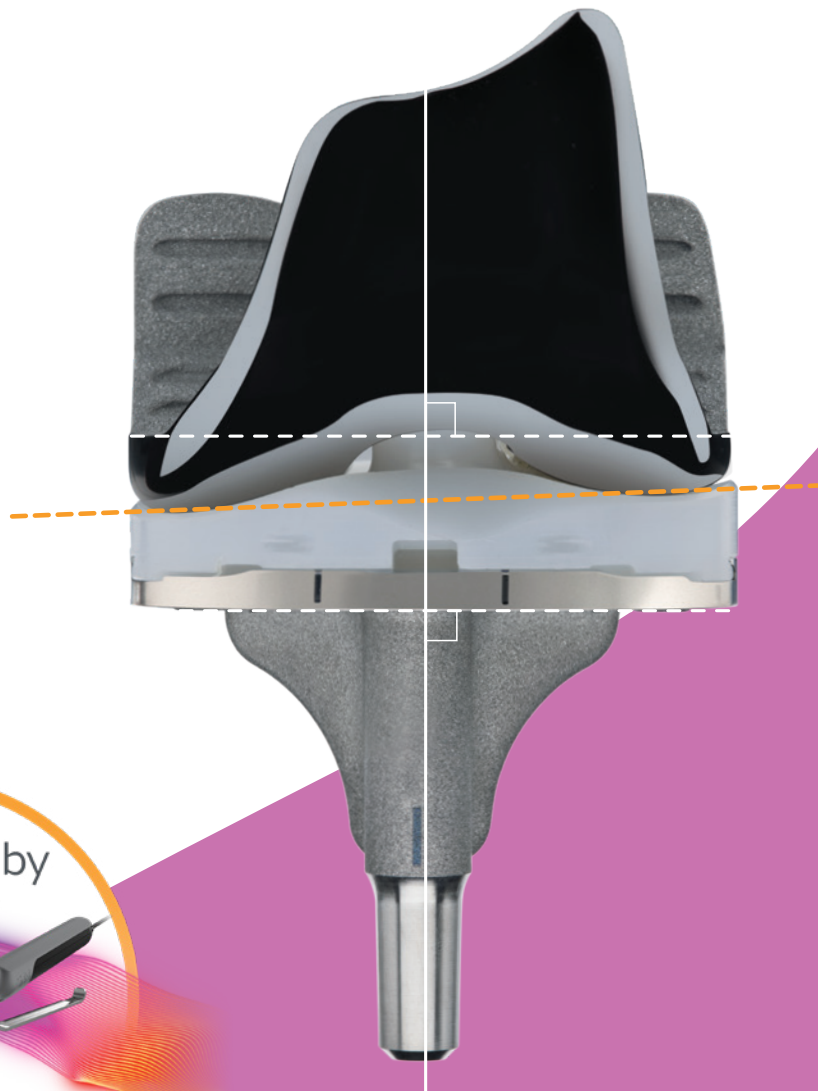


+ 3° for free

A personalized approach to alignment

Smith+Nephew

JOURNEY[◇] II
Total Knee Arthroplasty



Amplified by



CORI[◇] XT
Handheld Robotics Platform

The rise of personalized alignment

Since anatomic alignment was first described in 1985¹, several personalized alignment philosophies have been introduced to challenge traditional mechanical alignment, including Kinematic Alignment and Functional Alignment.

Although differing in technique, these approaches share a common objective: to restore the femoral and tibial joint lines to the patient's native, pre-arthritic anatomy. Achieving this restoration is believed to promote more natural soft-tissue balance and knee function, reduce the need for soft-tissue releases, and ultimately help address the persistent patient satisfaction gap observed in total knee arthroplasty.^{2,3}

Accurate joint line restoration is achieved when the thickness of each bone resection closely matches the corresponding implant thickness. In practice, this often requires positioning the femoral component in approximately 3° of valgus and the tibial component in approximately 3° of varus to replicate the patient's native joint line (Figure 1).

99%

of TKA procedures with a symmetric implant change the patient's constitutional anatomy²

