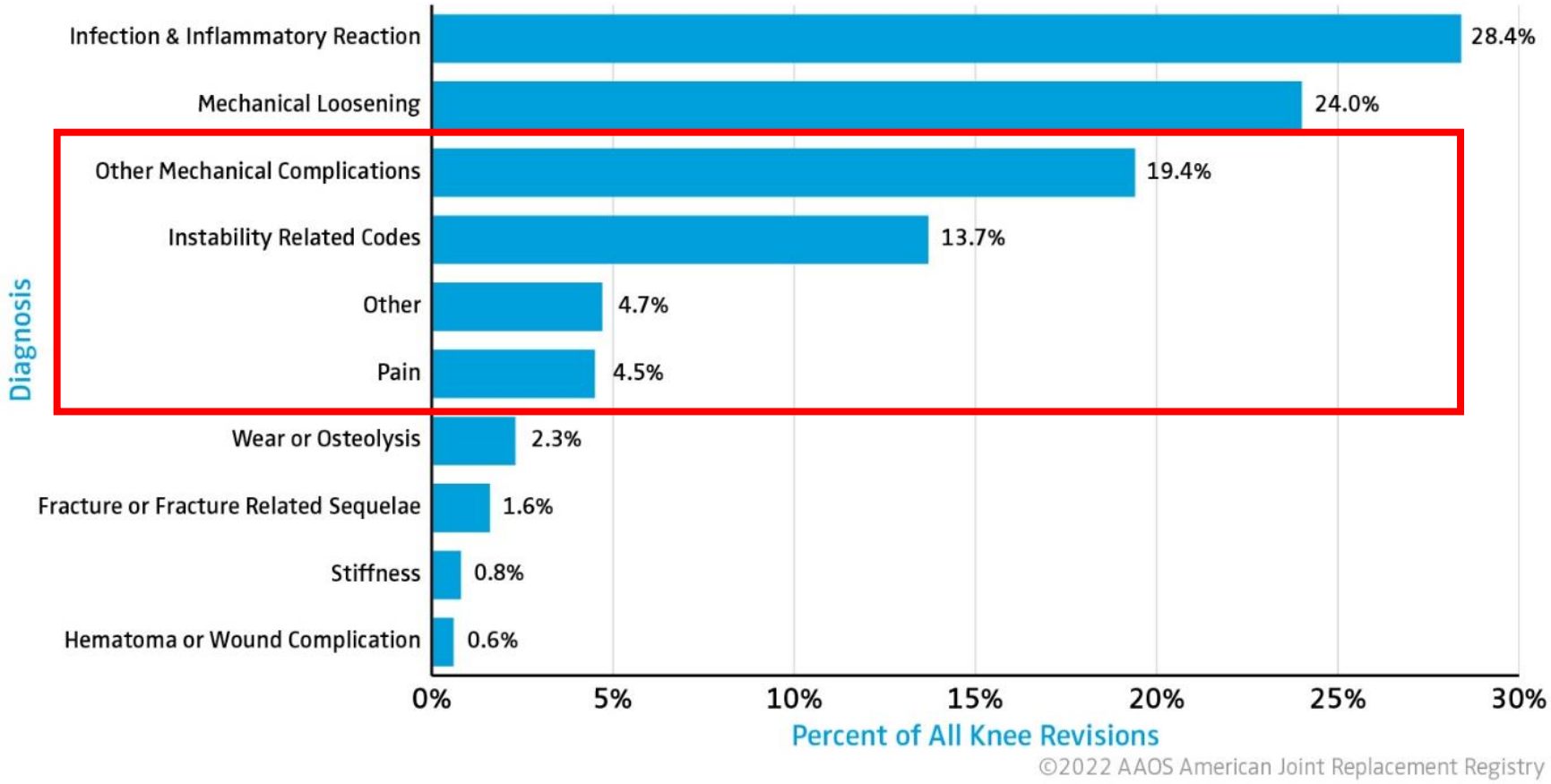
Robotics TKA is too expensive!!

Why?

- TKA dissatisfaction rate remains around 20% despite….
  - Improved instrumentation, mechanical alignment, cement technique and cementless fixation
  - Improved joint kinematics with more modern design

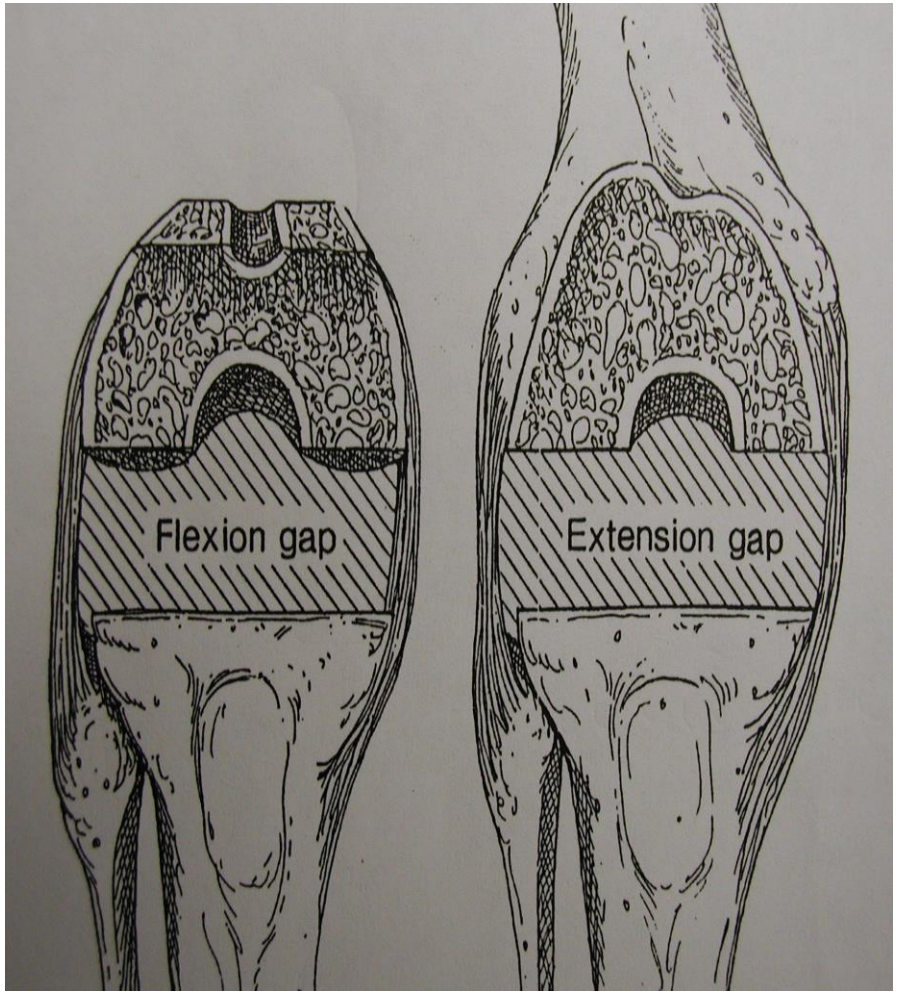


Reasons for Revision



AJRR 2022

Evolution in Thought about Knee Alignment



Evolution in Thought about Knee Alignment

Optimizing Asymmetric Native Knee Flexion Gap Balance Promotes Superior Outcomes in Primary Total Knee Arthroplasty

