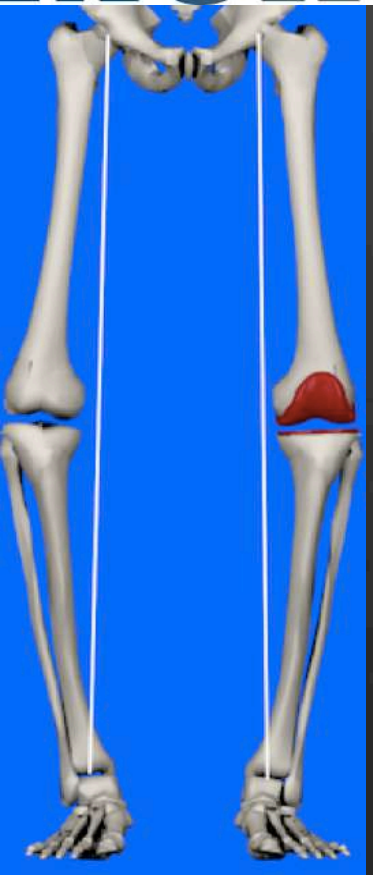
MSk LAB

Imperial College London



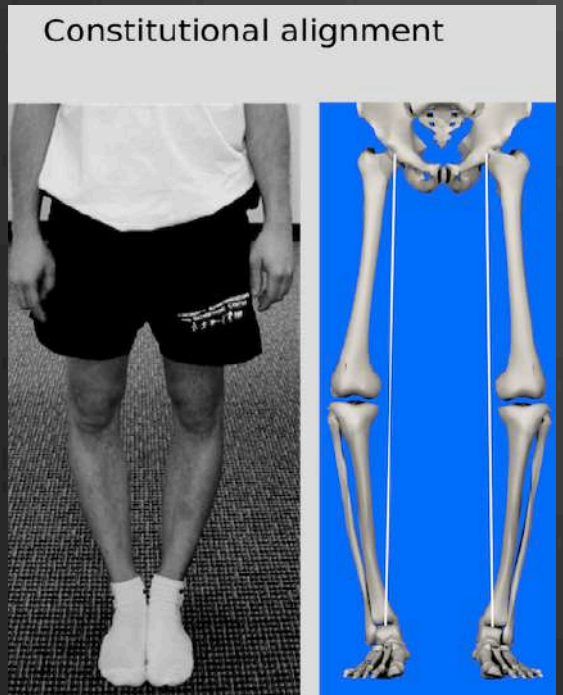
Kinematic Alignment Technique For TKA

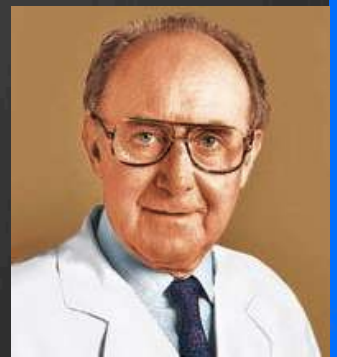
Charles C.J Rivière

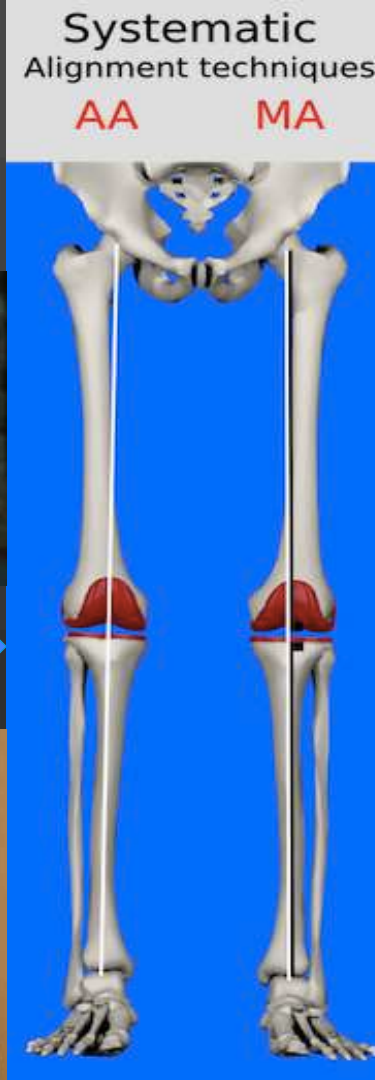
ISTA 2019 - Keynote

What have we done so far?

- Systematic approaches







What have we done so far?

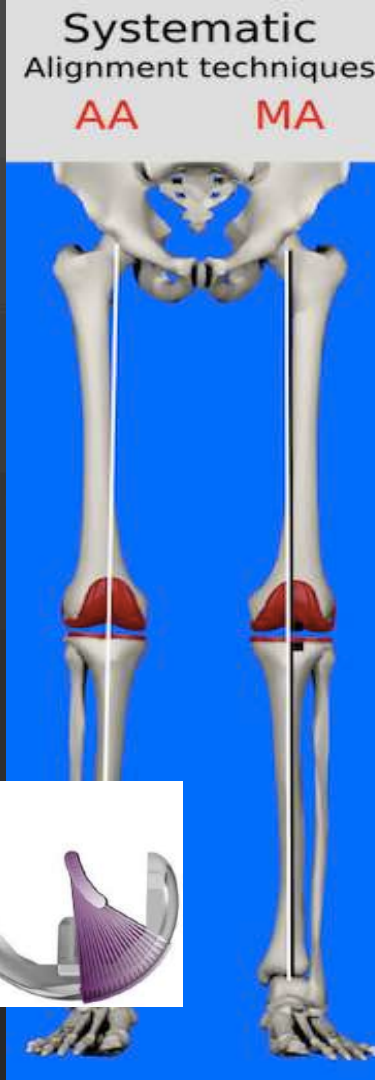
- Systematic approaches
- ➢ Poor functional outcomes !

- Dissatisfaction 10 to 20%
- Residual symptoms > 50%
  - *residual pain 33%*
  - *stiffness 41%*
  - *swelling or tightness 33%*
  - *knee 'normal feeling' 66%*
  - *difficulty with stairs 54%*

What have we done so far?

- Systematic approaches
- ➢ Poor functional outcomes !

  - ~~Lack of precision ?~~
  - ~~Poor implant design ?~~



What have we done so far?

- Systematic approaches
- ➢ Poor functional outcomes !
  - ~~Lack of precision ?~~
  - ~~Poor implant design ?~~

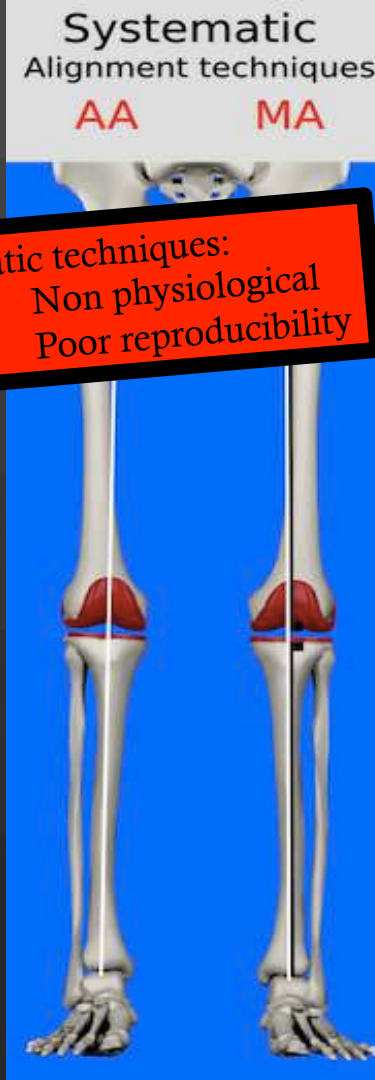
…Intrinsical limitations ?

…Intrinsical limitations ?

1. No respect of constitutional knee anatomy:
   - FT joint
   - PF joint

2. No respect of physiological knee laxity
   - FT joint
   - PF joint

3. Technically demanding
   - Soft tissue balance
   - Aligning F component with TEA



Solution ?

- New implants alignment

Orthopaedics & Traumatology: Surgery & Research xxx (2017) xxx–xxx

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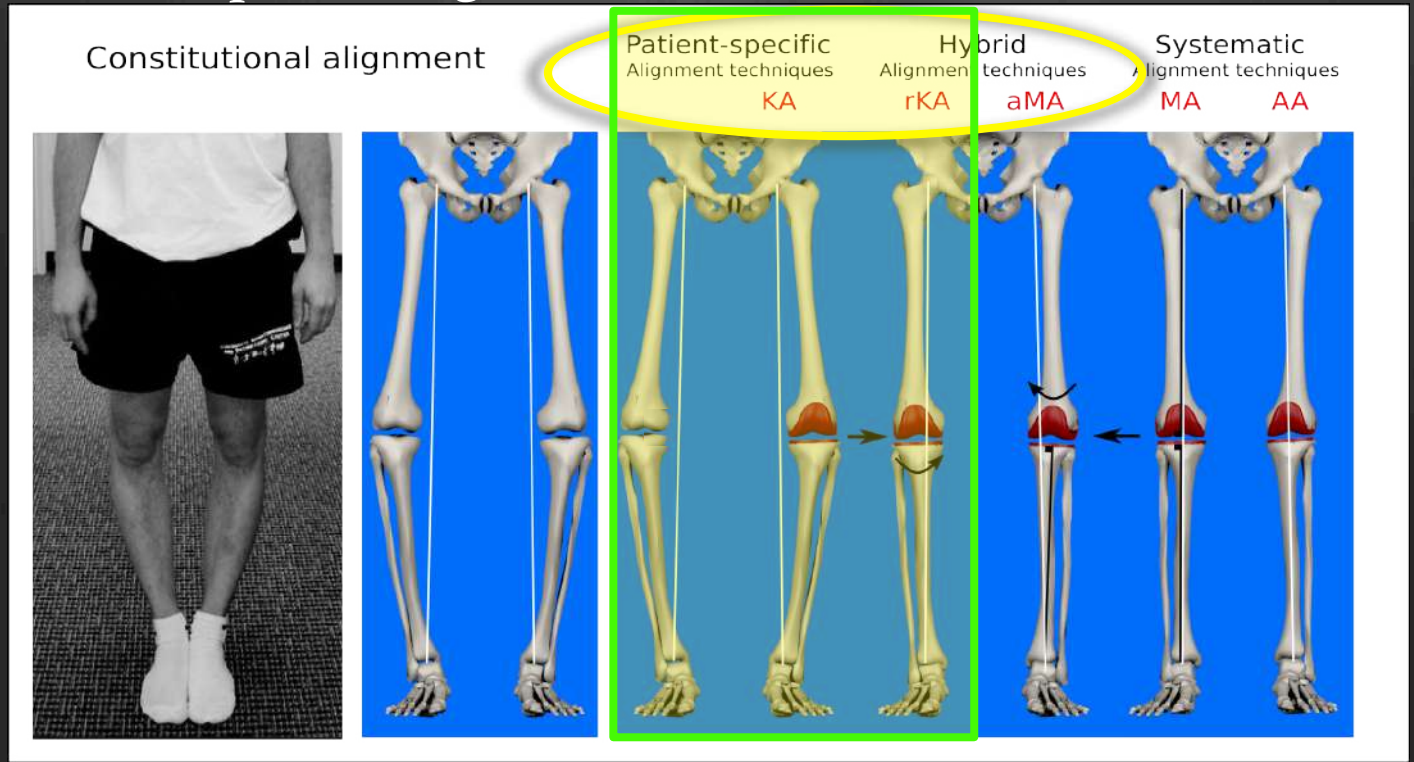
Review article

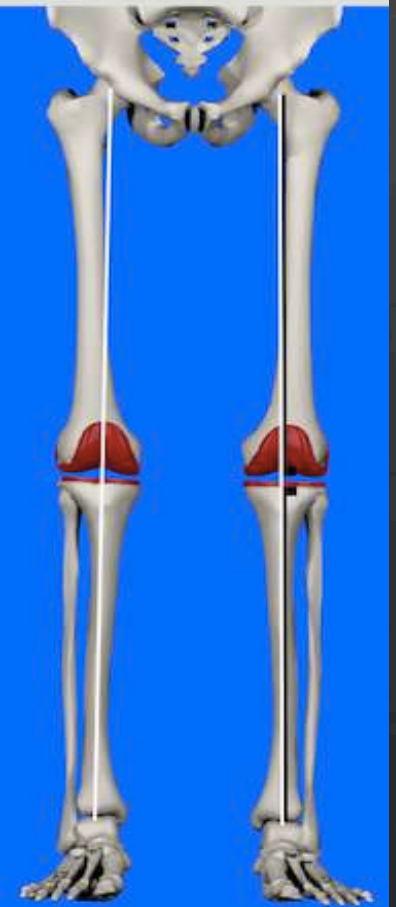
Alignment options for total knee arthroplasty: A systematic review

C. Rivière[a,*], F. Iranpour[a], E. Auvinet[a], S. Howell[b], P.-A. Vendittoli[c], J. Cobb[a], S. Parratte[d]



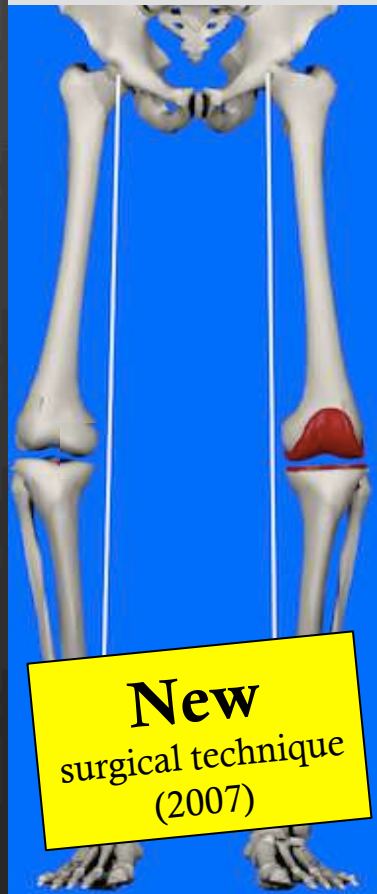
Systematic
Alignment techniques

AA MA



Patient Specific
Alignment techniques

KA



	MA technique "systematic approach"		KA technique "patient specific approach"
F flexion	similar		
F distal cut	perpendicular to femoral mechanical axis	≠	parallel to frontal femoral slope after correction of wear
F posterior cut	- external rotation/PCL - measured resect° or gap balancing	≠	- neutral rotation/PCL - measured resection tech only
T frontal cut	perpendicular mechanical axis of tibia	≠	parallel to frontal tibial slope after correction for wear
T slope	2 to 7° posterior slope	≠	slope of medial plateau
T rotation	towards ATT	≠	parallel to axis of lateral plateau

New
surgical technique
(2007)

Systematic
Alignment techniques

AA MA

Patient Specific
Alignment techniques

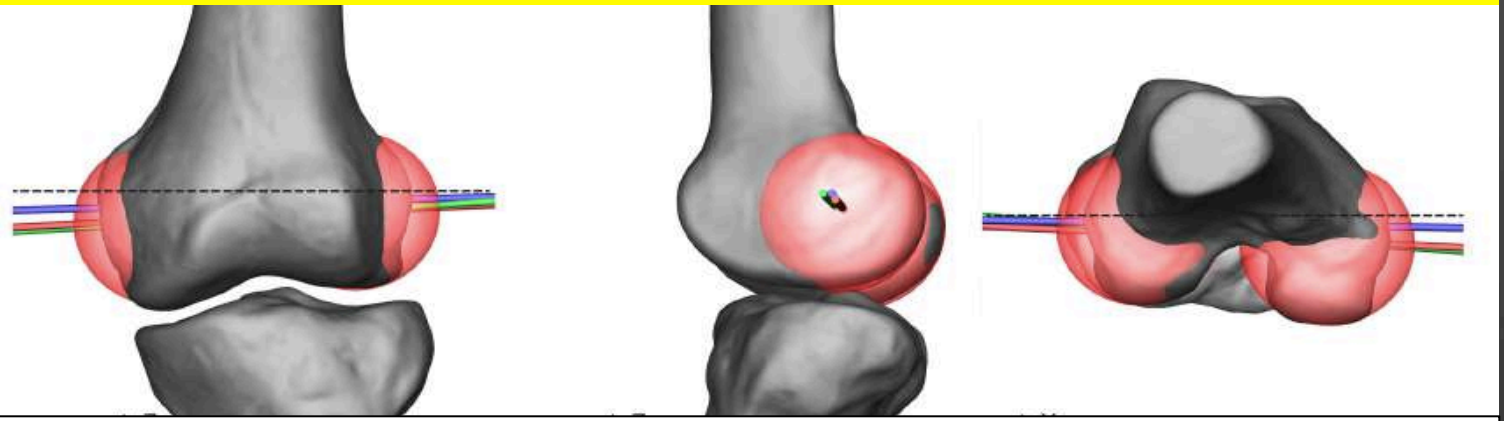
KA

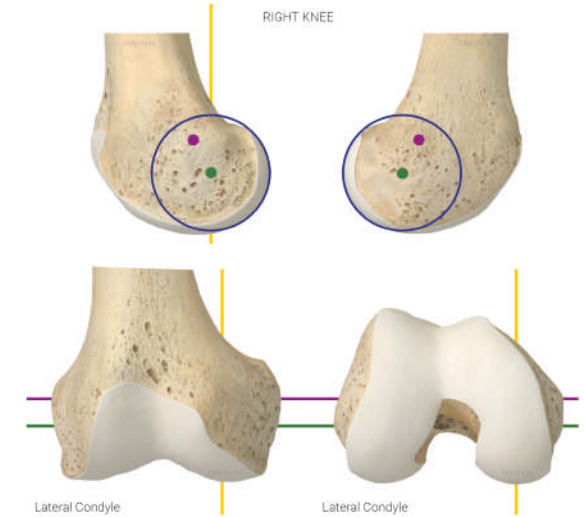
Makes everyone the same

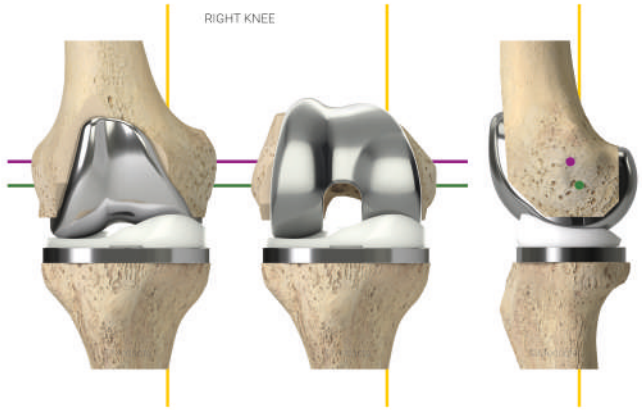
Keeps everyone unique

(2007)