20%

of TKA patients report unmet levels of satisfaction³

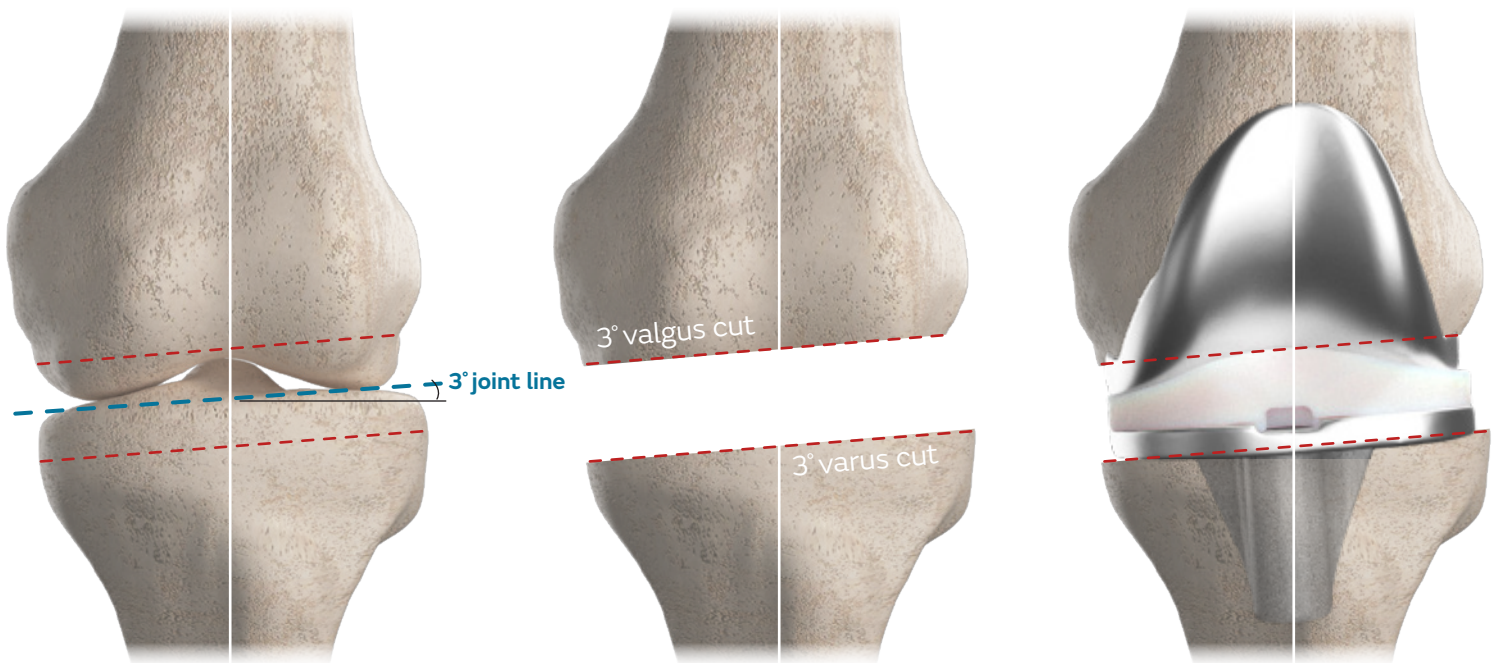


Figure 1: Execution of a personalized alignment with a symmetric implant that attempts to restore the joint line

What does the normal knee look like?

The normal knee has asymmetric shapes and thicknesses on both the femur and tibia and, when combined, form a 3° joint line in the average person.^{1,4}

In 2021, Dr. Samuel MacDessi et al. introduced the Coronal Plane Alignment of the Knee (CPAK), a classification system that defines nine knee phenotypes based on overall limb alignment and joint-line orientation (Figure 2).⁵ Their analysis showed that more than 65% of patients fall into CPAK Type I or Type II, characterized by a varus tibial joint line combined with neutral or slightly varus full leg alignment when standing.

CPAK (Coronal Plan Alignment of the Knee) Arithmetic Hip-Knee-Ankle (aHKA = MPTA - LDFA)