Menenghini et al J Am Acad Orthop Surg 2023;00:1-11

Laxity Profiles in the Native and Replaced Knee—Application to Robotic-Assisted Gap-Balancing Total Knee Arthroplasty

Sami Shalhoub, MS [a,*], Wayne E. Moschetti, MD, MS [b], Leonid Dabuzhsky, MD [c], David S. Jevsevar, MD, MBA [b], John M. Keggi, MD [d], Christopher Plaskos, PhD [a]

The Journal of Arthroplasty 33 (2018) 3043-3048

■ KNEE

Coronal Plane Alignment of the Knee (CPAK) classification

A NEW SYSTEM FOR DESCRIBING KNEE PHENOTYPES

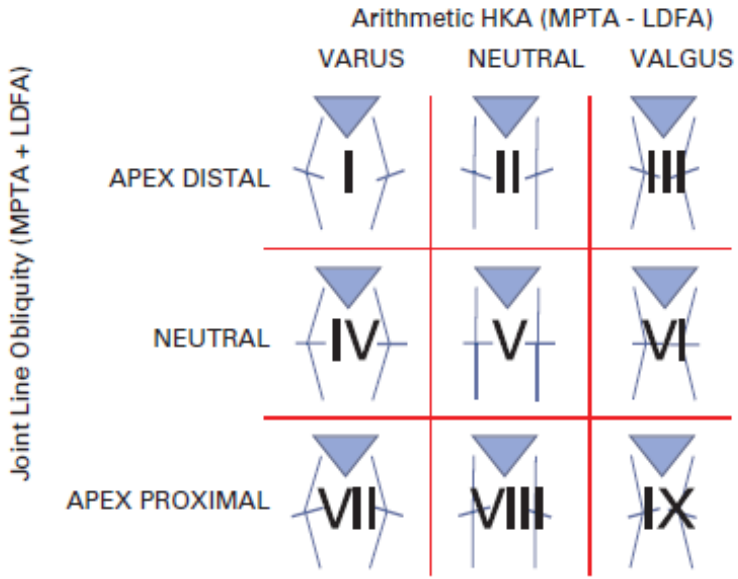


Fig. 4

Bone Joint J 2021;103-B(2):329—337.

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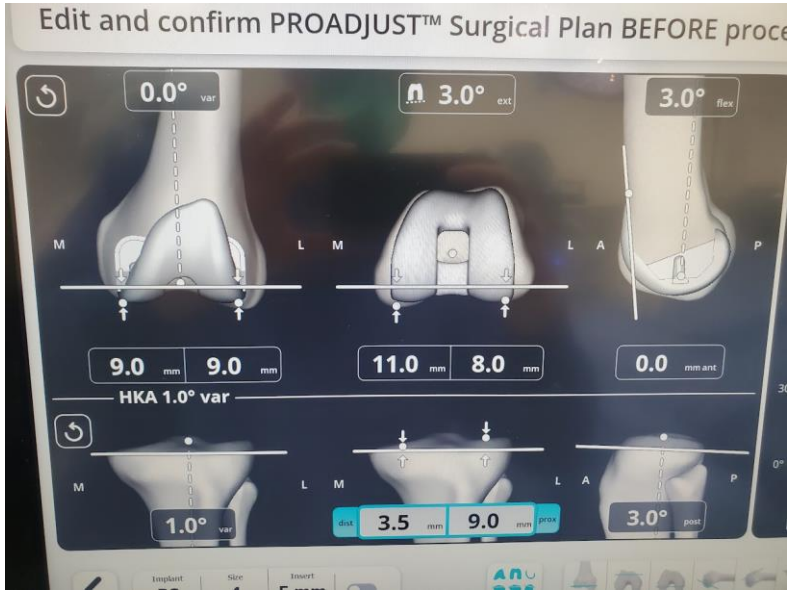
Evolution in Thought about Knee Alignment…and instrumentation



Mechanical Alignment

Restricted Kinematic Alignment

Kinematic Alignment

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What Flavor of Robot?

Set up time

Footprint

CT or imageless?

Block vs saw vs burr

Cost

Potential Advantages of Modern Era Robotics

- Surgical:
  - Improved precision in alignment and implant position.
  - Objectively evaluate native knee kinematics and compare the pre-post reconstruction data (be able to plan before 1 bony cut).
- Clinical:
  - Improved clinical outcomes?
  - Improved Survival?
- Economic:
  - Reduction in tray use
  - Reduction revisions?
  - Patient demand/consumerism

Potential Disadvantages of Robotics

- Learning Curve/ Time
- Footprint
- Capital Costs and Disposables
- Pin Site Morbidities

Better Accuracy ….

Robot-assisted total knee arthroplasty improves mechanical alignment and accuracy of component positioning compared to the conventional technique

Chang Hyun Nam, Su Chan Lee, Jin-Hong Kim, Hye Sun Ahn and Ji-Hoon Baek*

Journal of Experimental Orthopaedics (2022) 9:108

A biomechanical comparison between robotic and conventional total knee arthroplasty (TKA) in resection accuracy: a meta-analysis on cadaveric specimens

Sean B. Sequeira*, Grant T. Duvall and Henry Boucher

BJO

KNEE

Clinical results and patient-reported outcomes following robotic-assisted primary total knee arthroplasty

A MULTICENTRE STUDY

Bone Jt Open 2022;3-7:589–595.