Cylindrical Axis (trans-condylar)

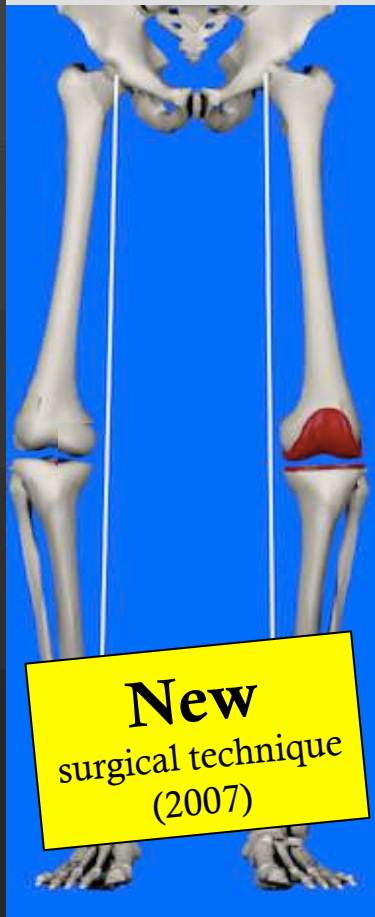






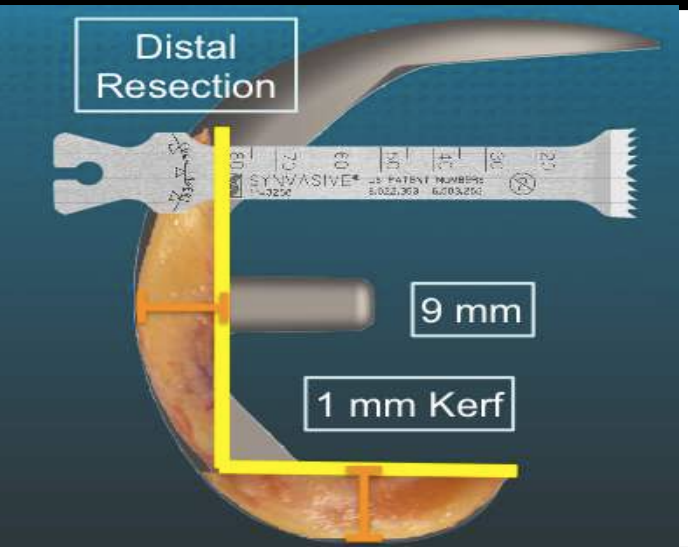
Patient Specific
Alignment techniques

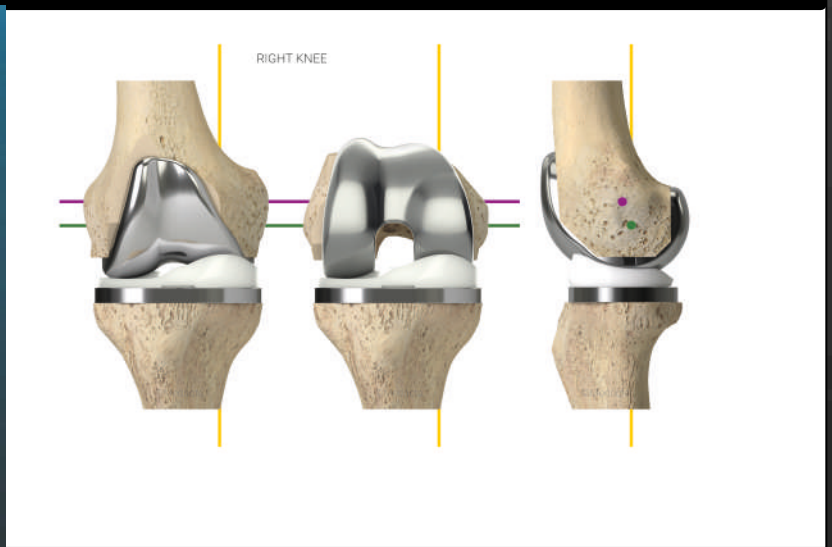
KA



New
surgical technique
(2007)

-True Knee Resurfacing
-No Ligaments release





Patient Specific
Alignment techniques

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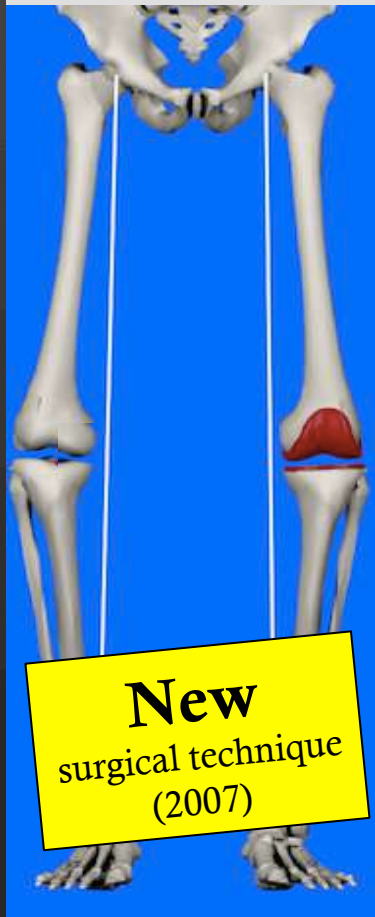
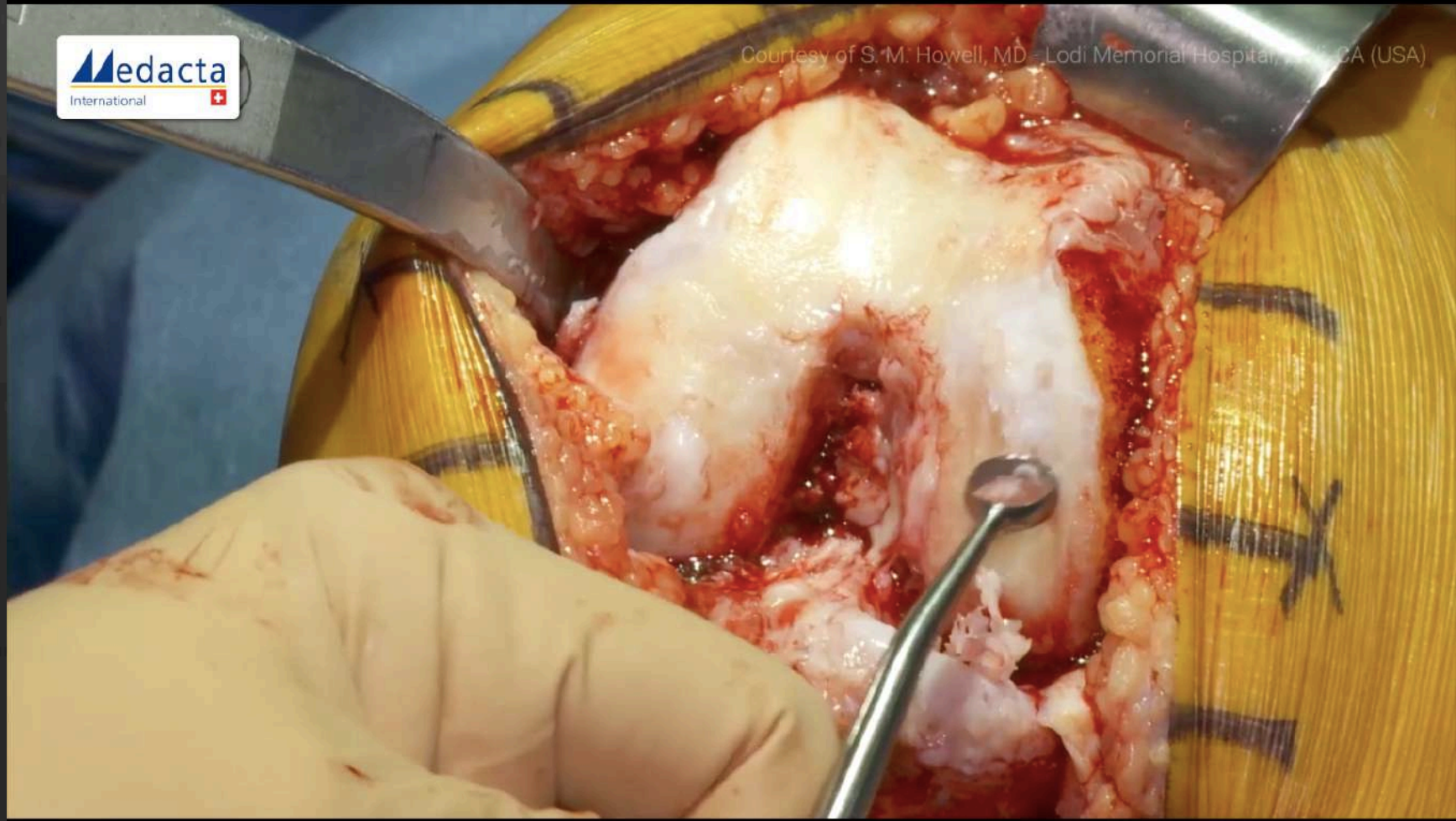