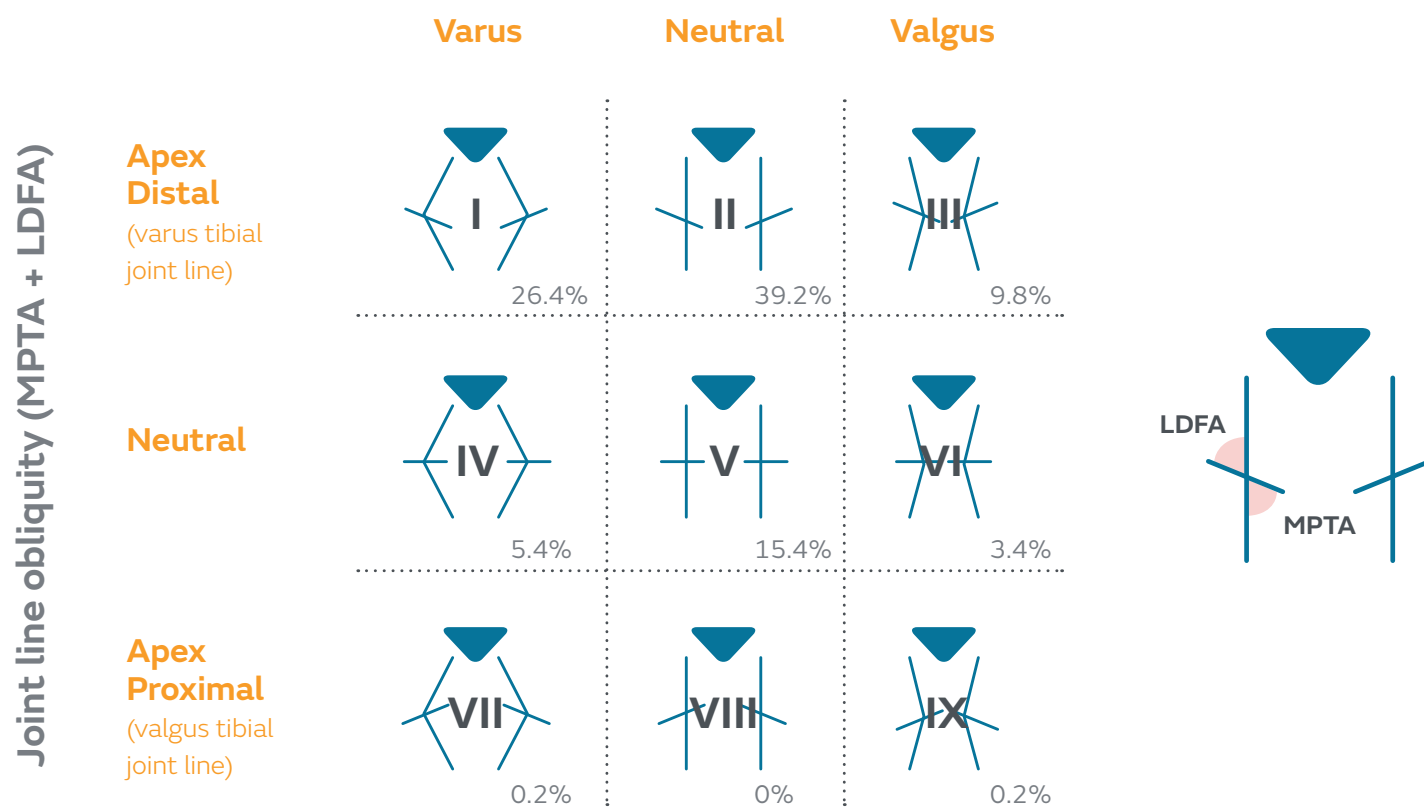


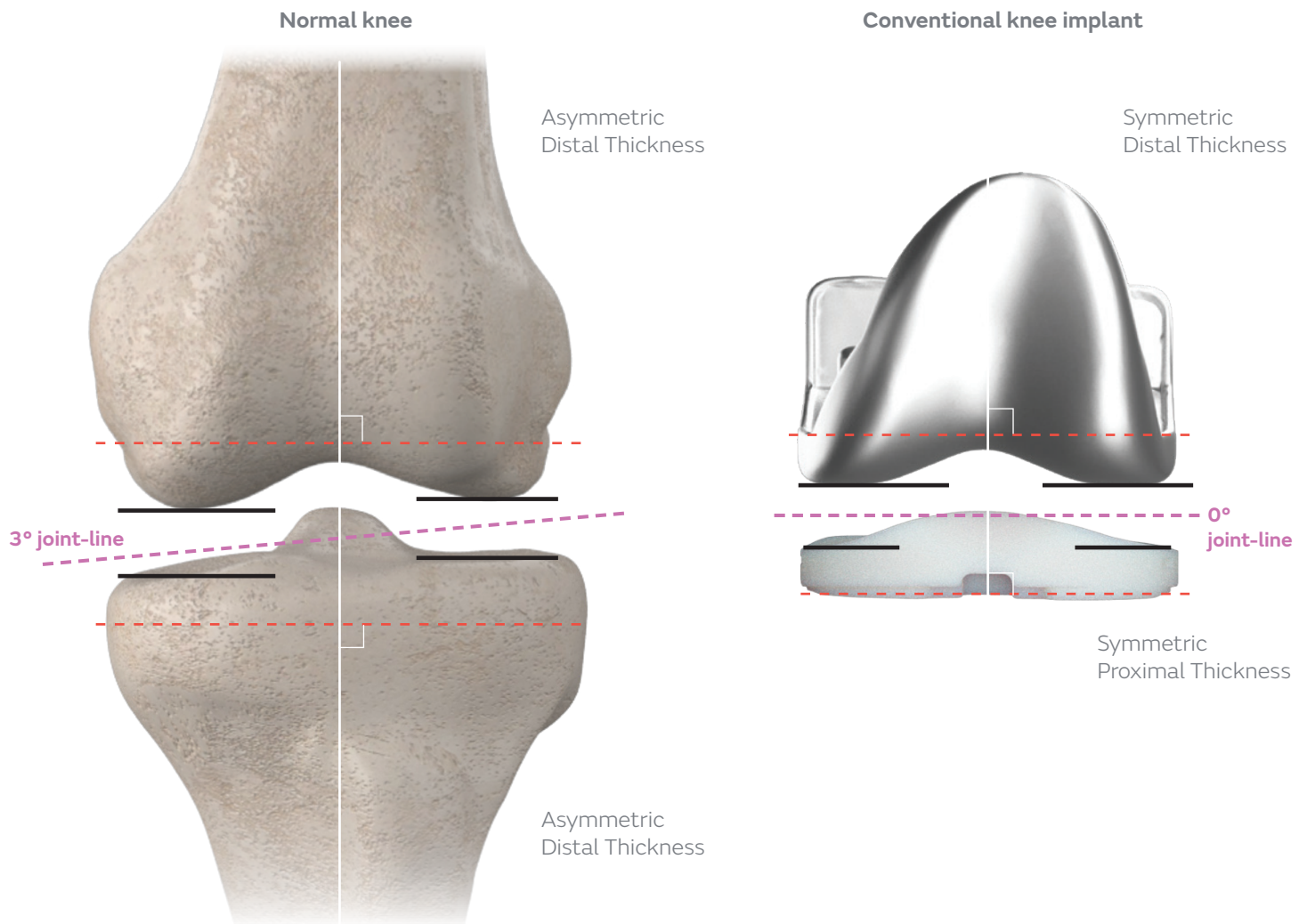
Figure 2: Coronal Plane Alignment of the Knee (CPAK) classifies patients into nine different phenotypes based on joint line obliquity (JLO) and the arithmetic HKA (aHKA)⁵

MPTA = Medial Proximal Tibial Angle

LDFA = Lateral Distal Femoral Angle

Implant design and alignment execution

Despite the normal knee being asymmetric in nature, conventional knee designs have symmetric, non-anatomic femoral and tibial components that create a 0° joint line. To replicate a patient's natural joint line, a symmetric implant often needs to be positioned 3° or more from the mechanical axis.