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Better Accuracy ….but is it better clinical outcomes

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 [illegible] Nathan L. Cafferky, MD [c], Jess H. Lonner, M[illegible]

Primary Arthroplasty

Robot-Assisted Total Knee Arthroplasty Does Not Improve [illegible]logic Outcomes

[illegible]hD [a, b, *], Sang Jun Song, MD, PhD [b]

[illegible]angdong, Seoul, Republic of Korea
[illegible]iversity, Seoul, Republic of Korea

Not Surprising…We are still aiming for the same goal

Acta Orthopaedica 2023; 94: 60–79

Clinical and radiological outcom[illegible] versus conventional total knee arthroplasty: a systematic review and meta-analysis of randomized controlled trials

Pakpoom RUANGSOMBOON [1,2], Onlak RUANGSOMBOON [3,4], Chaturong PORNRATTANAMANEEWONG [2], Rapeepat NARKBUNNAM [2], and Keerati CHAREANCHOLVANICH [2]

[illegible]al of Arthroplasty 34 (2019) 1656e1661

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Table 1. Main results of robotic-assisted total knee arthroplasty (RA-TKA) in the literature

Authors [Reference]	Year	Level of Evidence	Results
Matassi et al [7]	2019	NA	Accelerometer-based navigation accurately achieved neutral mechanical alignment and optimal implant position after TKA in patients with extraarticular deformity.
Kayani et al [1]	2019	NA	RA-TKA was associated with decreased postoperative pain, better early functional rehabilitation and shorter time to hospital discharge compared with C-TKA. However, there was no difference in medium to long-term functional outcomes between C-TKA and RA-TKA.
Kim et al [4]	2020	I	After a minimum follow-up of 10 years, no differences were found between RA-TKA and C-TKA in terms of functional outcome scores, aseptic loosening, overall survival and complications. Considering the additional time and expense associated with RA-TKA, the authors did not recommend its widespread use.
Vaidya et al [5]	2020	I	Compared with C-TKA, RA-TKA is highly accurate in terms of the placement of prosthetic components in the coronal plane and mechanical alignment. In C-TKA, the joint line is elevated but can be accurately reestablished by RA-TKA, which can result in better patellofemoral kinematics.
Batallier et al [9]	2020	IV	Compared with C-TKA, the Mako system reduced postoperative pain and improved implant placement. At 1 year after surgery, functional outcomes were equal or slightly superior with the Mako system.
Sires et al [8]	2021	NA	The Mako system showed high accuracy in achieving the preoperatively planned bone resection and final coronal alignment of the limb.
Lei et al [6]	2021	I	Navigation and the robot improved alignment accuracy compared to patient-specific instruments and C-TKA, although clinically there was no difference in postoperative outcomes.
St Mart and Goh [2]	2021	NA	RA-TKA improved component positioning and reduced alignment outliers compared with preoperative planning.
Siddiqi et al [3]	2021	NA	Compared with conventional C-TKA, RA-TKA has been shown in some studies to demonstrate greater reproducibility and accuracy in restoring mechanical alignment, with improved early functional outcomes and cost savings within 90 days of surgery.

RA-TKA, robotic-assisted TKA; C-TKA, conventional TKA; NA, not available

Arch Bone Jt Surg. 2022; 10(12): 989-991.

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What DO we know today

1. Comparable in safety and complications to conventional TKA
2. Similar in pain and functional outcomes in the short term
3. Better accuracy of implant position
4. Increased cost and possible increased length of time

What we can't answer today

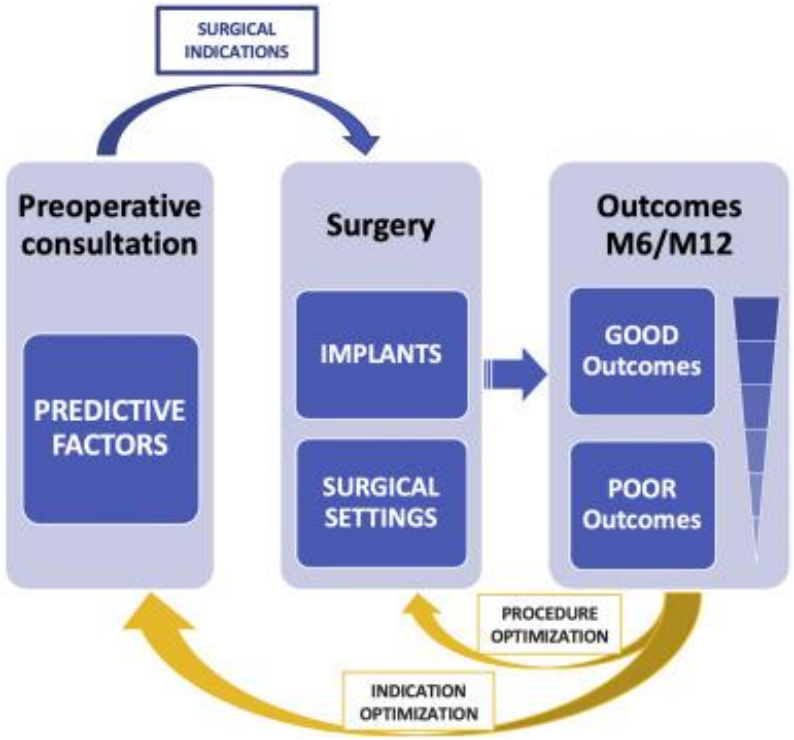
1. Mid to long term patient outcomes
2. Survival advantage?
3. Improvement in the TKA Albatross (20% unsatisfied).
4. Is the technology there yet.