New
surgical technique
(2007)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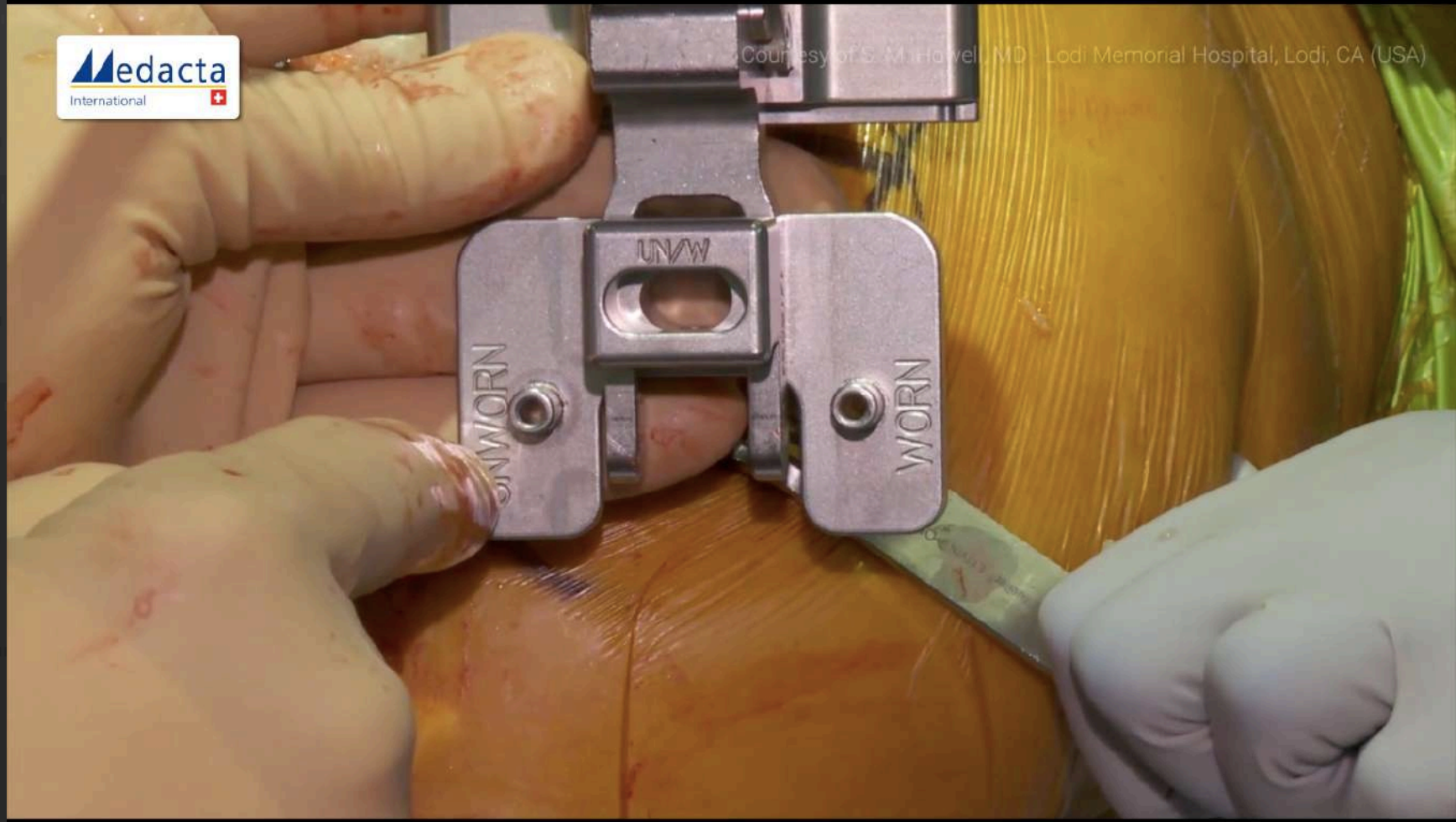
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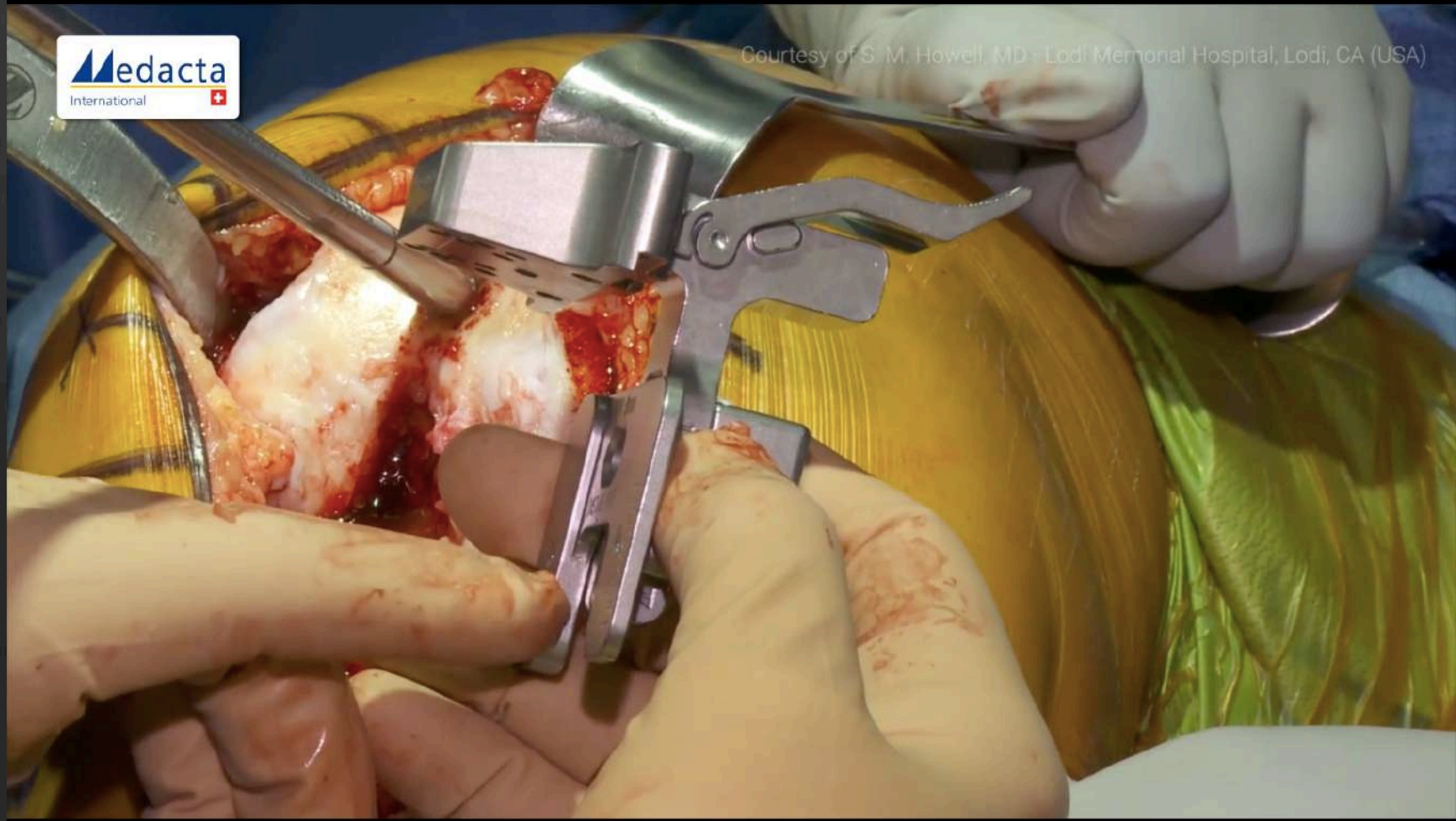
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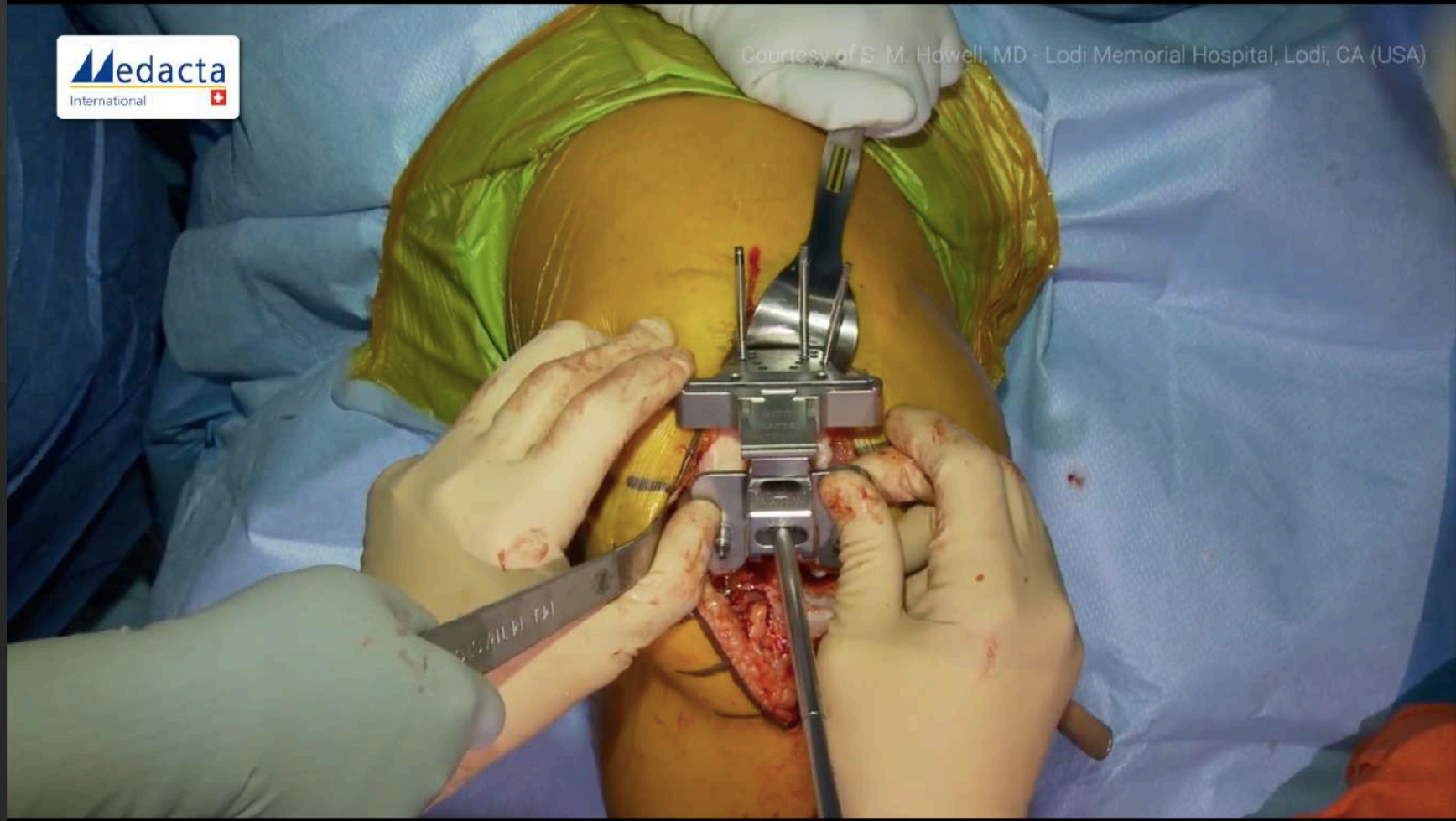
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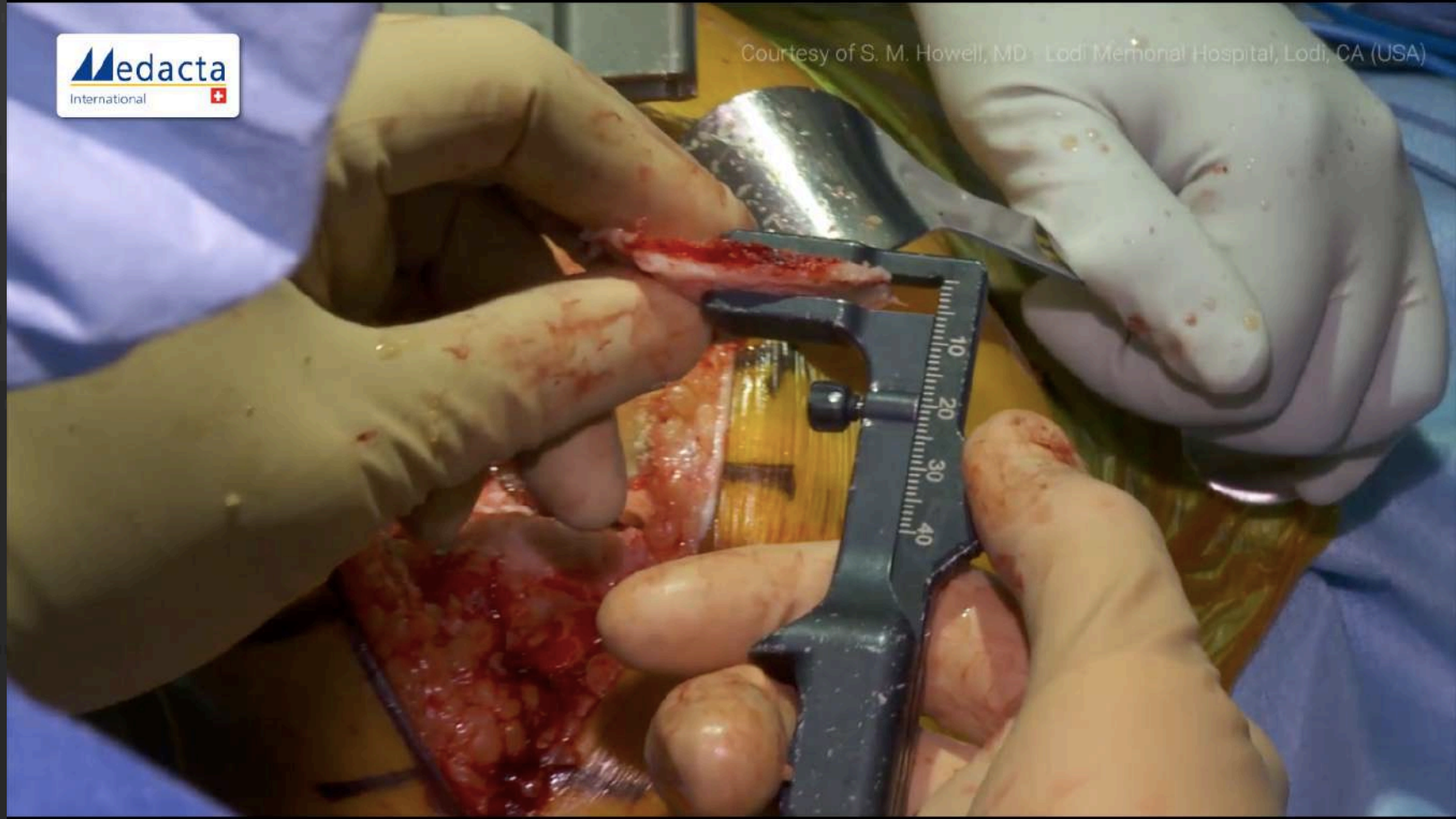
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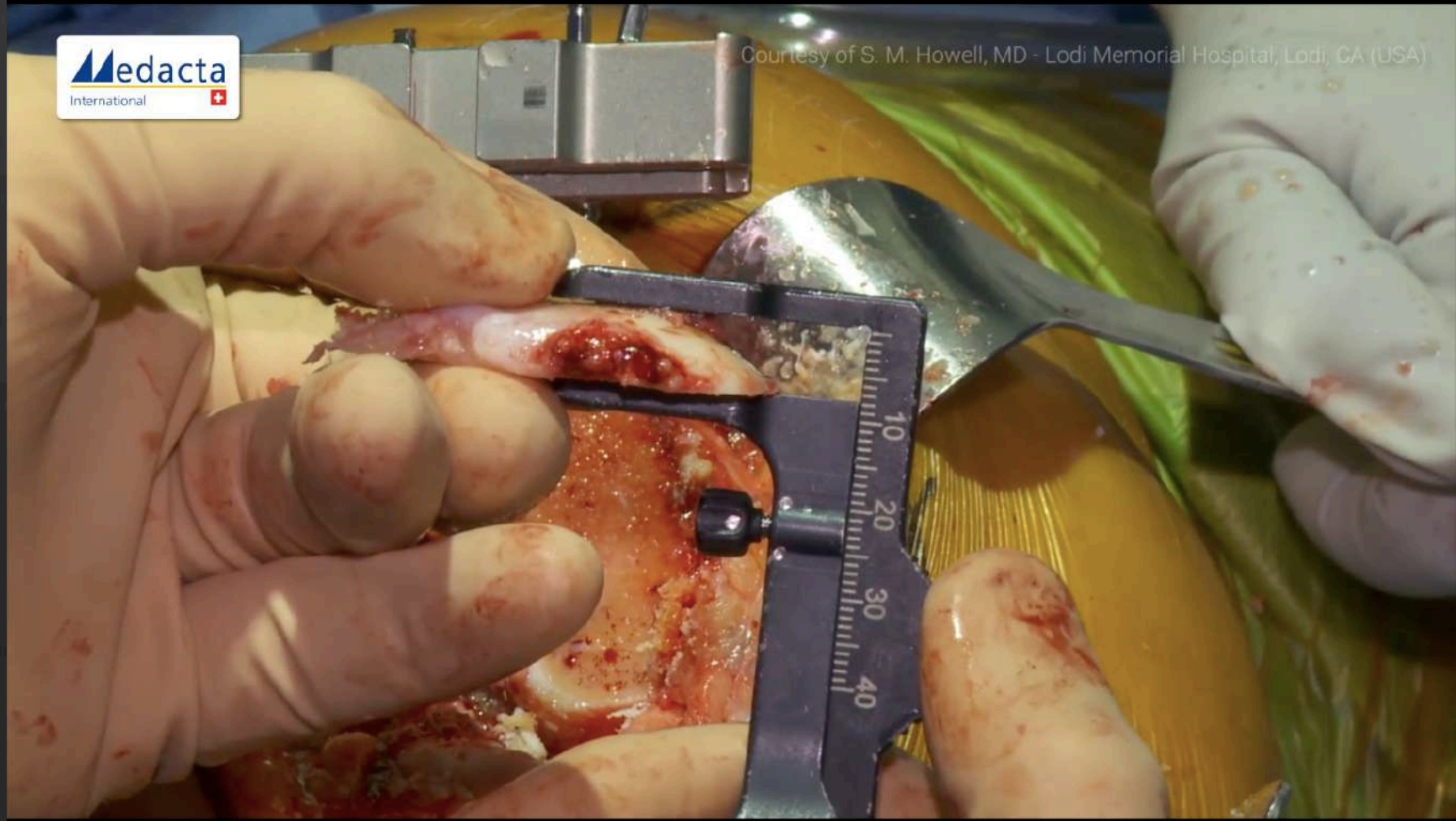