The symmetric design of conventional knee implants often doesn't match the patient's native anatomy.²

Figure 3 shows the joint line restoration ability of a symmetric implant within $\pm 3^\circ$ of the mechanical axis (blue diamond). As shown below, less than 50% of the patients in MacDessi's data fall within this range of being able to restore the joint line using a symmetric implant design. To address the remaining anatomy types, going beyond 3° from the mechanical axis is required.⁵

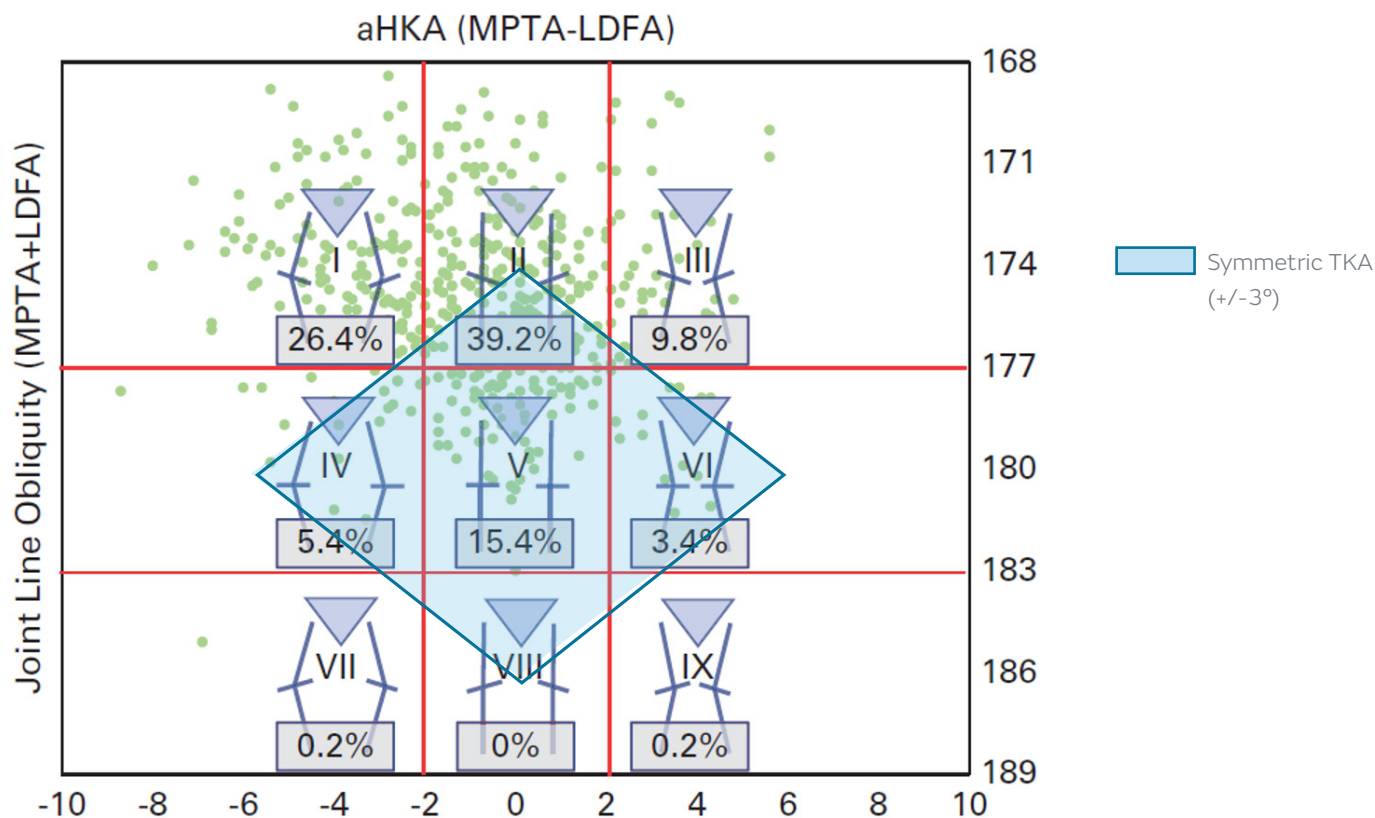


Figure 3: Plot of aHKA against joint line obliquity for a healthy population showing distribution by percentage in the nine CPAK types. Blue region indicates portion of population where the joint line can be restored by a symmetric TKA implanted within $\pm 3^\circ$ from the mechanical axis.⁵

Risks of going beyond 3°

Literature warns of the risks associated with aligning the knee, particularly the tibia, more than 3° from the mechanical axis and rotating the femur more than 3° from the epicondylar axis.⁶⁻¹⁶

Malalignment in the coronal plane (>3° from mechanical axis)

Aligning the knee more than 3° from the mechanical axis has been associated with increased stresses on the tibial baseplate and ultimately TKA failure.⁶⁻¹¹



Increased risk of collapse, wear, loosening, instability and pain⁶⁻¹¹

6.9x

increased risk of failure by medial tibial collapse ($p < 0.0001$)¹⁰

Figure 4 shows how a symmetric implant must be positioned to match the patient's native joint line to achieve Functional Alignment with a robotic system. In this example, the femur needs to be aligned in 5° valgus and the tibia in 6° of varus in order to match the patient's native joint line.