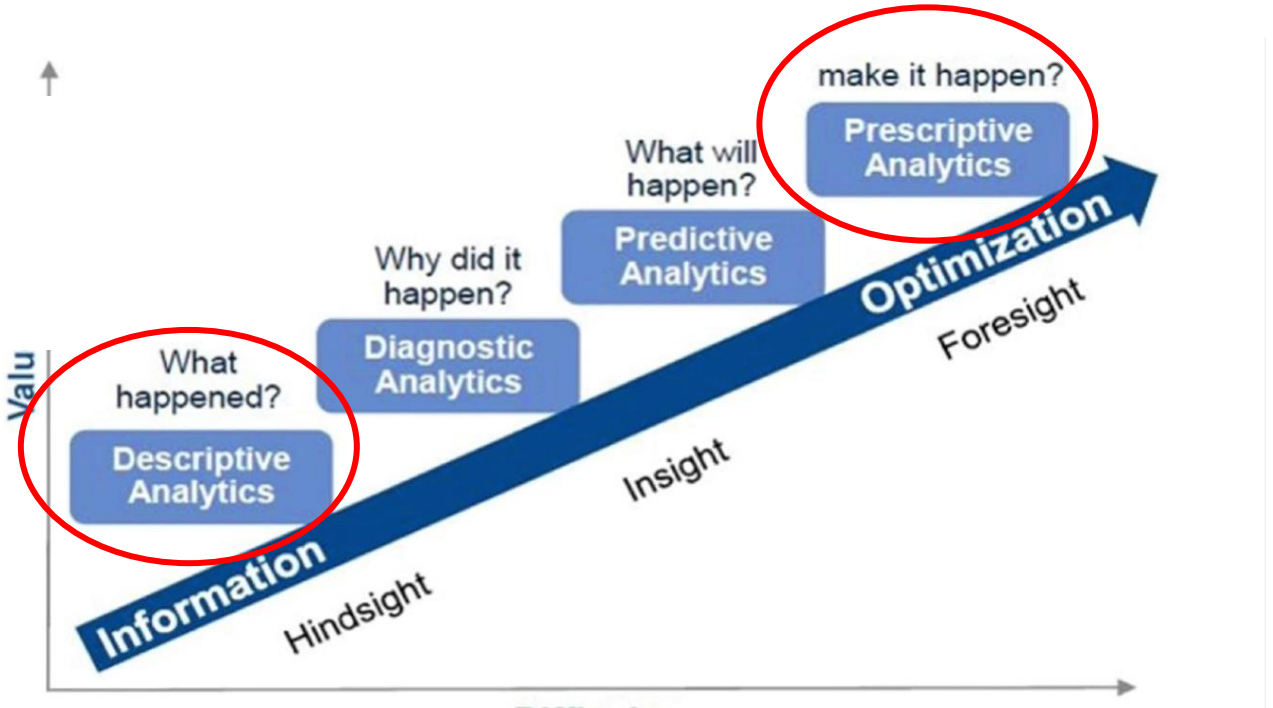
Future of Robotics

Systematic review

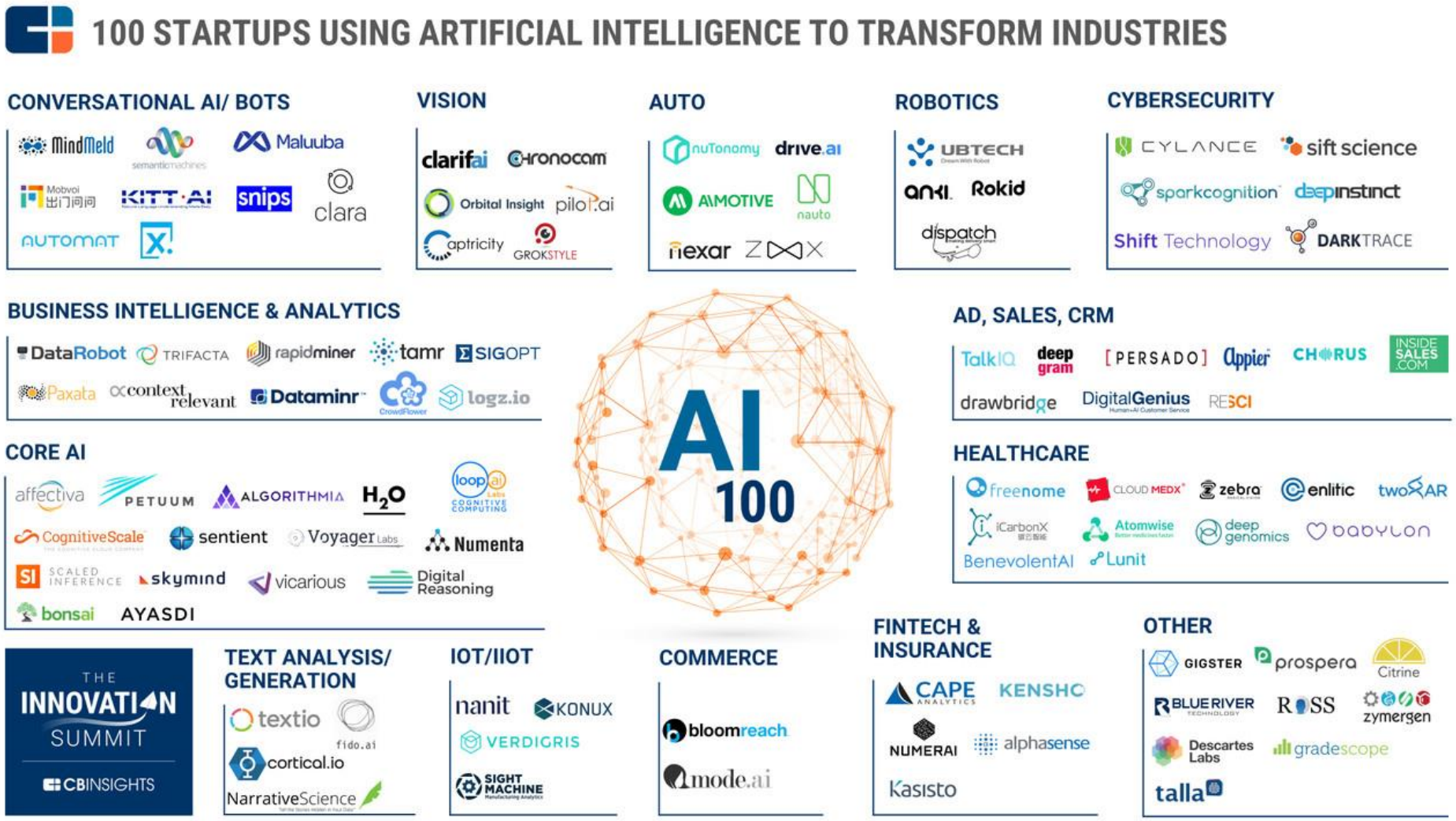
Predictive Models for Clinical Outcomes in Total Knee Arthroplasty: A Systematic Analysis

Cécile Batailler, MD [a, b, *], Timothy Lording, FRACS [c], Daniele De Massari, PhD [d], Sietske Witvoet-Braam [d], Stefano Bini, MD, PhD [e], Sébastien Lustig, MD, PhD [a, b]