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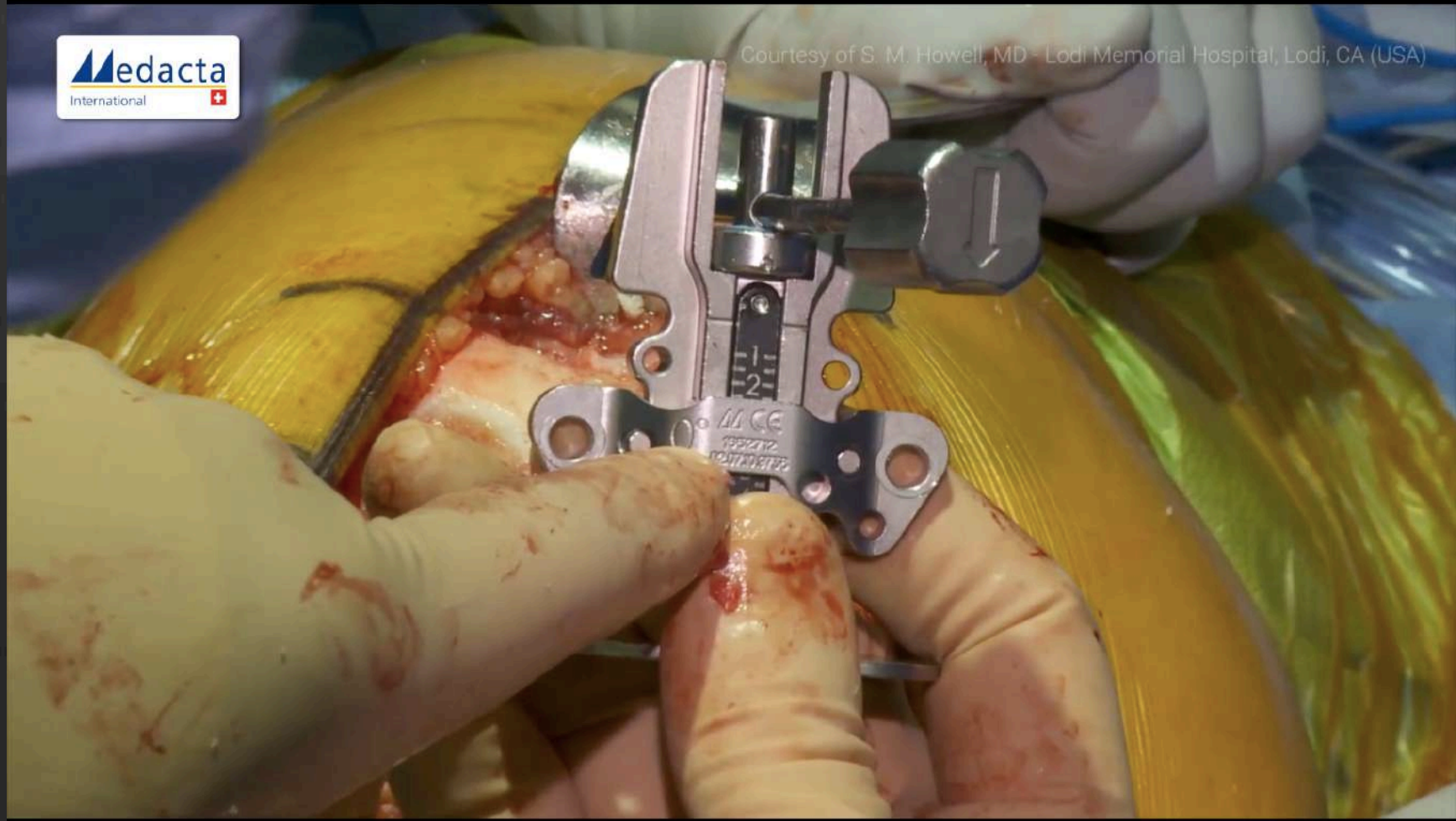
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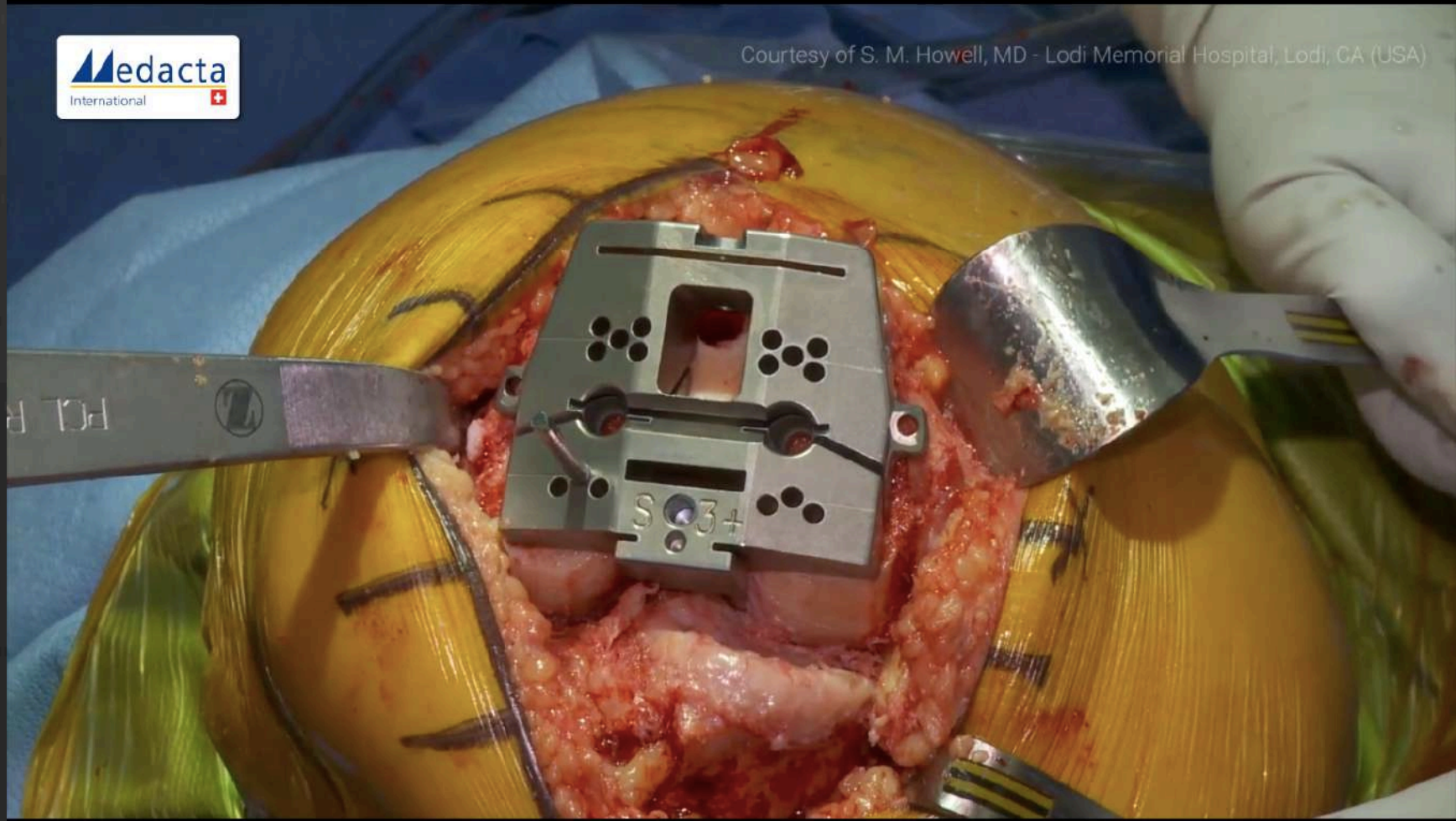
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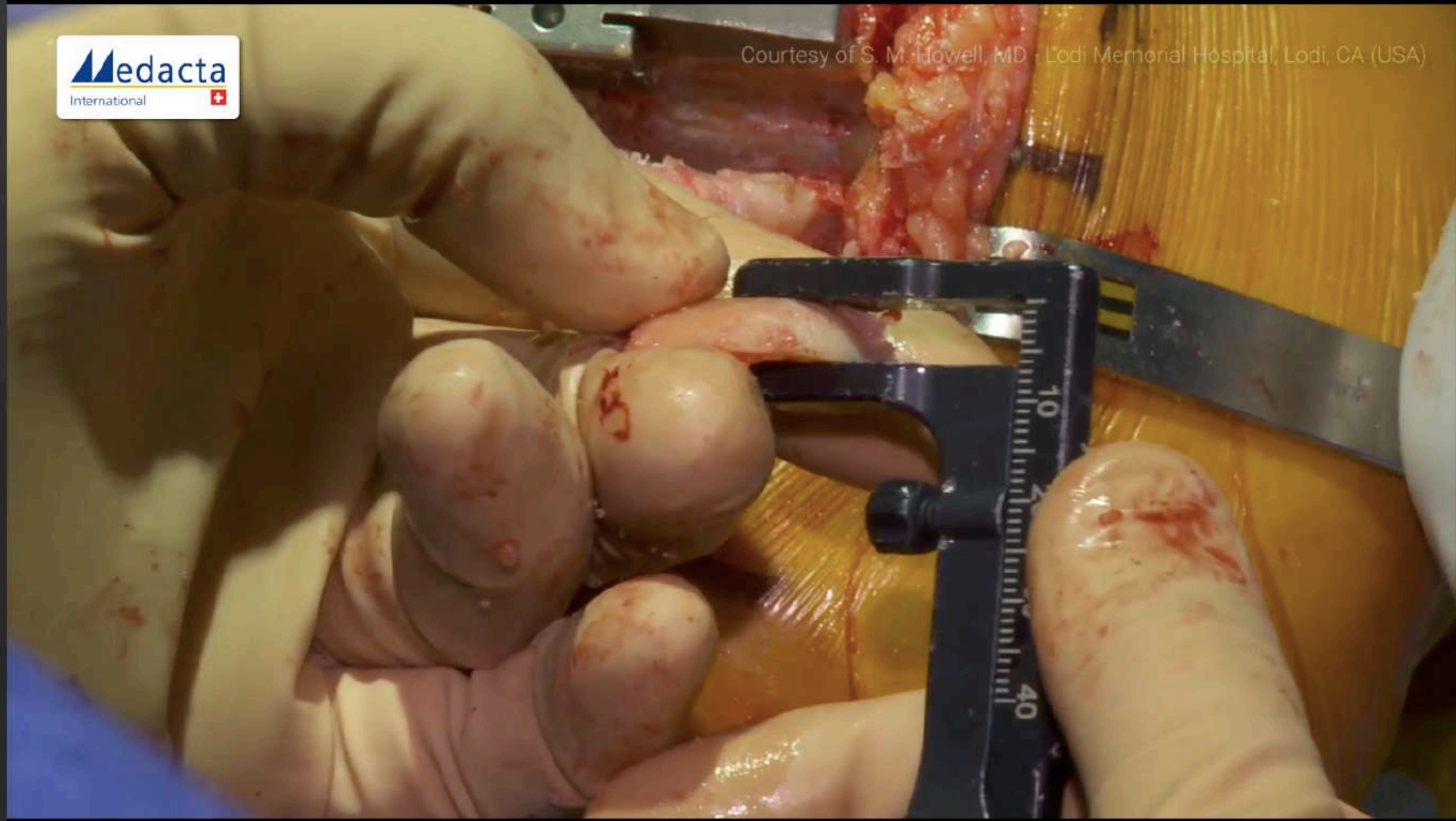
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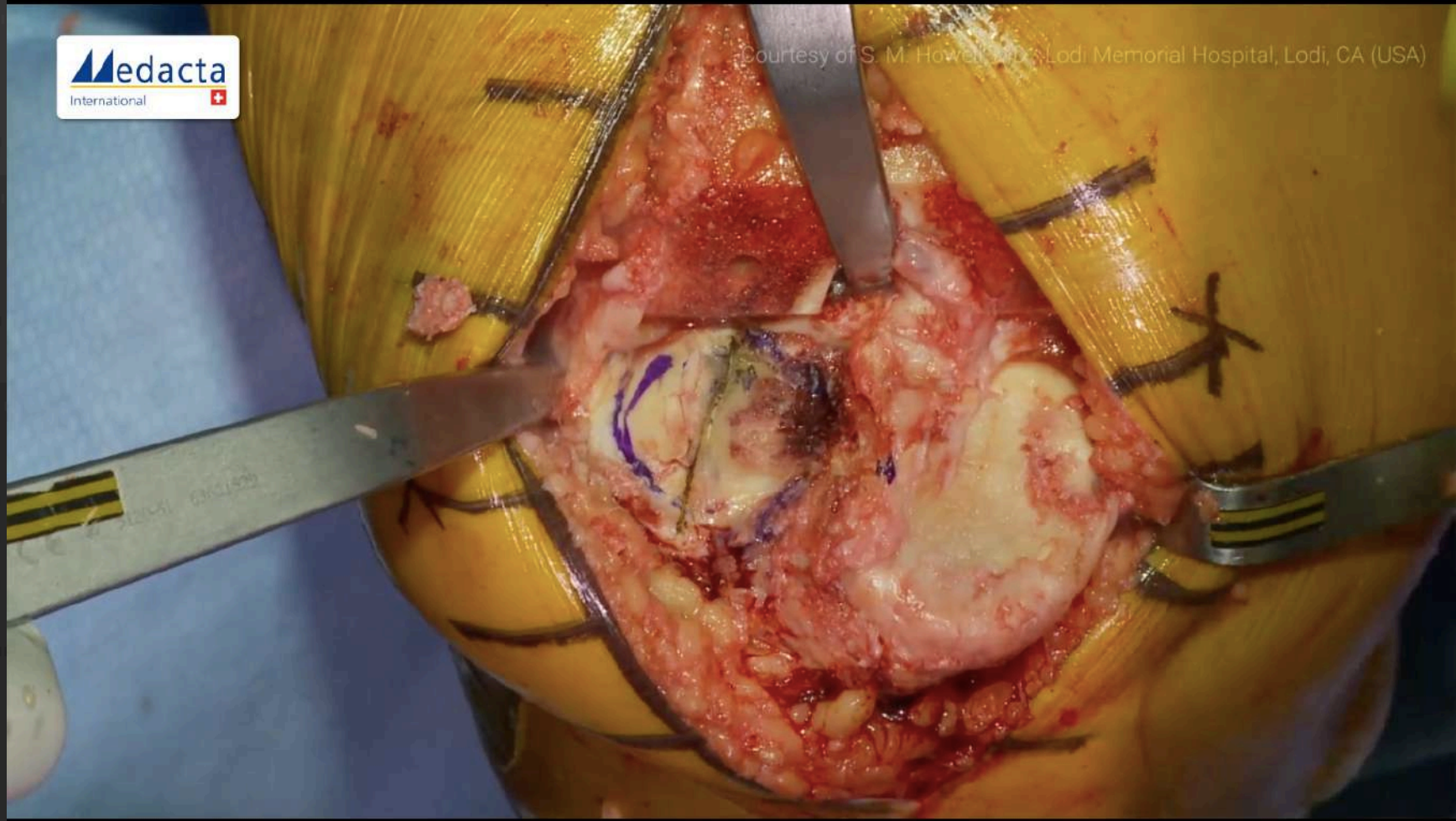
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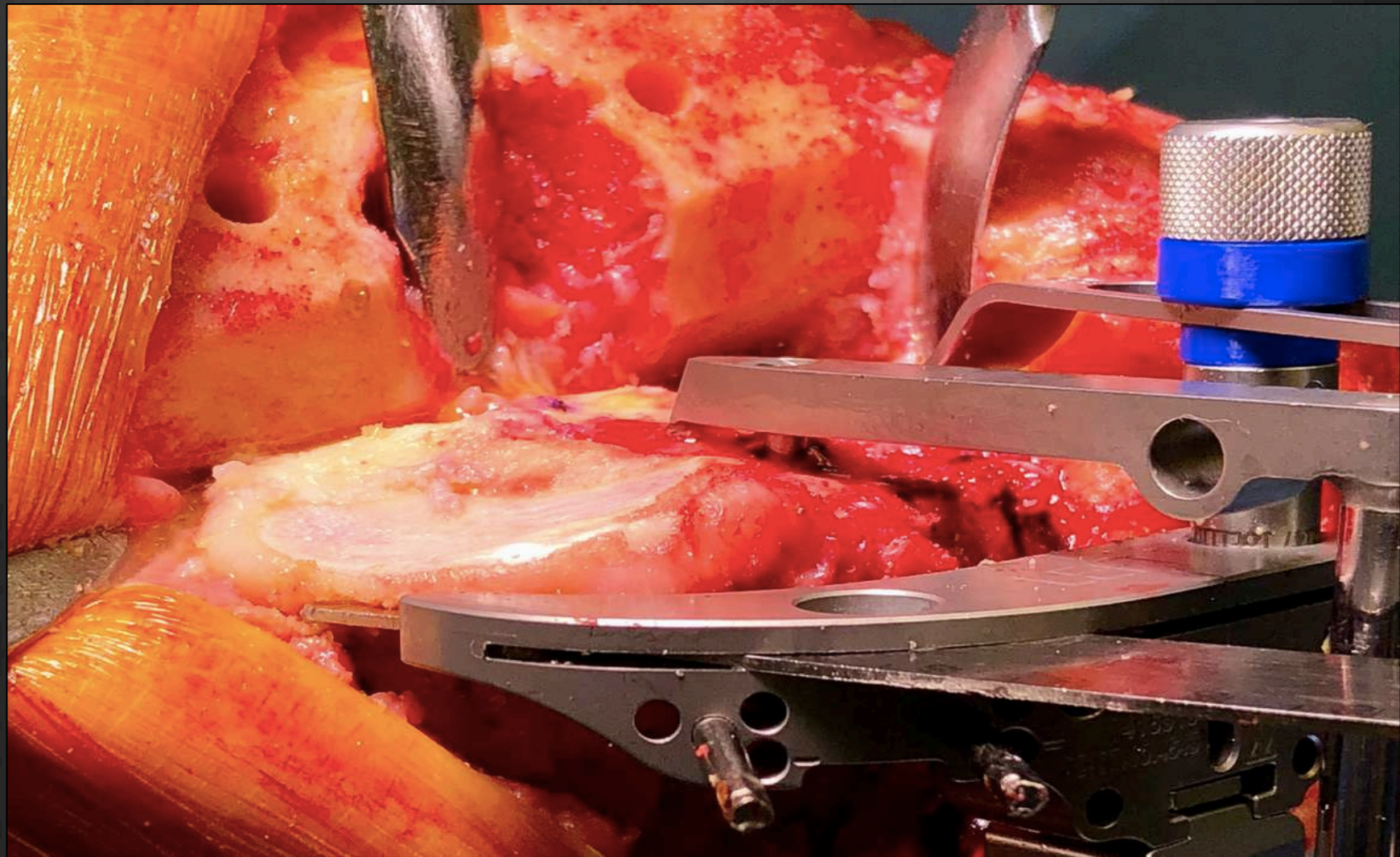