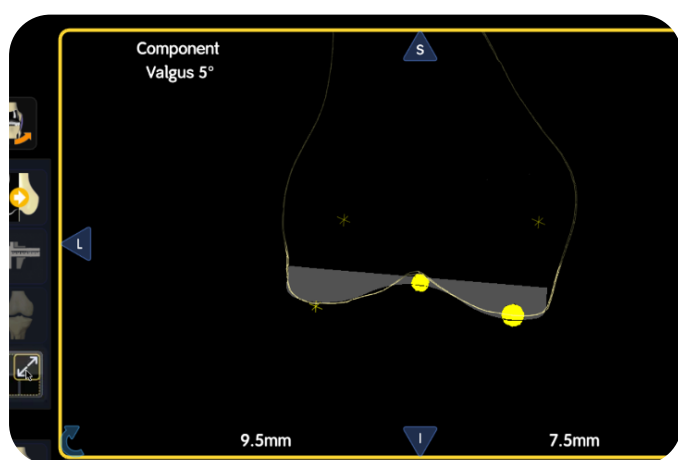
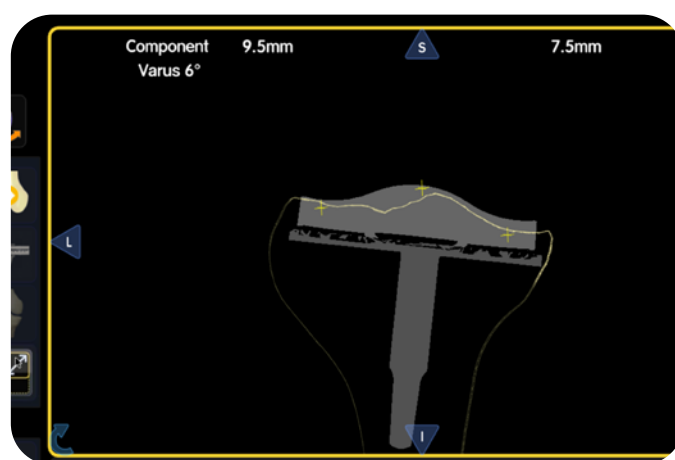


Figure 4: Screenshots from a robotic platform that shows the amount of varus/valgus adjustment needed with a symmetric implant in order to achieve proper implant placement according to the Functional Alignment philosophy.

Malalignment in the transverse plane ($>3^\circ$ from epicondylar axis)

Internally rotating the femur greater than 3° from the epicondylar axis medializes the trochlear groove and places the patella in a nonanatomic position. This has been shown to result in increased risks of:¹²⁻¹⁶

- Patellar tracking issues
- Patellar contact forces
- Pain
- Failure

Figure 5 shows how a symmetric implant must be rotated to match the patient's native posterior joint line to achieve Functional Alignment with a robotic system. This posterior joint line replication is at the cost of moving the trochlear groove away from its natural position.

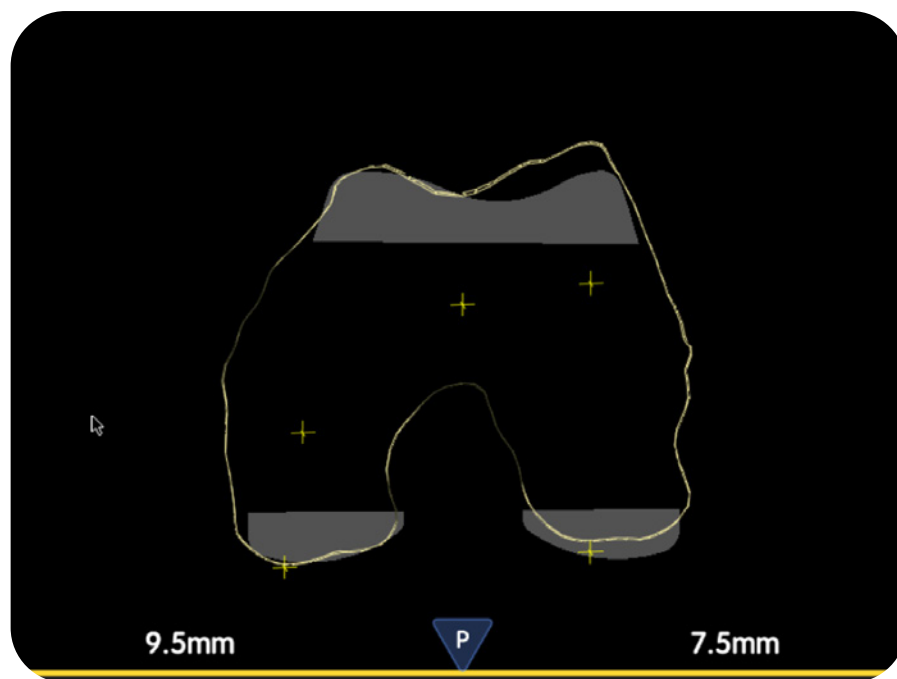


Figure 5: Screenshot from a robotic platform that shows the mismatch between the trochlear groove of a symmetric implant compared to the patient's trochlear groove when rotating the femoral component according to the Functional Alignment philosophy.