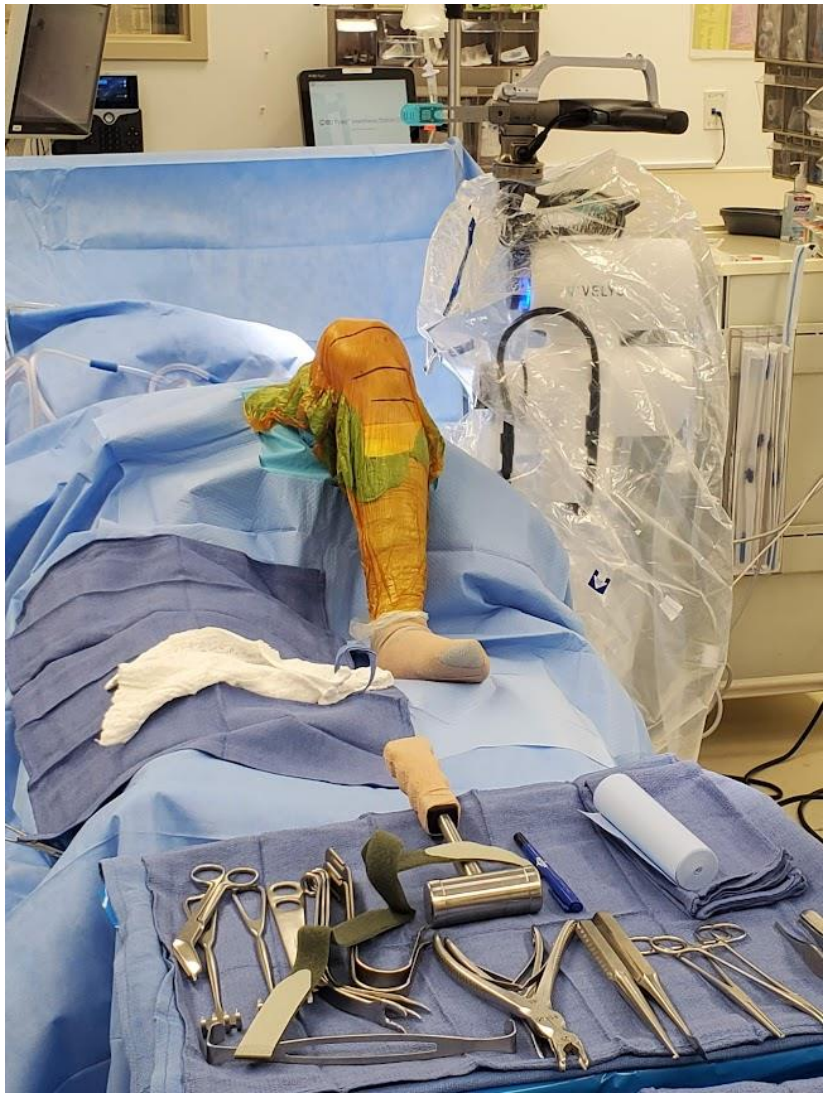


Future of Robotics = AI integration



Why Integrate Robotics into my practice?

- Data showed equivalence
- Understanding of TKA is changing
- Work with the technology to understand its potential
- Fellow Education

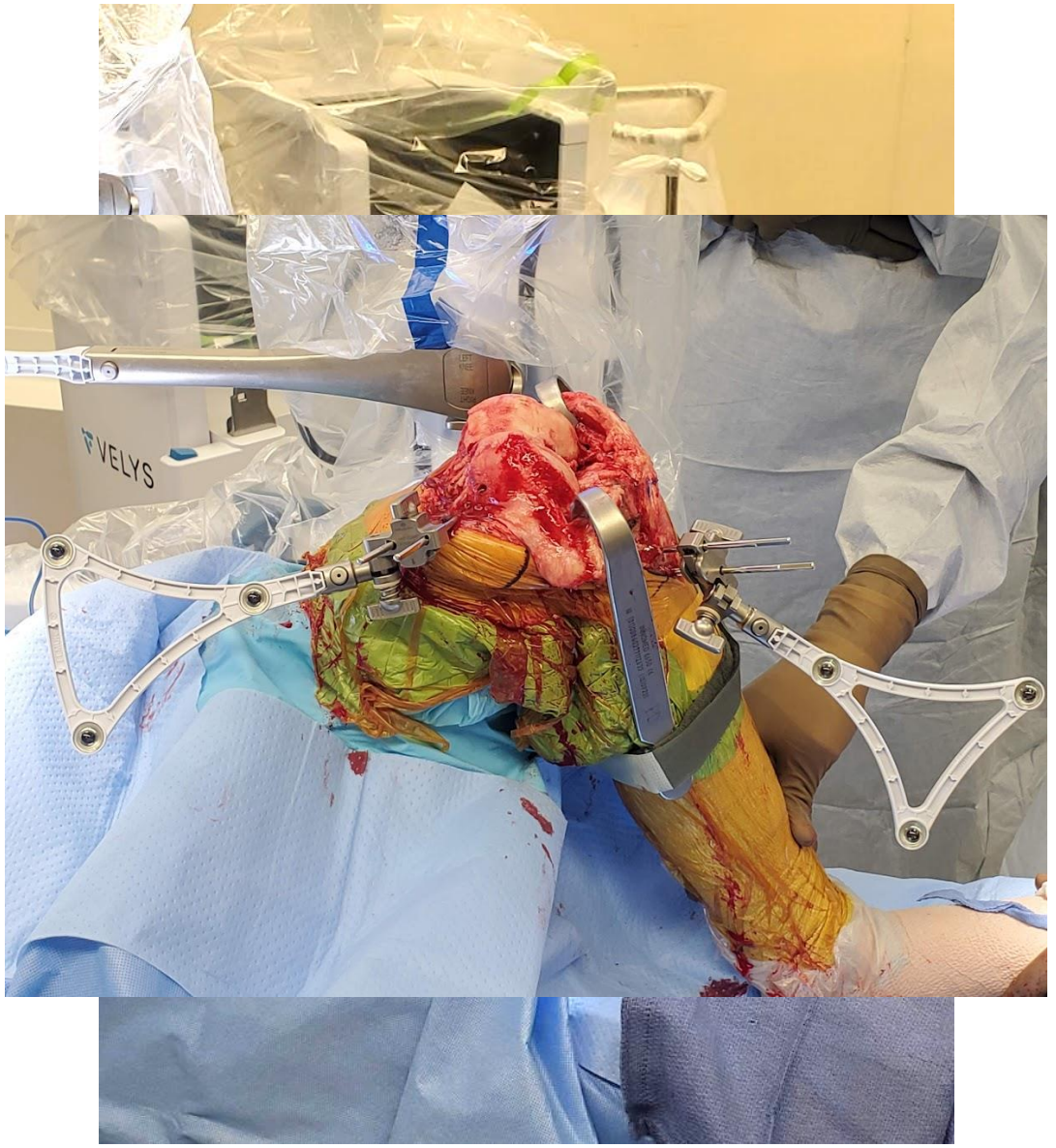


Lessons Learned: Room Setup

- Line of site
  - Camera Slightly more superior
  - Tubes and wires out of the way
  - Drapes down
- Assistant's Position
- Footprint of the robot