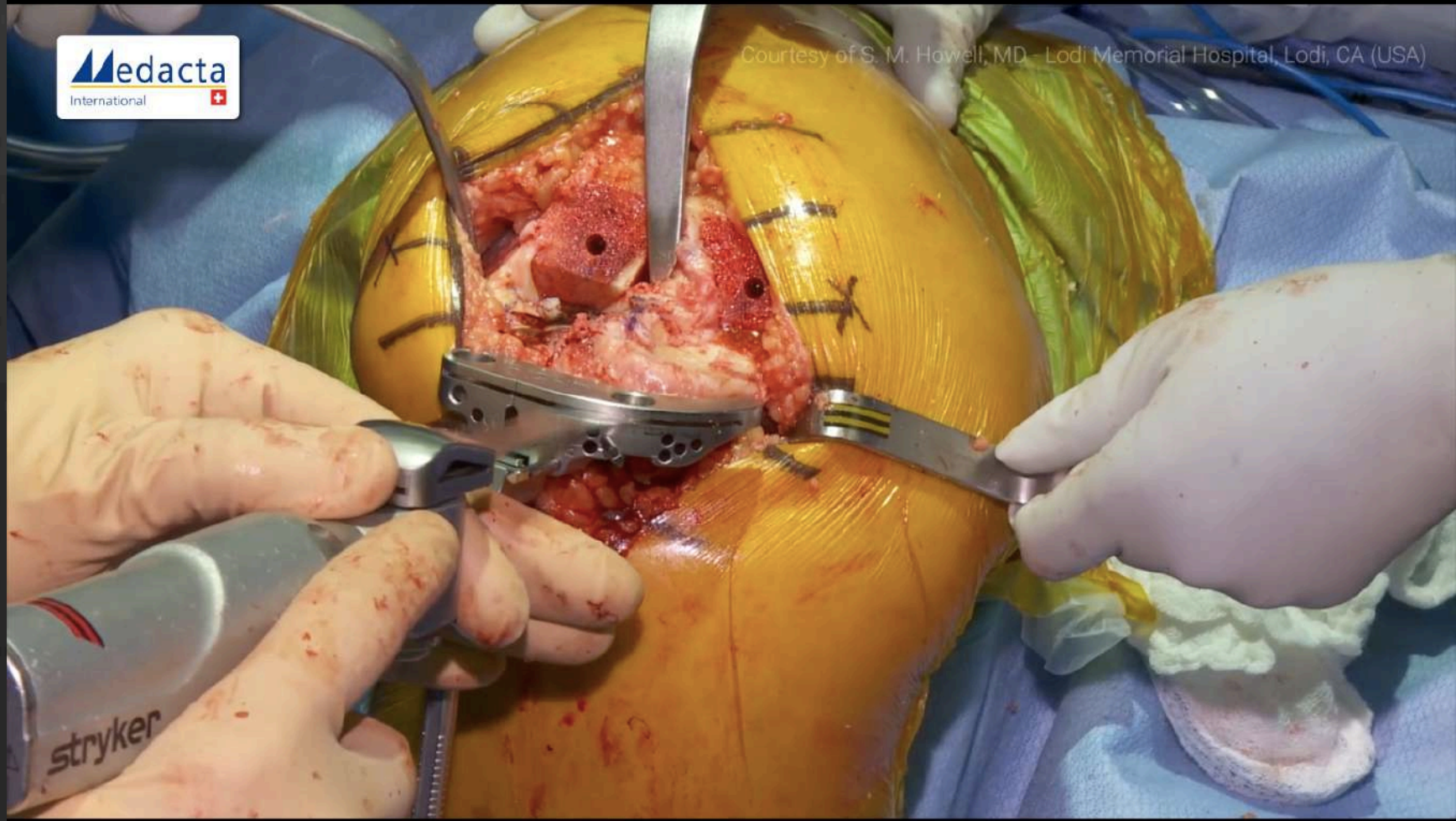
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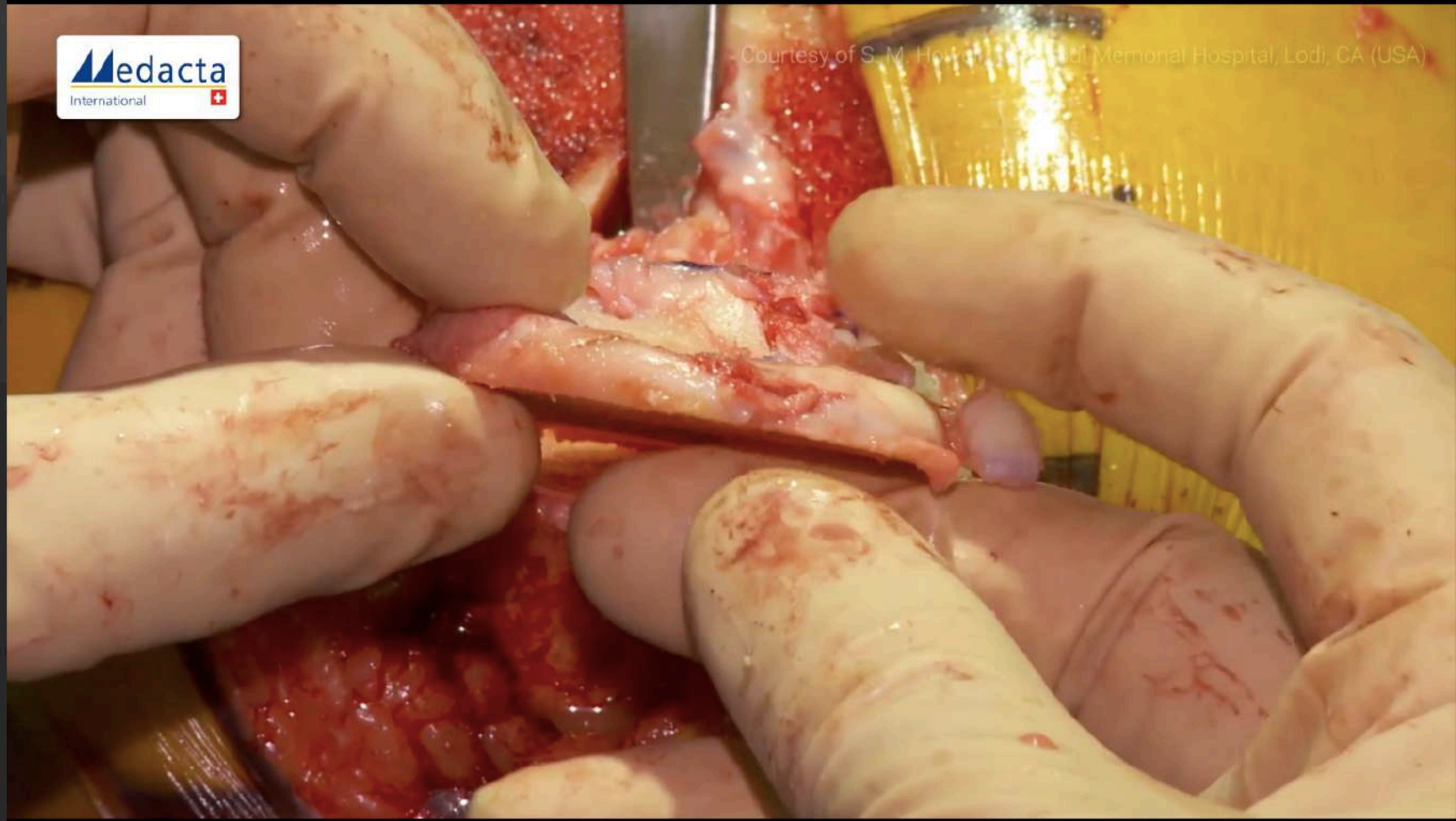
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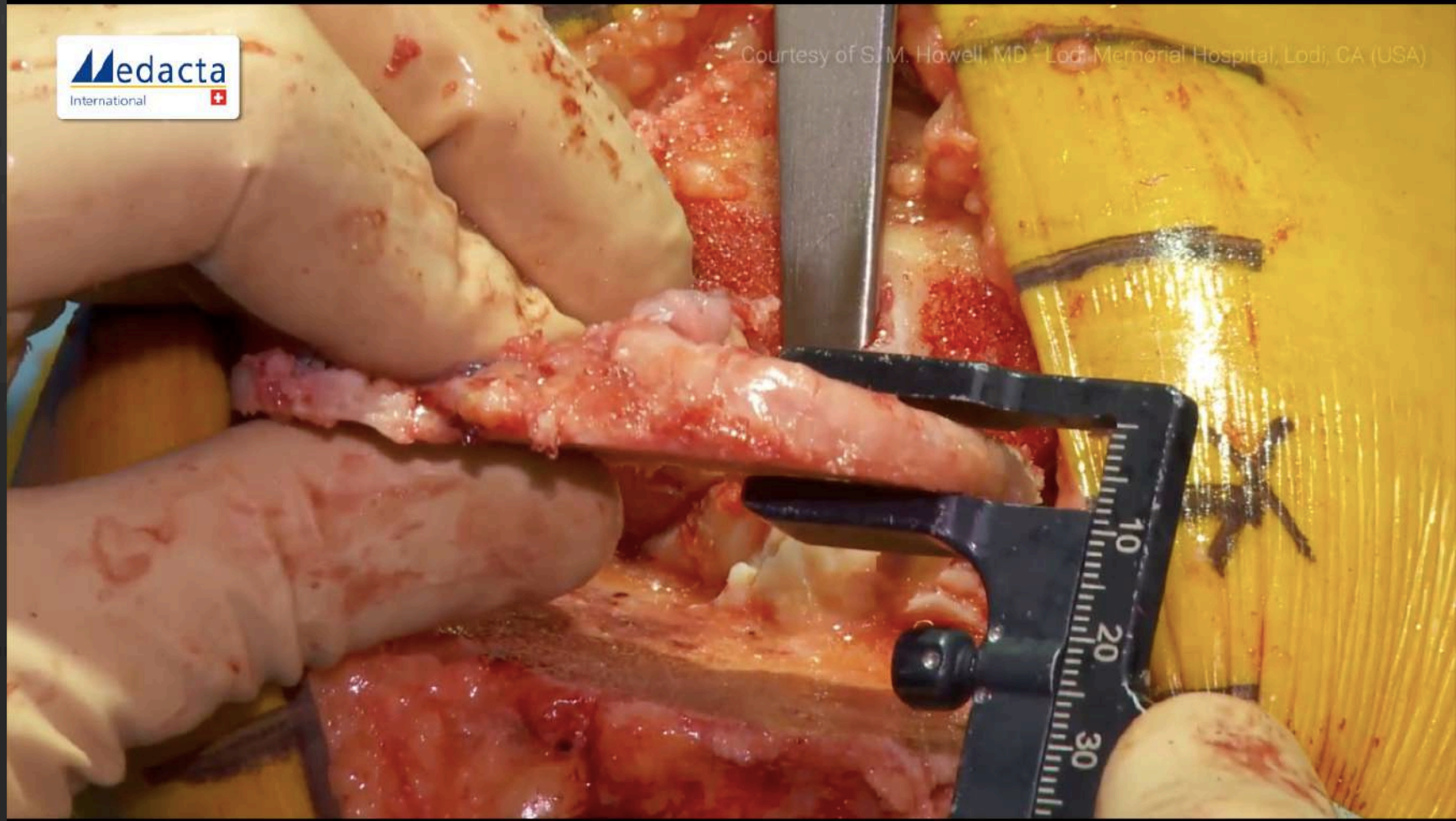
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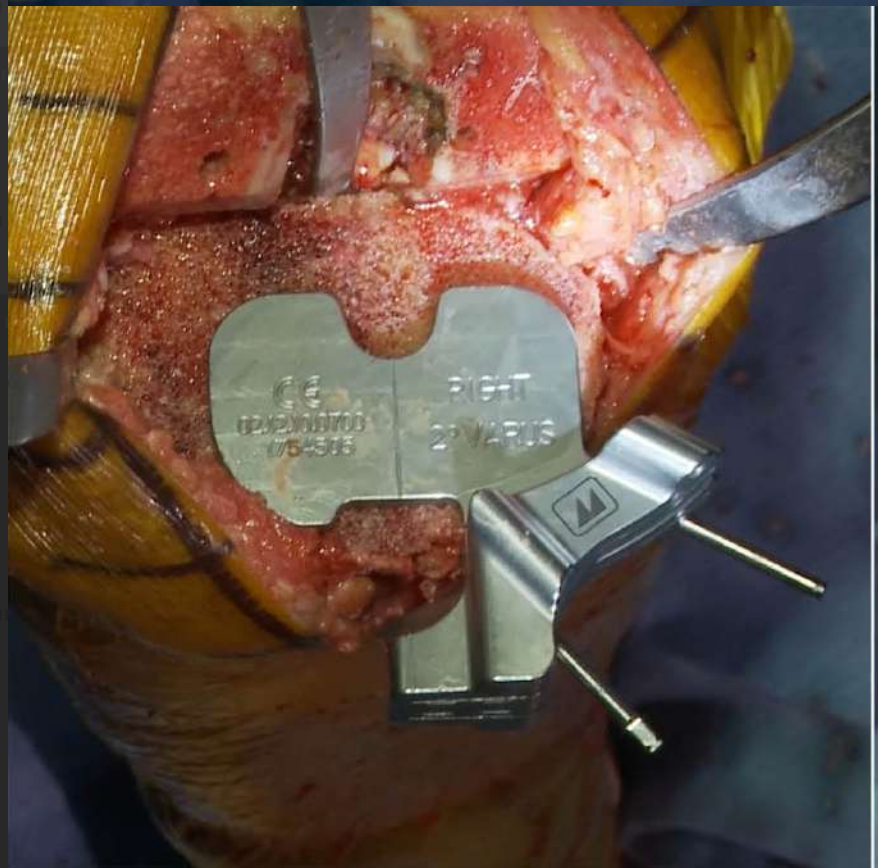