3° for free

A personalized approach to alignment through an anatomic implant

The goal of these personalized alignments is to better restore the patient's native anatomy compared to conventional techniques. That thought has been at the forefront of the JOURNEY[®] II TKA design since the beginning.

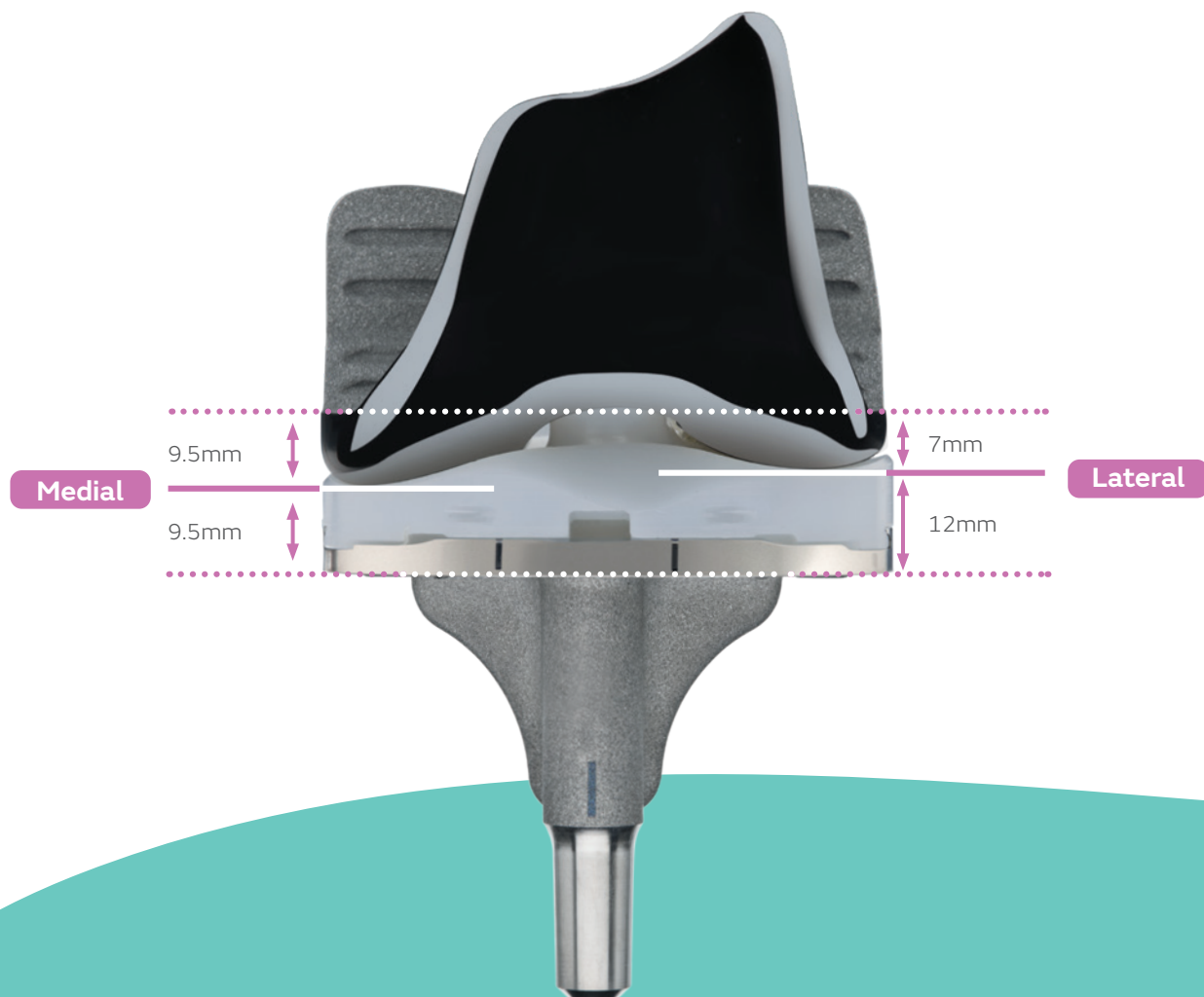
JOURNEY II TKA is designed and clinically shown to restore the anatomic shape, position, and motion of the normal knee.¹⁷⁻²¹ This anatomic restoration has been associated with improved clinical outcomes and higher patient satisfaction.^{22-27*}

Normal shapes^{19-21,28}

Like the normal knee, JOURNEY II TKA has been designed with an asymmetric femur and tibia.