Lessons Learned: Exposure

- Array Pin Placement (intra vs extra incisional)
- Optical Array Positioning
- Retractors to accommodate
  - Self retaining retractors
- Do More up Front
  - Osteophyte removal
  - Soft tissue release
  - Patellar resection
  - Sublux Tibia



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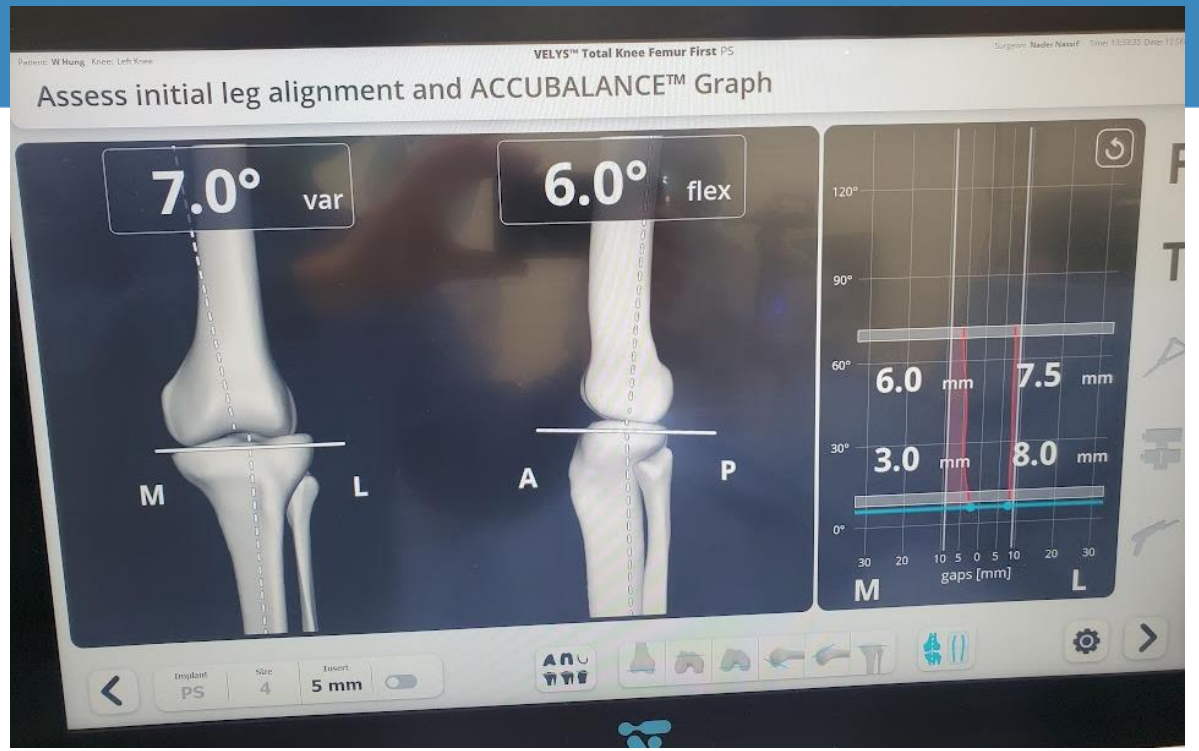
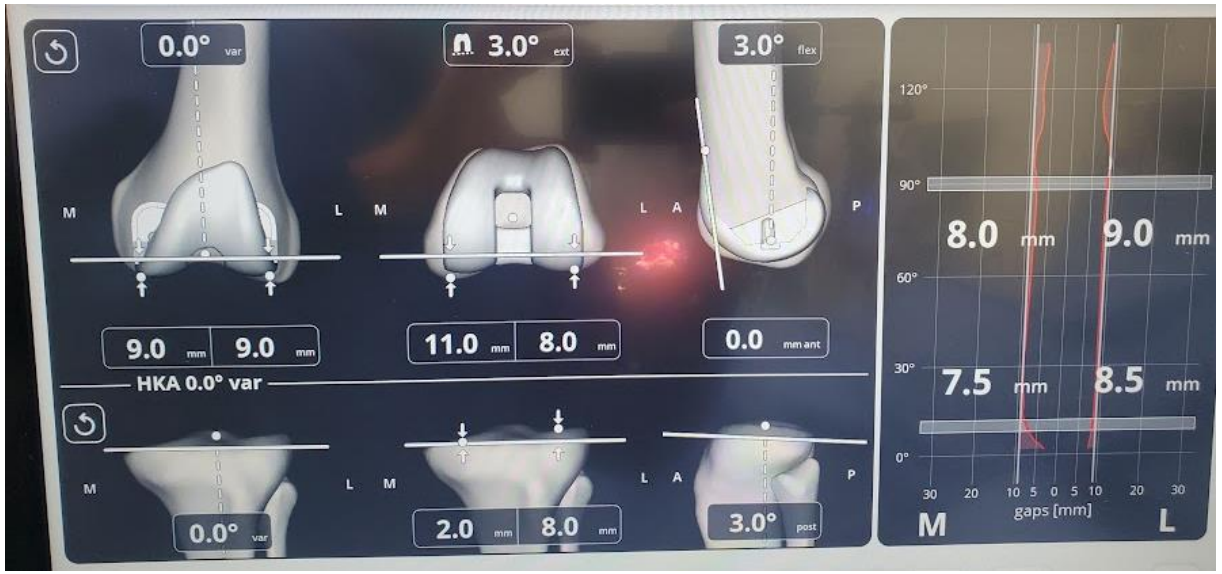
Managing Data Overload!

- Don't ignore fundamental understanding of the knee.
- Additional Data is both an advantage and disadvantage
  - Is the data accurate?
- Interpreting the data takes a little practice:
  - Evaluate the knee before looking at the numbers to make sure the numbers make sense
  - Ignore the full extension "J-curve"
  - The knee will get looser as the case goes on





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My Workflow

- Don’t chase numbers. Plan for the soft tissue releases!
- The plan is made before I make my first cut (femur first).
- Evaluate Balance in extension and flexion just like traditional instrumentation.