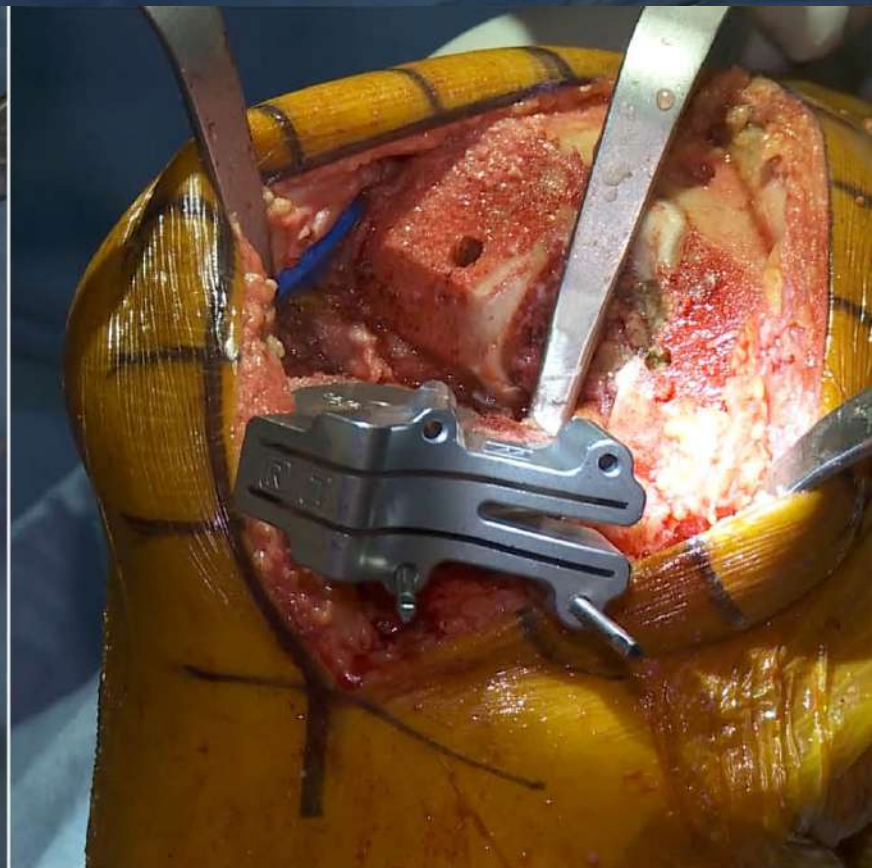

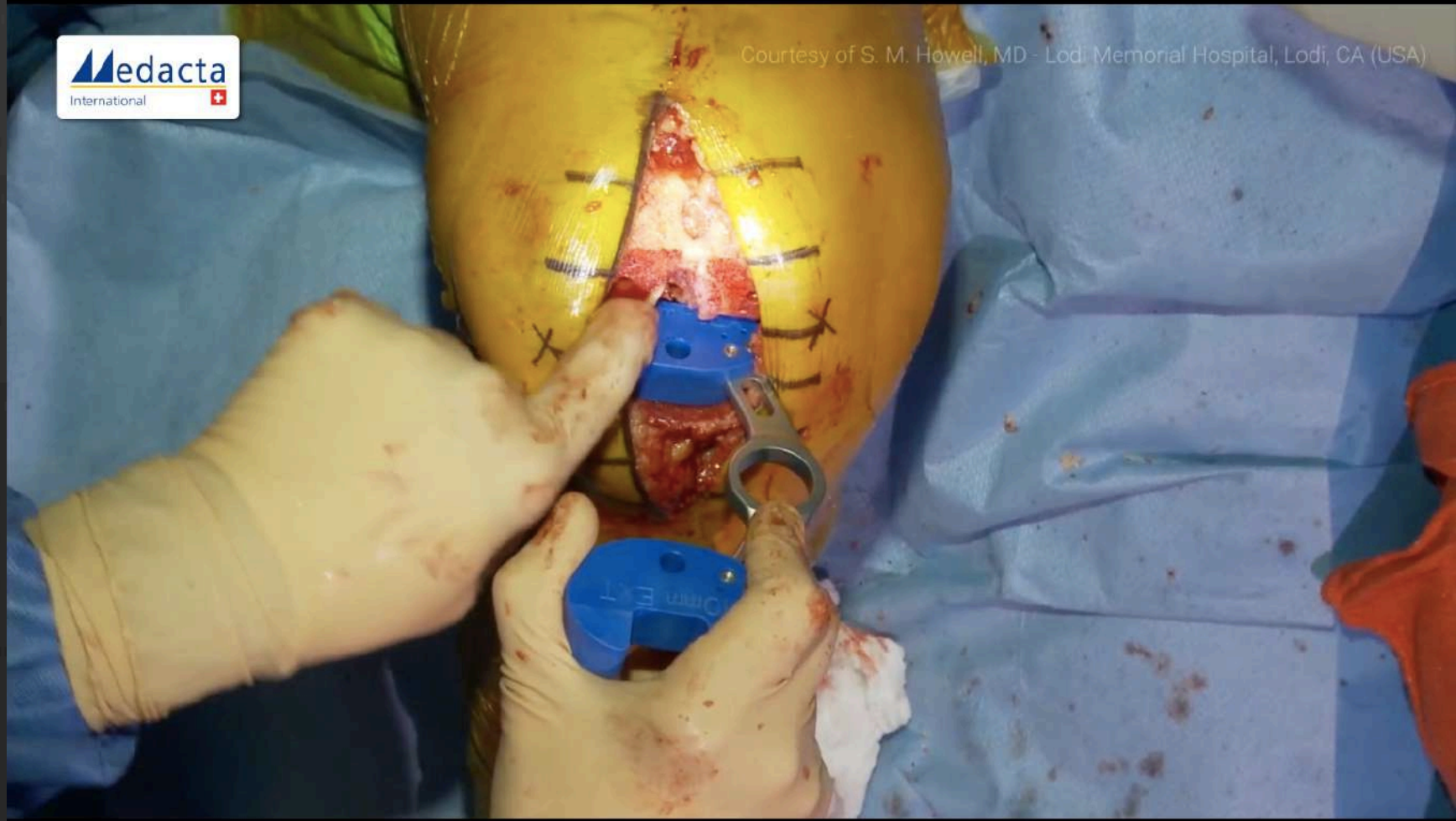
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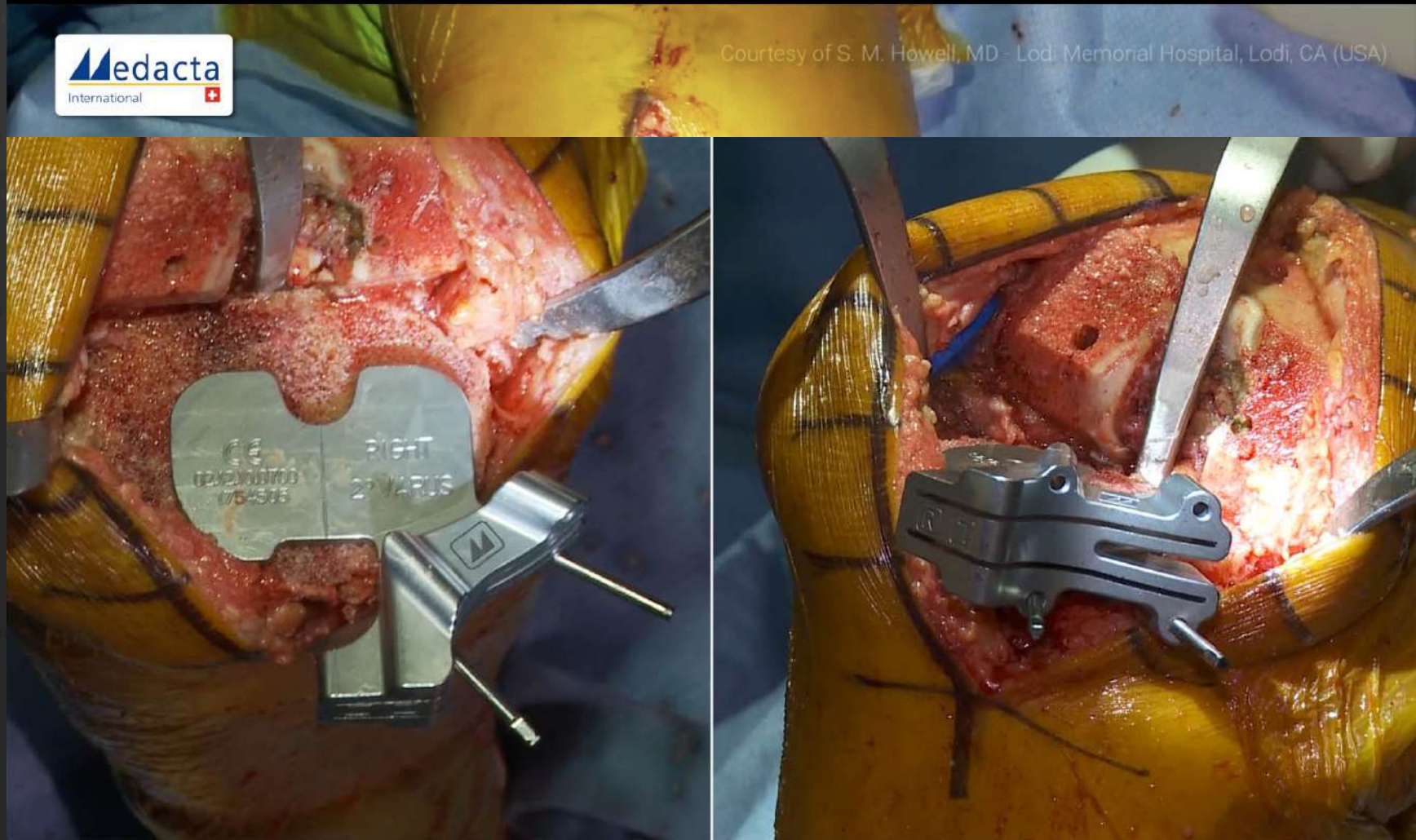
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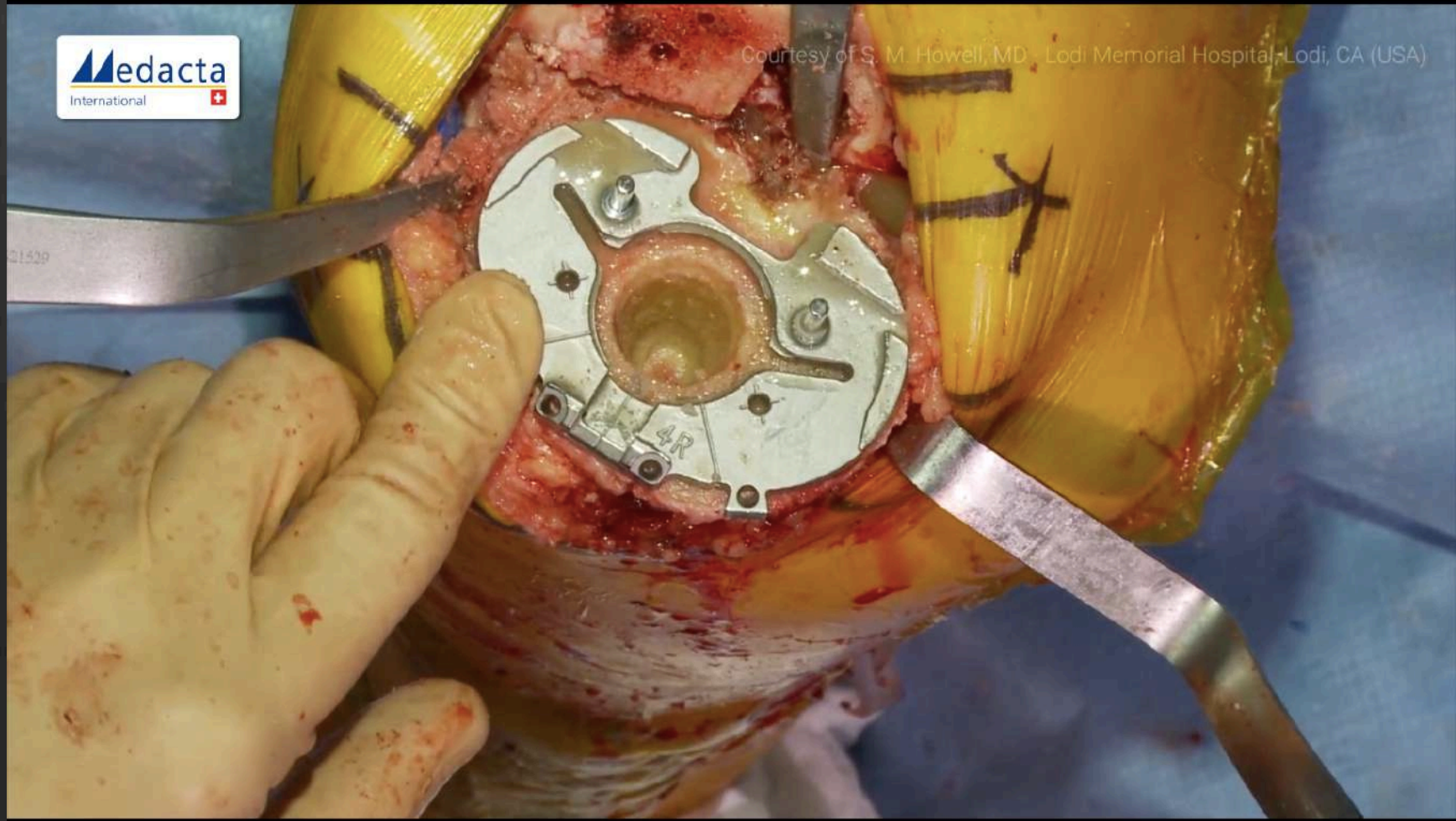
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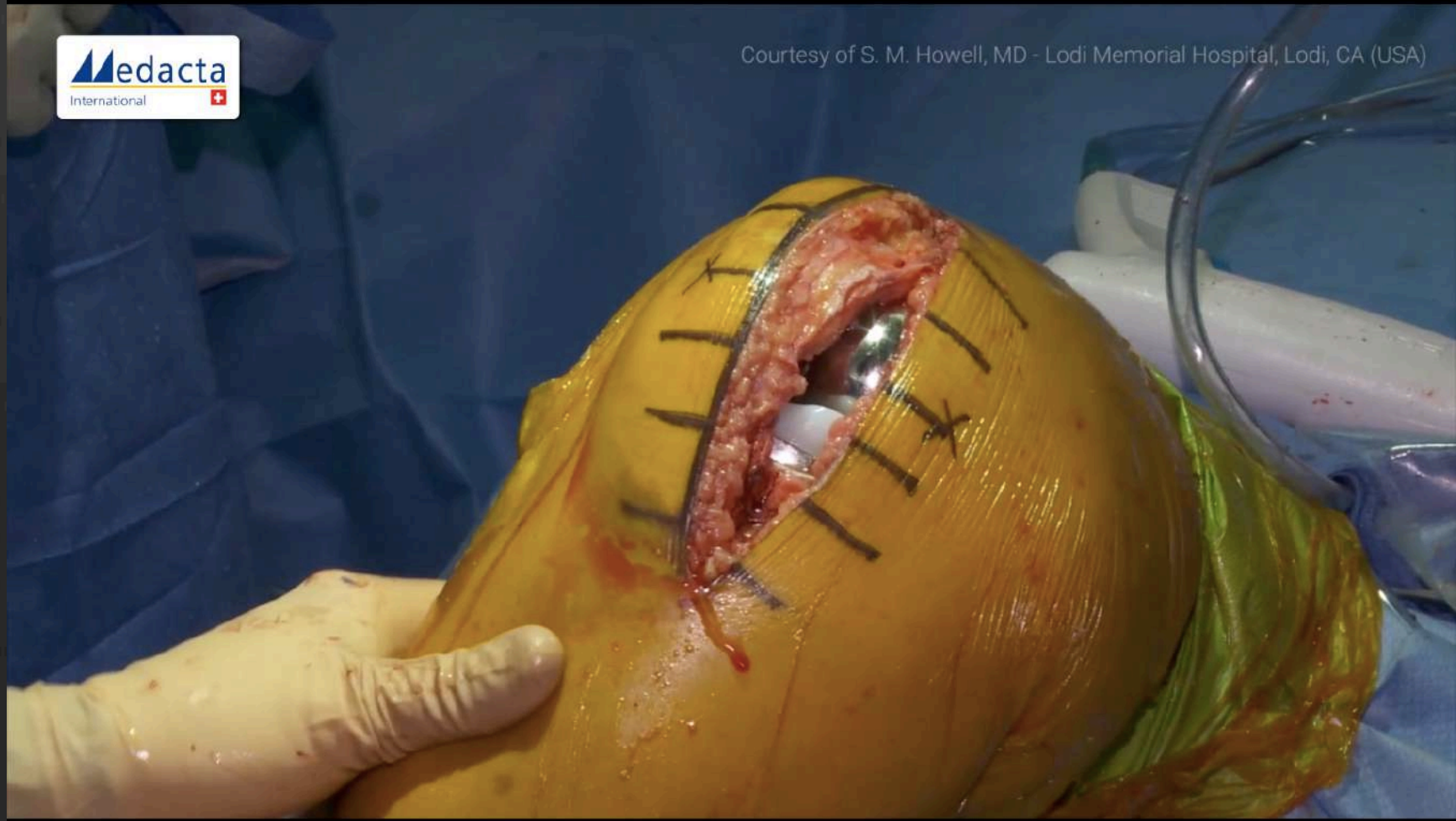
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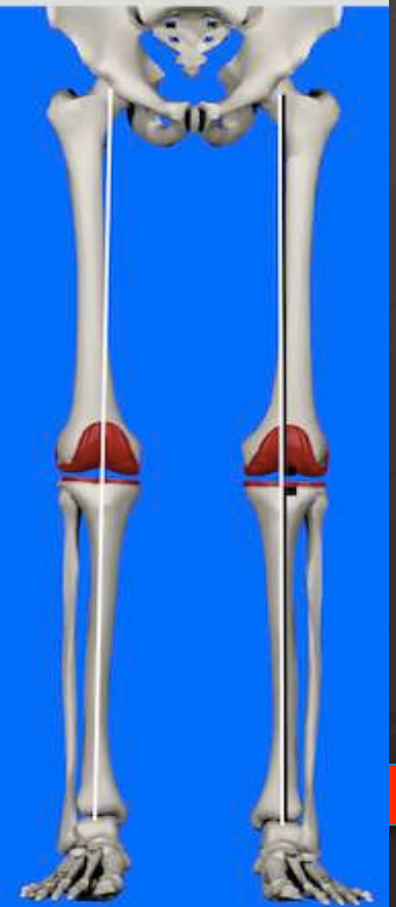
Systematic
Alignment techniques

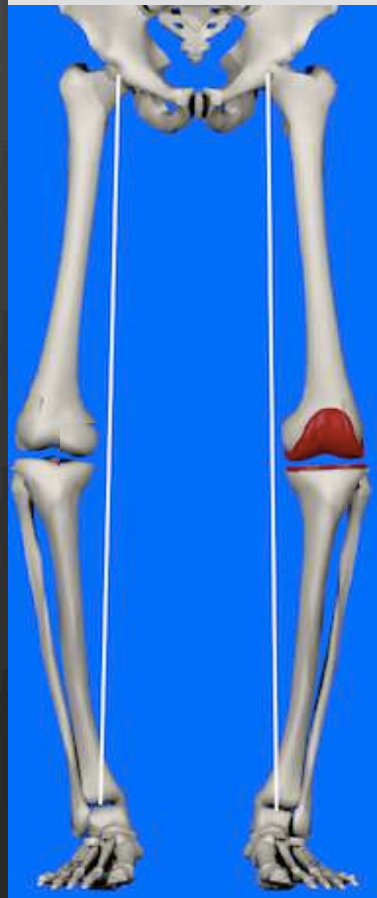
AA MA



1. No respect of constitutional knee anatomy
   - FT joint
   - PF joint
2. No respect of physiological knee laxity
   - FT joint
   - PF joint
3. technically demanding
   - Soft tissue balance
   - Aligning F component with TEA

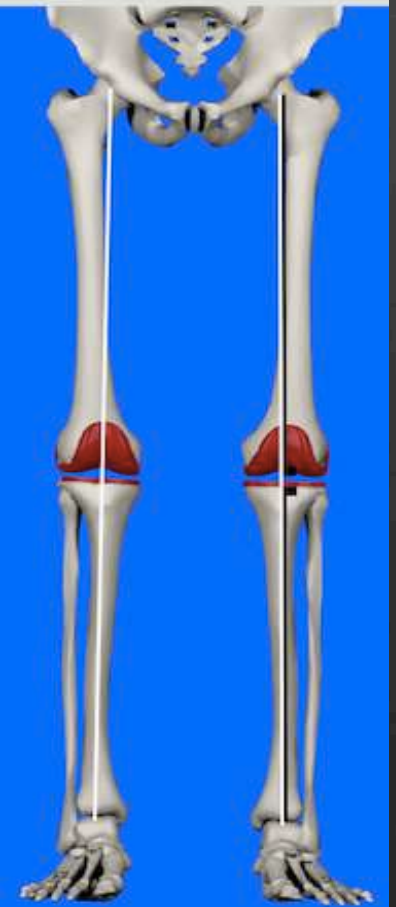
Patient Specific
Alignment techniques

KA



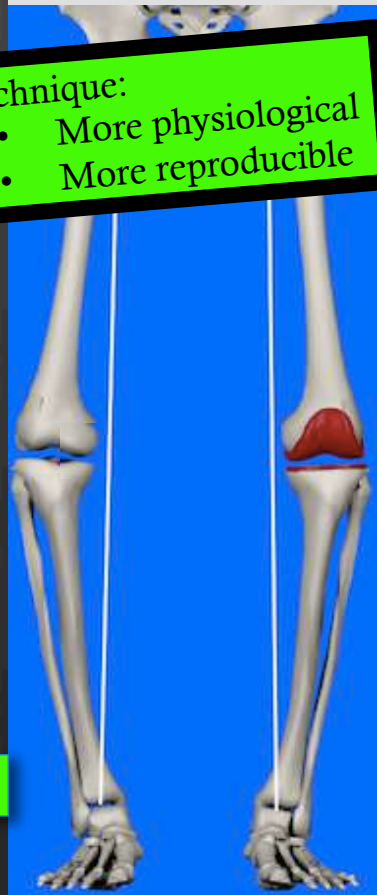
Systematic
Alignment techniques

AA MA



Patient Specific
Alignment techniques

KA



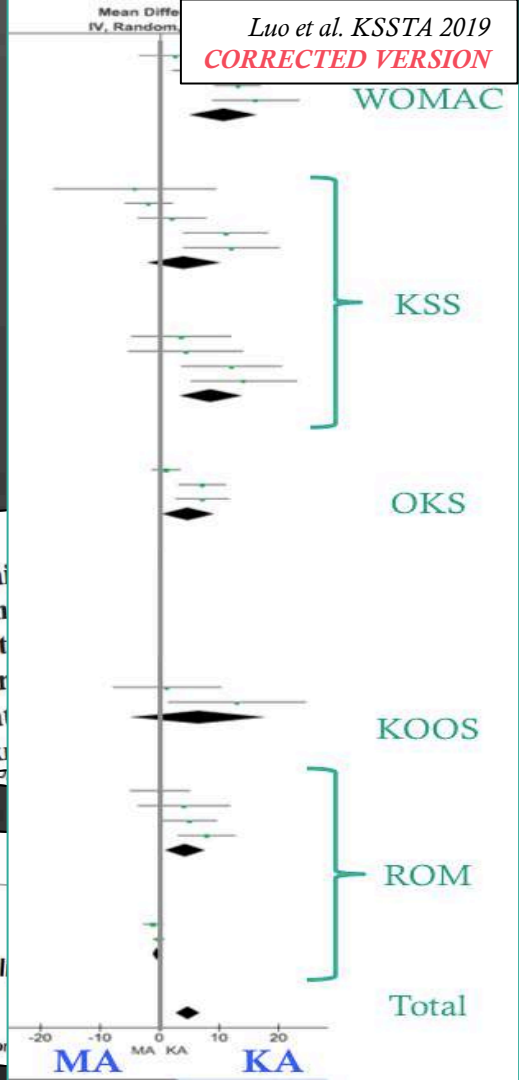
1. Respect of the constitutional knee anatomy:
   - FT joint
   - ~~PF joint~~
2. Respect physiologocal knee laxity
3. Technically simple:
   - No soft tissue release
   - Ease for aligning F component with cylindrical axis