Femur: the medial condyle is thicker than the lateral condyle

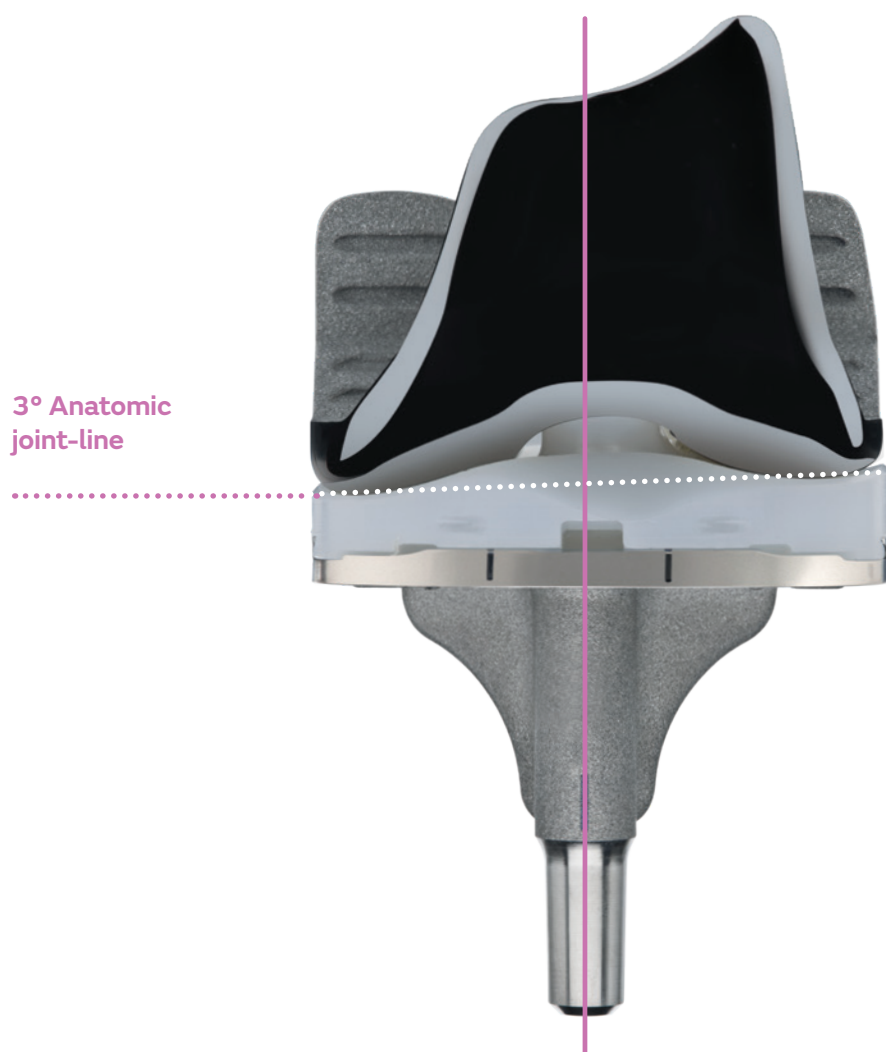
Tibia: the lateral plateau is thicker than the medial plateau



*compared to non-JOURNEY II knees

Normal position^{19,23,24,28-31}

When the asymmetric femur and tibia of JOURNEY II TKA are combined, they create the 3° joint line found in the normal, healthy knee. This replication of the normal joint line leads to more normal ligament tension and more natural patella tracking throughout the range of motion.^{†19,23,28,31}



Normal shapes + Normal position + Normal motion

[†]Based on BCS evidence

Executing “3° for free”

Because JOURNEY[®] II TKA already has a 3° joint line built into the implant, executing a personalized alignment philosophy to best match the patient’s native anatomy **requires less deviation from the mechanical axis** compared to symmetrical knee designs that have a 0° joint line.

Figure 6 adds an additional orange diamond that represents JOURNEY[®] II TKA’s ability to restore the native joint line in the patient population within MacDessi’s study.⁵ As the graph shows, the orange diamond captures a larger portion of the the patient population while still staying within the $\pm 3^\circ$ window from the mechanical axis. This is a huge advantage for JOURNEY II TKA compared to a symmetric implant when executing an alignment technique that is trying to better restore the patient’s original anatomy.