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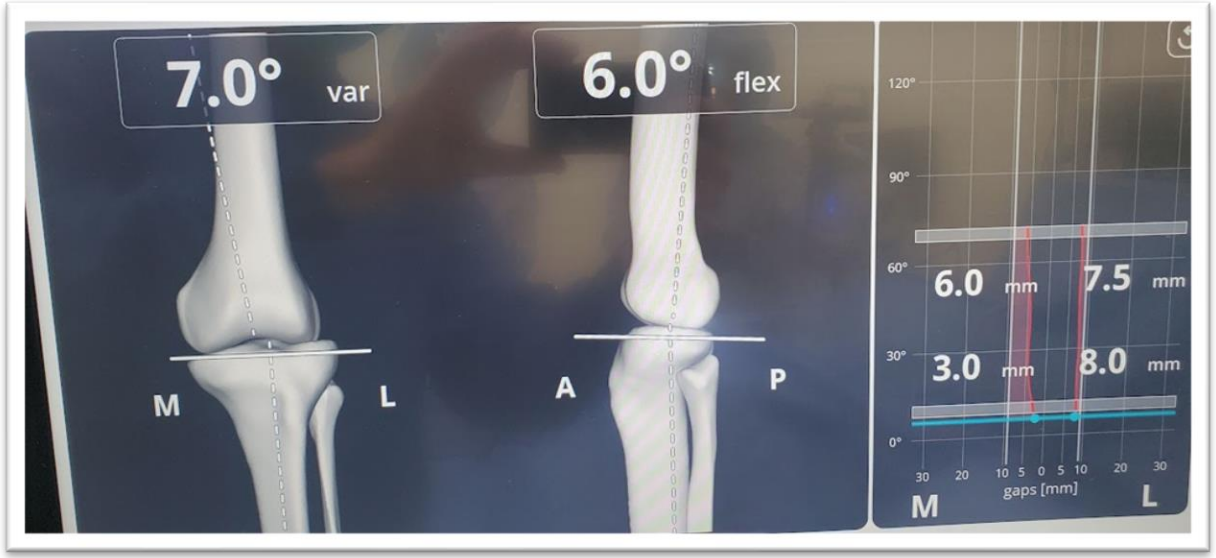
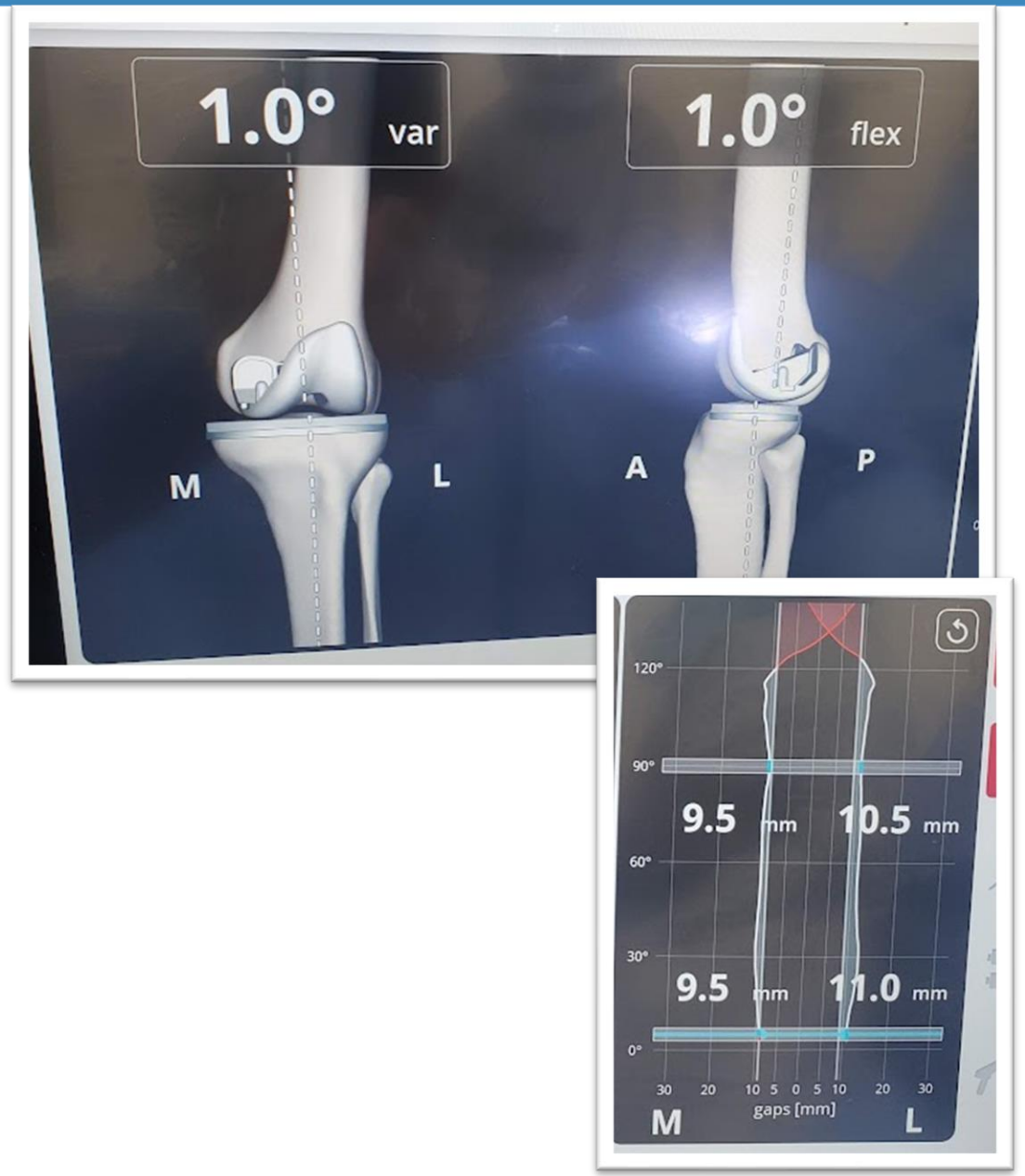
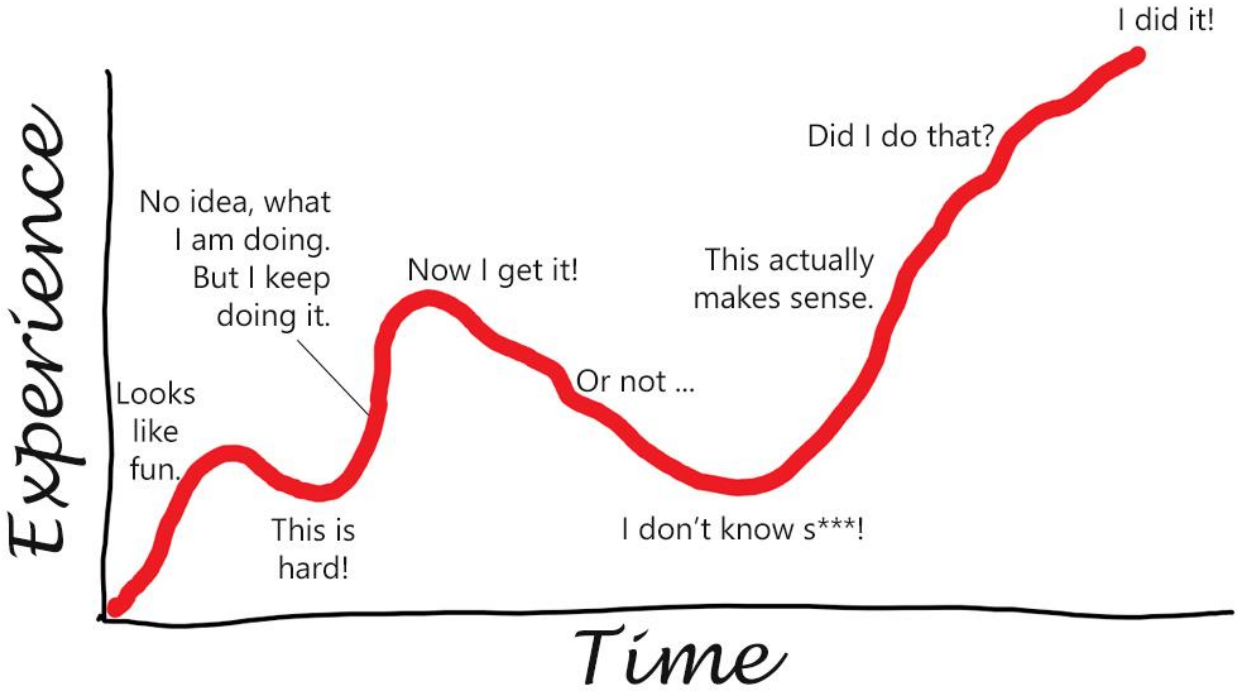
Before and After