KA technique:
- More physiological
- More reproducible

➢ Evidence:

KA > MA

- Functional performance:
  - ➔ 6 RCTs & 4 meta-analyses

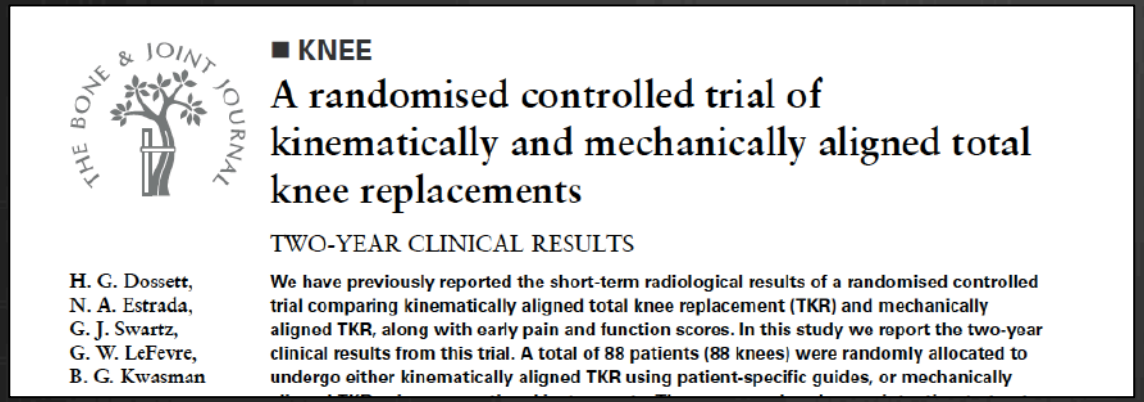


➢ Evidence:

- Functional performance:
  - ➔ 6 RCTs & 4 meta-analyses
- Anterior Knee Pain:

KA > MA

(Odds Ratio 5)



THE BONE & JOINT JOURNAL

■ KNEE

A randomised controlled trial of kinematically and mechanically aligned total knee replacements

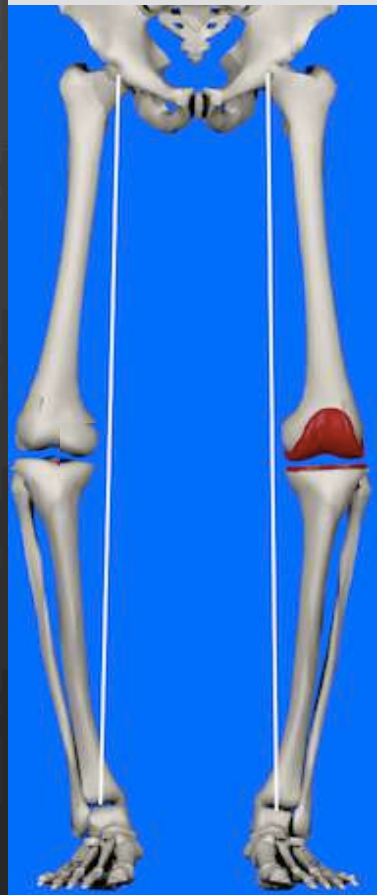
TWO-YEAR CLINICAL RESULTS

H. G. Dossett,
N. A. Estrada,
G. J. Swartz,
G. W. LeFevre,
B. G. Kwasman

We have previously reported the short-term radiological results of a randomised controlled trial comparing kinematically aligned total knee replacement (TKR) and mechanically aligned TKR, along with early pain and function scores. In this study we report the two-year clinical results from this trial. A total of 88 patients (88 knees) were randomly allocated to undergo either kinematically aligned TKR using patient-specific guides, or mechanically

Patient Specific
Alignment techniques

KA



➢ Evidence:

- Functional performance:
  - ➔ 6 RCTs & 4 meta-analyses
- Anterior Knee Pain:
- Patients' Satisfaction:

KA > MA

(Odds Ratio 3)

THE BONE & JOINT JOURNAL

■ MANAGEMENT FACTORIALS IN TOTAL KNEE ARTHROPLASTY

Patient dissatisfaction following total knee replacement

A GROWING CONCERN?

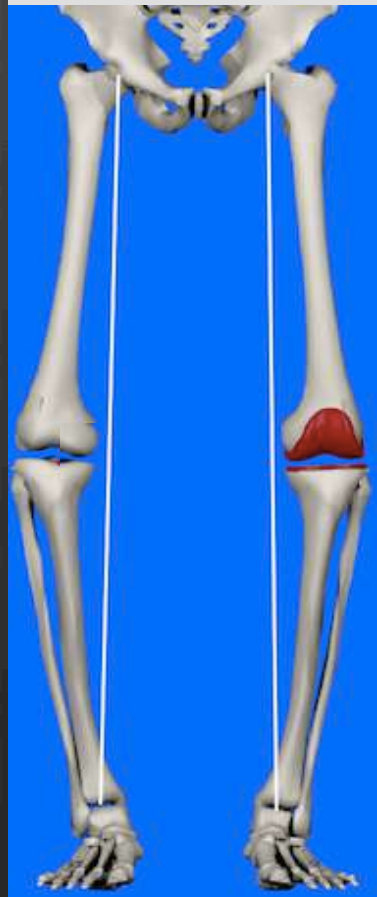
D. Nam,
R. M. Nunley,
R. L. Barrack

From Washington

A national, multi-centre study was designed in which a questionnaire quantifying the degree of patient satisfaction and residual symptoms in patients following total knee replacement (TKR) was administered by an independent, blinded third party survey centre. A total of 90% of patients reported satisfaction with the overall functioning of their knee, but 66% felt their knee to be 'normal', with the reported incidence of residual symptoms and

Patient Specific
Alignment techniques

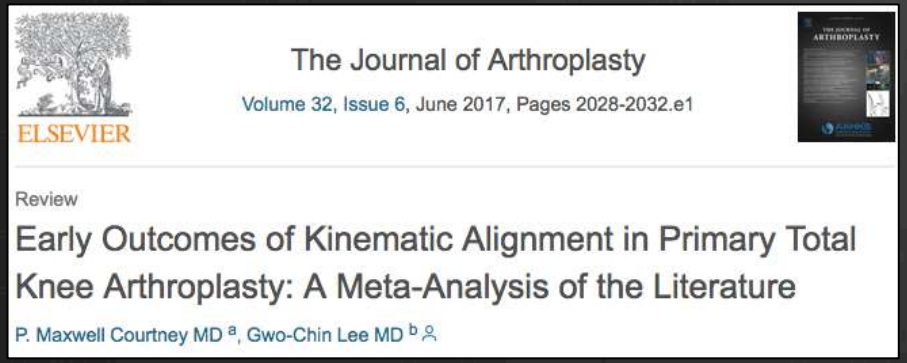
KA



➢ Evidence:

- Functional performance:
  - ➔ 6 RCTs & 4 meta-analyses
- Anterior Knee Pain:
- Patients' Satisfaction:
- Complication/Survivorship:

KA = MA



ELSEVIER

The Journal of Arthroplasty

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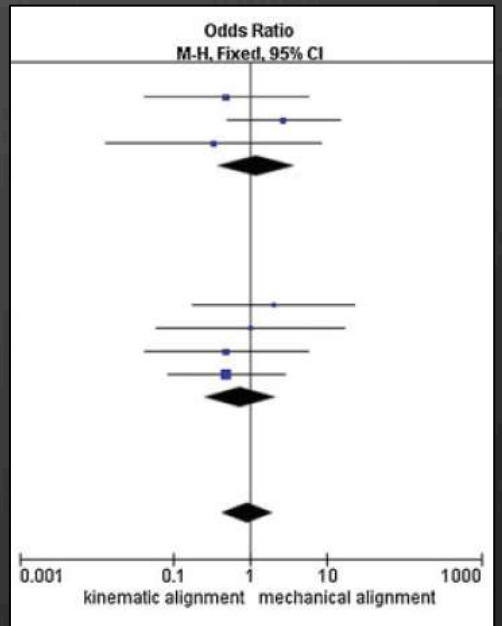
Review

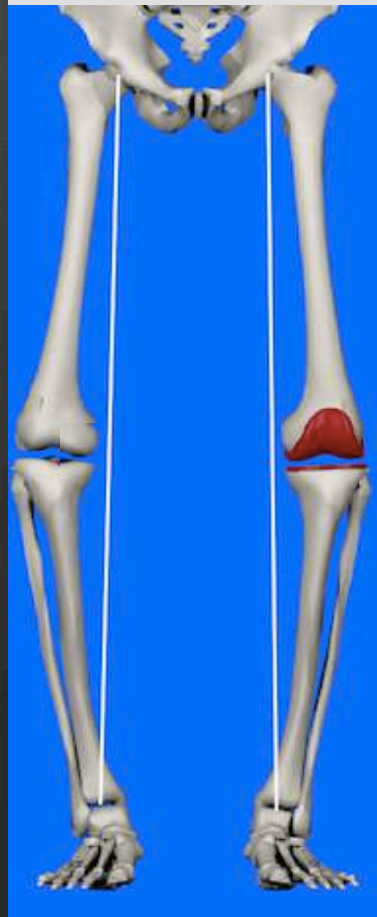
Early Outcomes of Kinematic Alignment in Primary Total Knee Arthroplasty: A Meta-Analysis of the Literature

P. Maxwell Courtney MD [a], Gwo-Chin Lee MD [b]



Patient Specific
Alignment techniques

KA



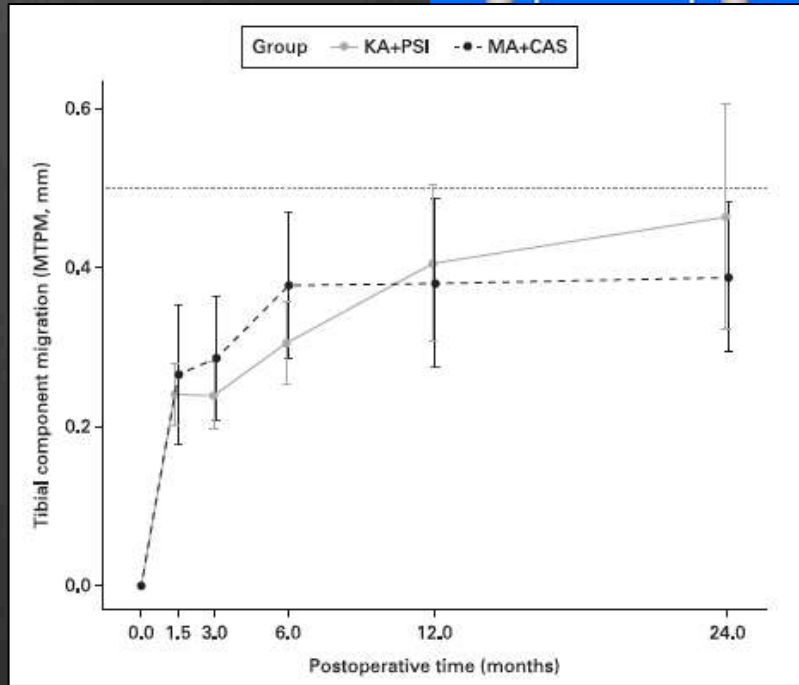
Patient Specific
Alignment techniques

KA

➢ Evidence:

- Functional performance:
  ➔ 6 RCTs & 4 meta-analyses
- Anterior Knee Pain:
- Patients' Satisfaction:
- Complication/Survivorship
- Implant migration (RSA)

KA = MA



THE BONE & JOINT JOURNAL EST. 1948

■ KNEE

A randomized controlled trial of tibial component migration with kinematic alignment using patient-specific instrumentation versus mechanical alignment using computer-assisted surgery in total knee arthroplasty

E. K. Laende,
C. G. Richardson,
M. J. Dunbar

Patient Specific
Alignment techniques

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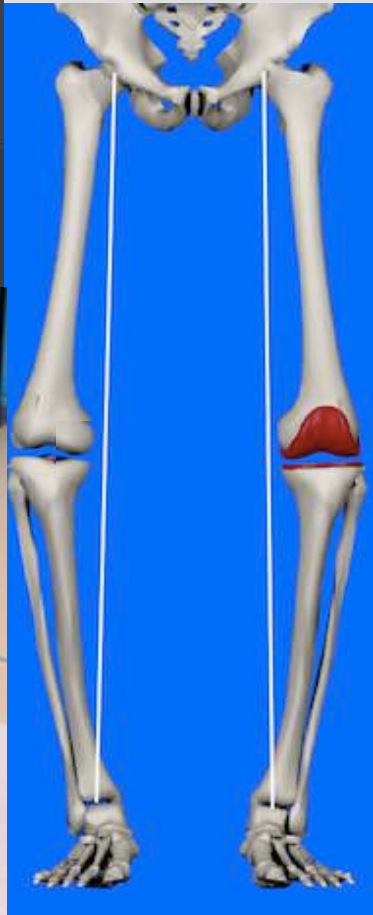
- Implant migration (RSA)
- Biomechanics

KA ≥ MA



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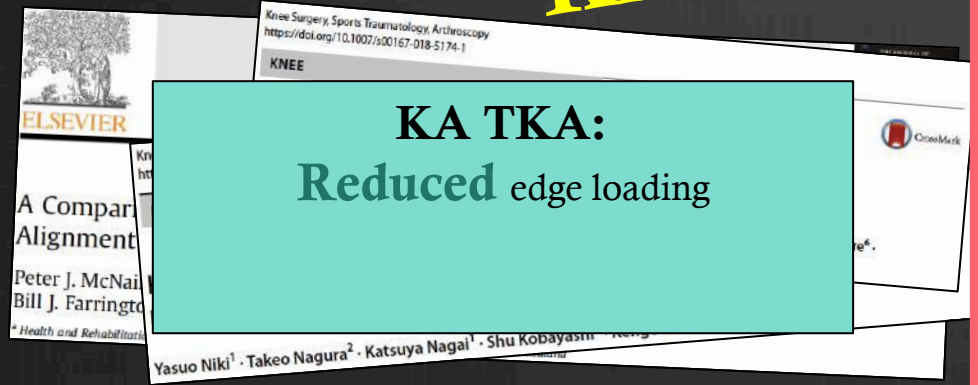
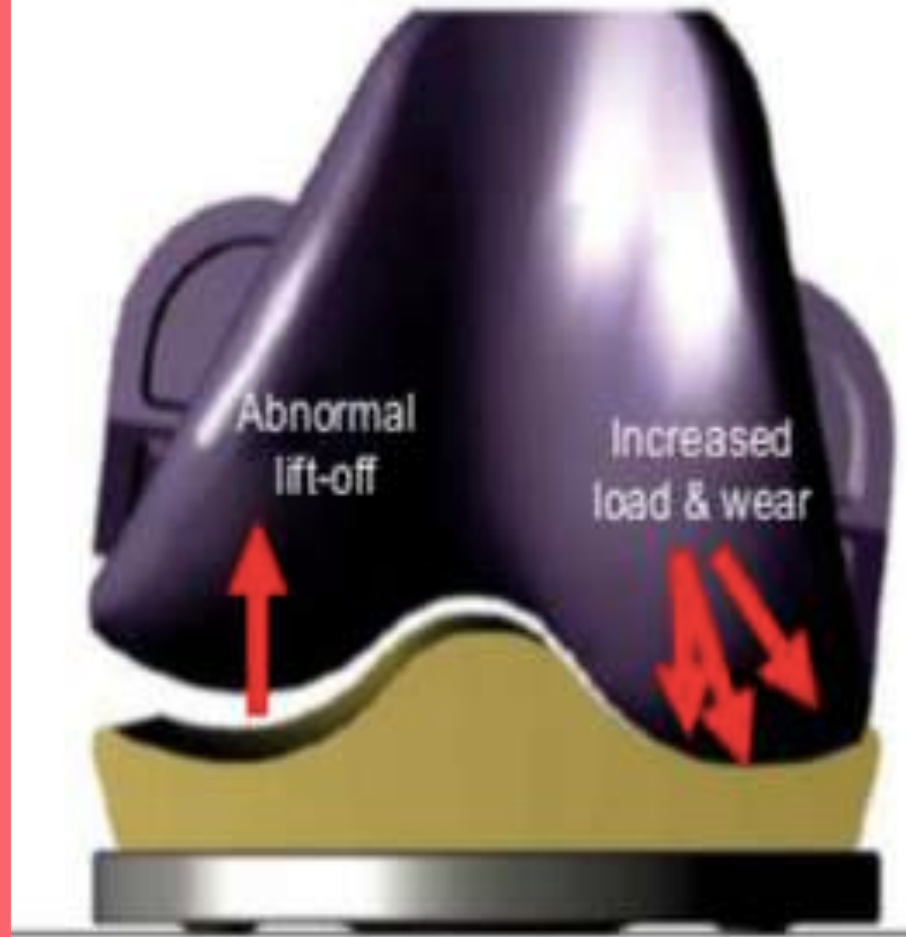


KA TKA:
Reduced edge loading

Reduced varus trust/lift-off



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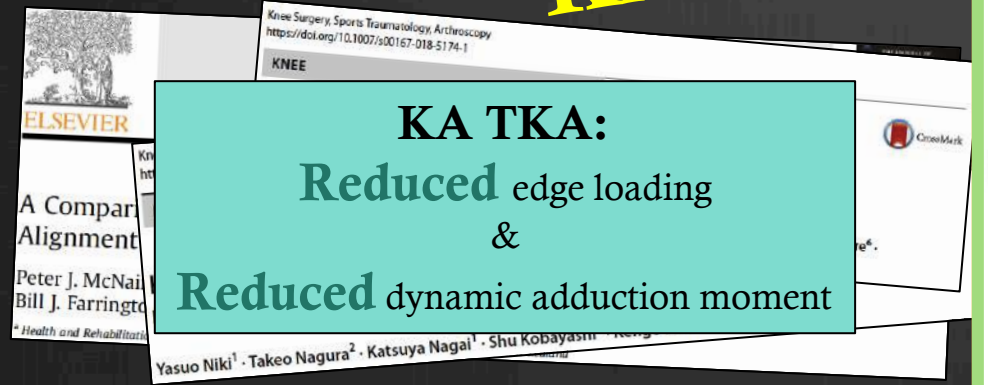


KA TKA:

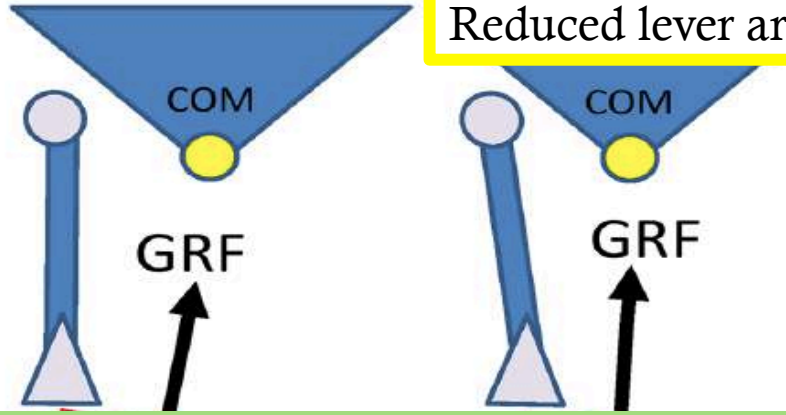
Reduced edge loading

&

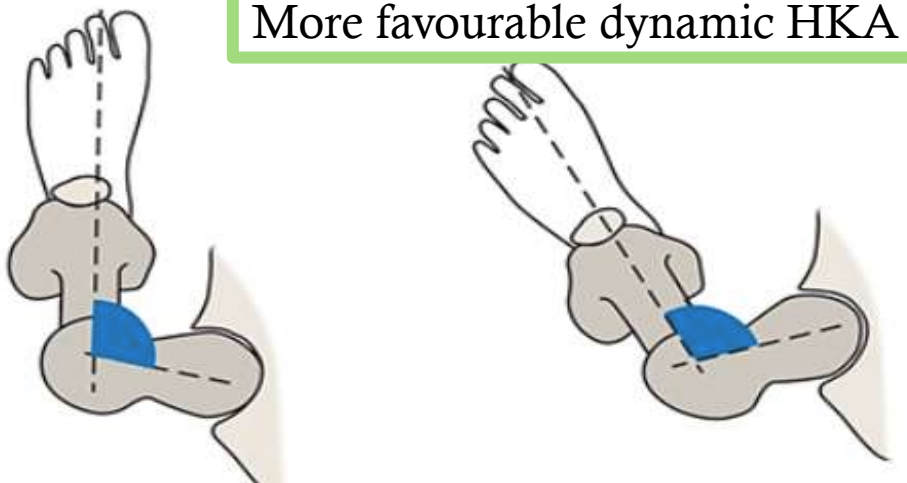
Reduced dynamic adduction moment

Reduced varus trust/lift-off

Reduced lever arm

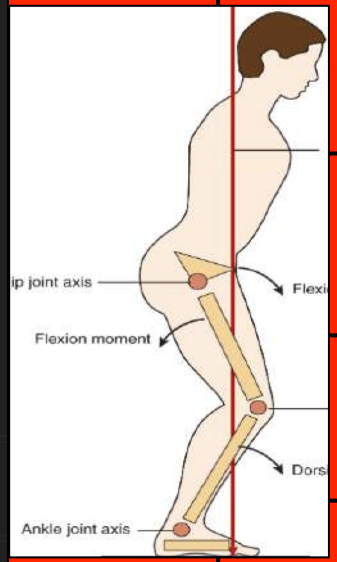


More favourable dynamic HKA



➢Don’t be scared of restoring constitutional limb alignment

ADD° MOMENT
→ negligible influence on total JRF



TOTAL JRF
applied on TKA

Negligible influence on TKA LIFESPAN (obesity does not hinder good long-term TKA fixation)

- Don't be scared of restoring constitutional limb alignment

Standing alignment has negligible influence on TKA failure/tibia component migration

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

Does varus alignment adversely affect implant survival and function six years after kinematically aligned total knee arthroplasty?

Stephen M. Howell[1,2,4] · Stelios Papadopoulos[1,2,3,4] · Kyle Kuznik[1,2,3,4] · Lillian R. Ghaly[1,2,3,4] · Maury L. Hull[1,2,3]

THE BONE & JOINT JOURNAL EST. 1948

■ KNEE

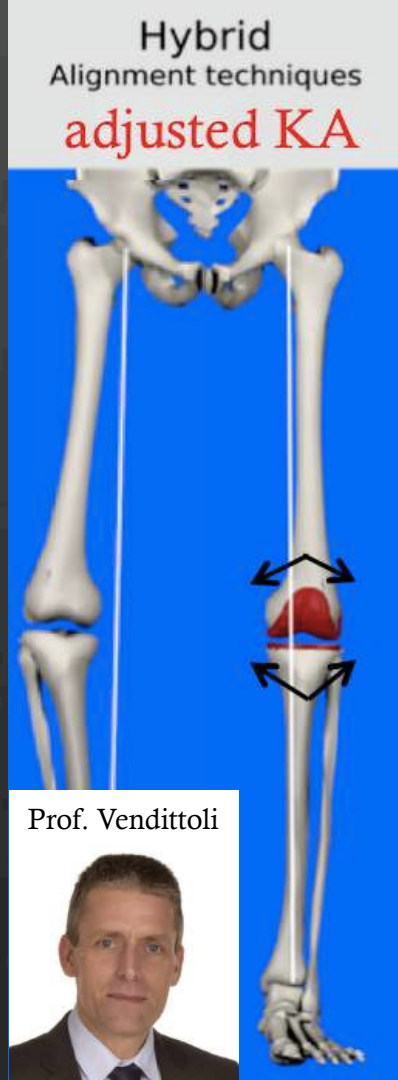
A randomized controlled trial of tibial component migration with kinematic alignment using patient-specific instrumentation versus mechanical alignment using computer-assisted surgery in total knee arthroplasty

E. K. Laende, C. G. Richardson, M. J. Dunbar

➢ Exceptional extreme deformities

....from developmental disease (e.g. Blount, Rickets, Volkman)

1. Adjusted KA TKA
2. Osteotomy + KA TKA



TAKE HOME MESSAGE

- KA TKA is:
  1. PHYSIOLOGICAL
  2. SIMPLE (➔ reproducible technique)
  3. VERY GOOD OUTCOMES…so far!
  4. Probably BIOMECHANICALLY FRIENDLY
  5. Probably for EVERYONE (➔ rKA TKA when severe deformity)

TAKE HOME MESSAGE

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Editorial

Mechanical alignment: The end of an era!

Half a century ago, Michael Freeman introduced the concept of right-angled femoral and tibial bone cuts in total knee arthroplasty (TKA)- mechanical alignment (MA) [1]. A little later, John Insall, raised the importance of balancing the resulting medial-lateral and flexion-extension joint gaps [2]. MA technique, subsequently, became the gold standard in total knee arthroplasty. The MA technique can be defined as "systematic", in that all patients are implanted in a standardised fashion, without considering the individual native knee anatomy and physiological soft tissue laxities (Fig. 1). This non-physiological implantation was thought to be biomechanically-friendly, aiming to reduce the knee adduction moment and thus the risk of unbalanced prosthetic joint load (Fig. 1). This rationale made sense at a time when polyethylene quality, cementation technique and instrumentation were rudimentary. Over the decades that followed, multiple implant designs were developed, the quality of the polyethylene improved, the precision of implantation of components enhanced through advanced instrumentation and technological assistance (e.g. computational, robotics), and the implant fixation optimised. MA surgical technique was refined to reduce residual knee instability linked to modification of joint gaps: using soft tissue release algorithms with measured resection technique or the gap-balancing technique [3].

Robust clinical data emerged confirming the excellent long-term implant survivorship, with acceptable functional performance [4,5]. However, recent studies found that MA-TKA produces disappointing clinical results, particularly when compared to those of total hip replacement [5,6]. Rates of dissatisfaction and residual symptoms (e.g. pain, instability, stiffness) following MA-TKA have been reported to be approximately 15% and 50%, respectively [7]. In addition, patients' perception of their prosthetic knees is rarely "natural" and forgotten joint scores are disappointing [6]. Interestingly, neither the use of technological assistance (to aid precision of implantation) nor new implant designs have solved these issues [5]. This highlights the technical limitations that are inherent to the MA technique, in that it produces a non-physiological prosthetic knee through alteration of the native anatomy, physiological ligament balance and kinematics [8–11] (Fig. 1).

Recent research has found the rationale supporting the MA technique to be questionable, resulting in a shift in beliefs within the orthopaedic community [12]. We now have a better understanding of the native knee anatomy and kinematics following the work from Eckhoff [13], which defined the three knee kinematic axes that dictate the motion of the tibia and patella around the femur. They showed that the tibia rotates around the cylindrical (or condylar) axis between 10 and 120 degrees of knee flexion, but not around the trans-epicondylar axis, as was always believed. Aligning the femoral component on the trans-epicondylar axis, as recommended by the MA technique, is therefore likely to be kinematically suboptimal. We have also learned that the post-operative standing frontal limb alignment (HKA angle) is of poor predictive value in assessing the risk of prosthetic failure [14] and predicting the knee compartment load [15]. Research from the Mayo Clinic has shown that slight varus or valgus limb deformity after MA-TKA did not impair the 20-year follow-up clinical outcomes [14]. Potential explanations are that the HKA angle varies when walking and thus should be seen as a dynamic value [16,17]; secondly, the two-dimensional X-rays measures of the frontal knee and limb alignments (short knee and long-leg, respectively) are a poor estimate of the true limb alignment as measured on three-dimensional images [18] even if digitized X-rays improve accuracy [19]. The one size fits all MA bone cuts may therefore not be the only way to achieve good long-term clinical outcomes [14].

It is clear we need to move beyond the simplistic concept that good long-term implant fixation can only be achieved by implanting TKA components within a pre-defined position, measured on antero-posterior radiographs of the lower limb. The systematic approach promoted by knee arthroplasty pioneers was sound for a period, but a paradigm-shift is developing. A patient specific and personalized surgical technique in which surgeons look to restore the individual knee anatomy, kinematics, and soft-tissue balance may improve clinical results while matching the MA implant survivorship.

Thirteen years ago, Stephen Howell developed an alternative technique for positioning TKA components, namely the kinematic alignment (KA) technique [8,10]. The KA technique aims to generate a more physiological, prosthetic knee, by aiming to restore the individual native knee anatomy and physiological soft-tissue balance (Fig. 1). KA aligns the femoral component on the cylindrical axis, anatomical rather than mechanical bone cuts are performed (true knee resurfacing), and no soft-tissue release is required. This personalised TKA implantation is intended to solve the aforementioned issues affecting MA-TKA (Fig. 1). KA is a new surgical technique composed of a series of well-defined steps, which carry little comparison to the original MA technique. Several studies have demonstrated the accuracy of the KA technique for correct component positioning [20], as well as the reproducibility in restoring the native knee's anatomy [20,21] and physiological laxity [22,23]. Early- to mid-term safety (low complication rate) and efficacy (high function and satisfaction) have also been confirmed [24]. Today, 4 randomised controlled trials [25–28] and subsequent

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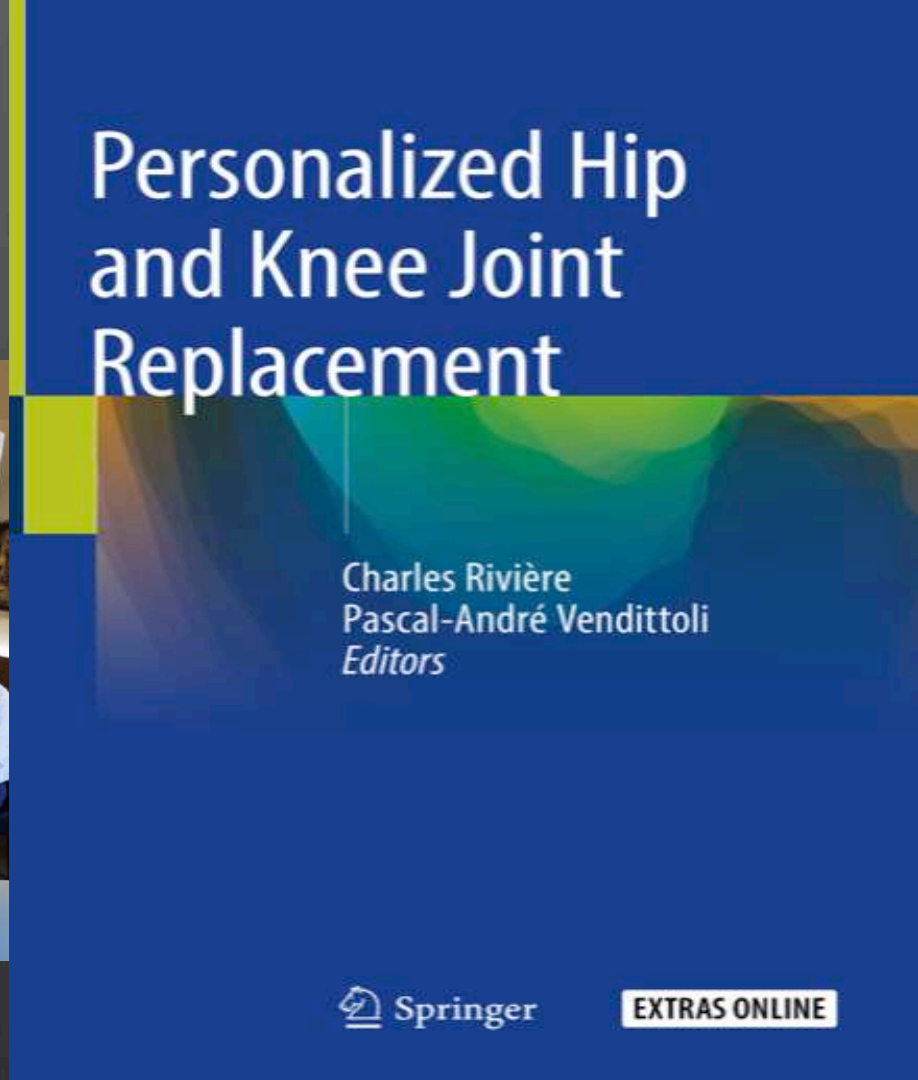
To learn more…



Thank You
For Your
Attention

KEEP
CALM
AND
SWITCH
TO KA