The Learning Curve



- Each Robotic Knee System is unique but they have common elements.

- Learning Curve = 20 cases
  - J Orthop Surg Res. 2023 Jun 12;18(1):425
  - BMC Musculoskelet Disord. 2023 Apr 27;24(1):332 (18 cases)
  - ANZ J Surg. 2022 Nov;92(11):2974-2979. doi: 10.1111/ans.17975. Epub 2022 Aug 12.
  - Arthroplast Today. 2022 Jan 22;13:194-198

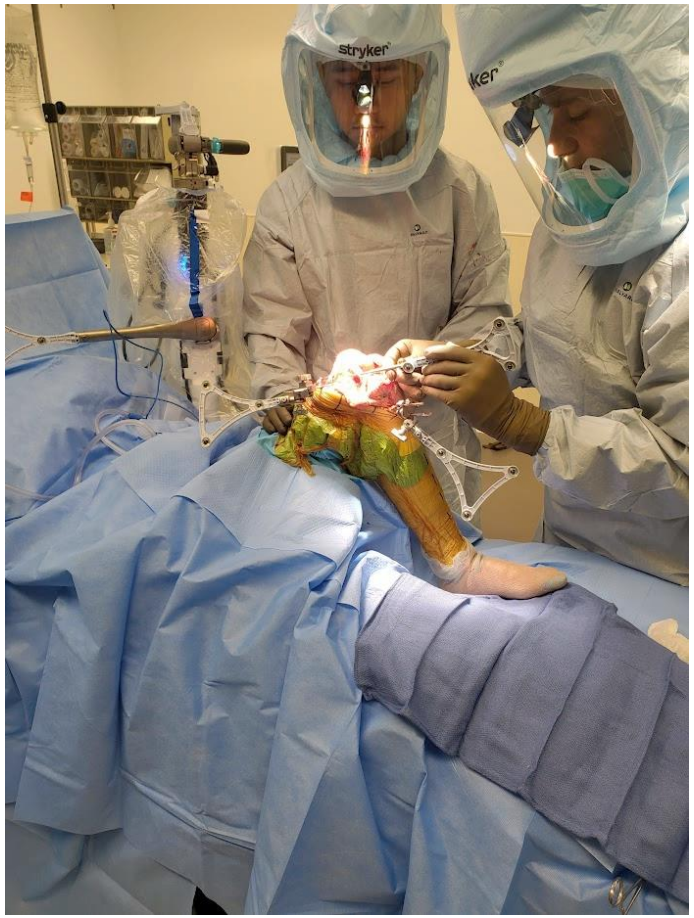
  - Eur J Orthop Surg Traumatol. 2023 Apr 27;1-7 (60 cases)

Gradually Increasing Complexity

- Mild Correctable Deformities
- Moderate Fixed deformities
- Post traumatic
- Severe deformities and Restricted ROM.

Training Ramifications for Residents

- Recent survey 20% of senior residents had rTKA as ›50% of their experience.
- 45% believed Robotics improved their understanding of the surgical procedures
- 25% felt it negatively impacted their learning of traditional instrumentation
- Residents did not significantly impact Surgical time.



Duensing et al JOA 2023

What happens when they go to fellowship

- There is a large variation in experiences with manual and robotic instrumentation before starting fellowship
- Fellowship applicants are asking about it
- Primary goal of Fellowship: To teach each fellows how to do a well balanced manually instrumented knee.
- Robotics can be a GREAT teaching tool :
  - Visualizing the knee balance graph
  - Improves their ability to do a better manual total knee
  - Getting through their learning curve faster and troubleshooting.
  - Robotics are NOT a substitute for learning how to do a traditional knee replacement

Take Home Points

1. **Robotics are no longer a fad.** They are an additional tool to achieve the goal of a perfect total knee reconstruction (whatever your philosophy is)

2. **rTKA is safe and efficacious.** Similar in short term outcomes

3. **Be Patient!** Learning curve is 20 knees

4. **Don't turn off your Brain!** Combination bony resection and soft tissue release

5. Fellows still need to **be proficient at manual instrumentation.**

Thank You

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