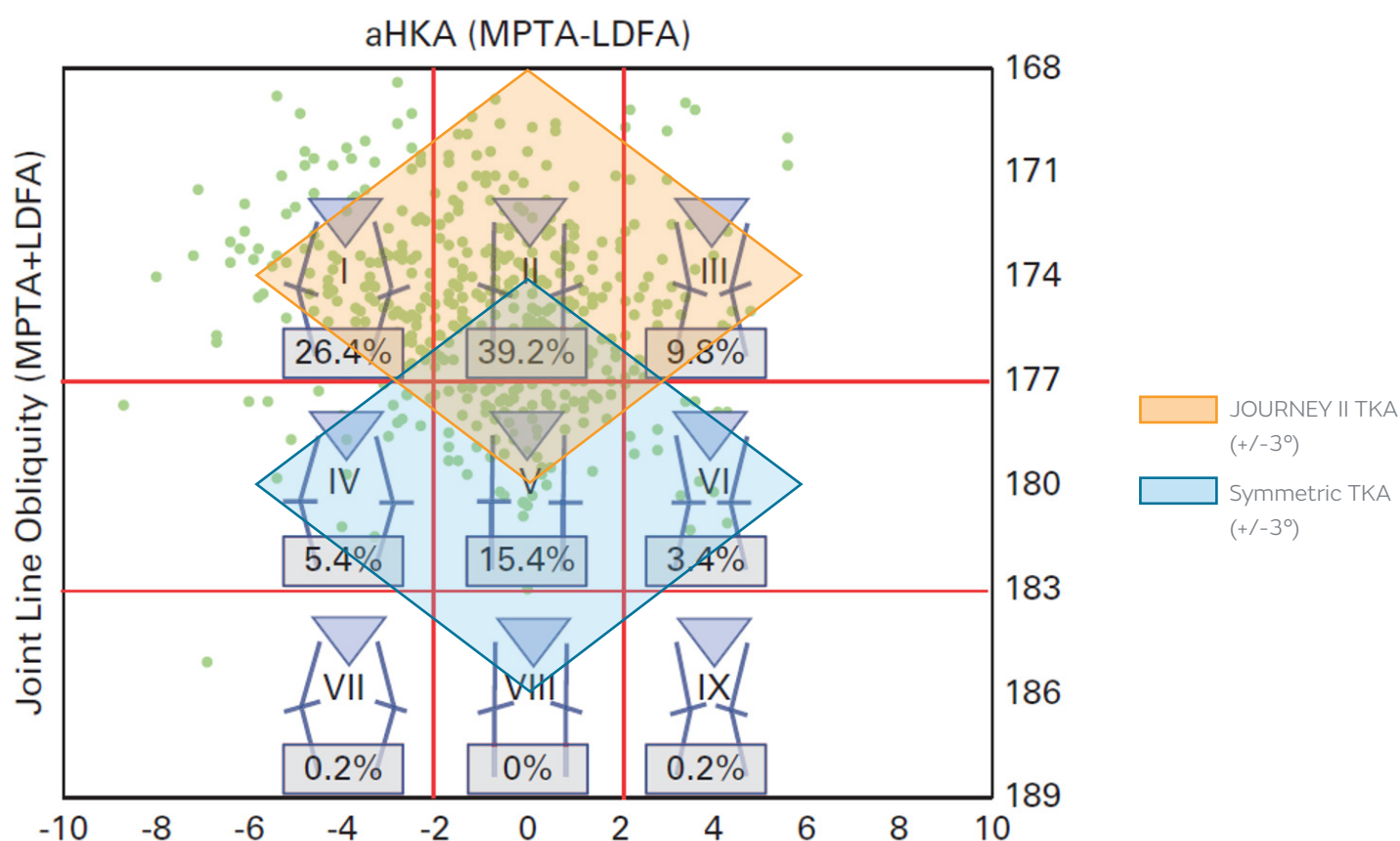
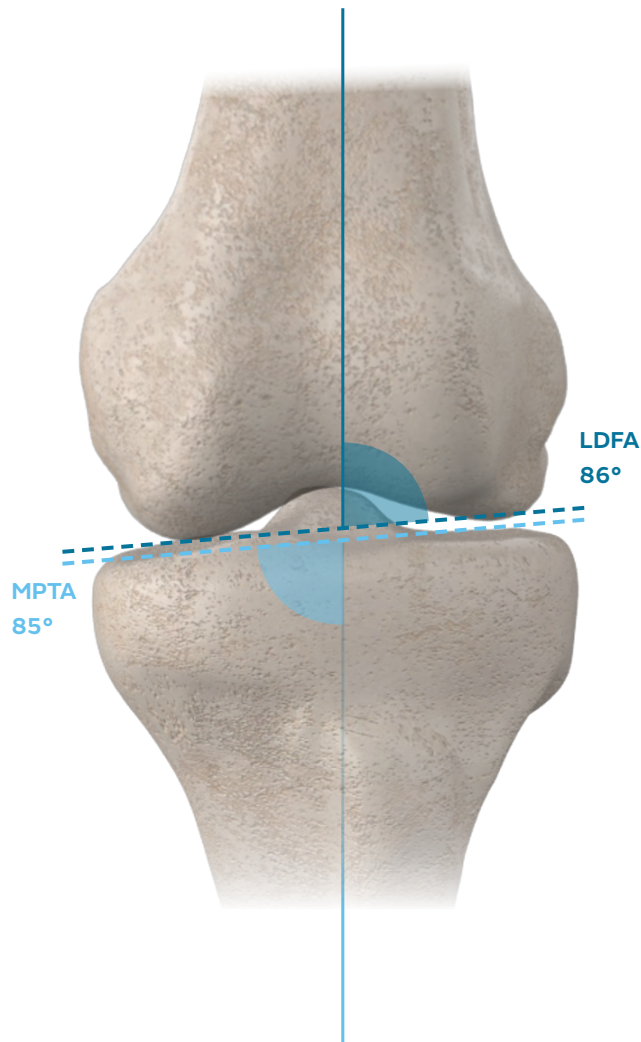


Figure 6: Plot of aHKA against joint line obliquity for a healthy population showing distribution by percentage in the nine CPAK types. Blue region indicates portion of population where joint line can be restored by a symmetric TKA implanted within $\pm 3^\circ$ from the mechanical axis. Orange region indicates portion of population where joint line can be restored by JOURNEY II TKA within $\pm 3^\circ$ from the mechanical axis. The orange JOURNEY II TKA region covers a noticeably larger portion of the normal and arthritic populations compared to the blue symmetric TKA region⁵

Slight Varus Deformity (CPAK Type II) with JOURNEY[◇] II TKA:

An example below shows the advantage JOURNEY II TKA has for a patient within the Type II phenotype (neutral or slightly varus full leg deformity and a varus tibial joint line). According to MacDessi, Type II patients make up 39.2% of the population.⁵



CPAK Type II Knee example

Patient Measurements:

MPTA = 85°

LDFA = 86°

aHKA (MPTA-LDFA) = -1° (neutral/slightly varus knee)

JLO (MPTA+LDFA) = 171° (varus tibial joint line)

Personalized Alignment with Symmetric Implant:

Align femur in 4° valgus



Align tibia in 5° varus

Personalized Alignment with JOURNEY II TKA:

Align femur in 1° valgus



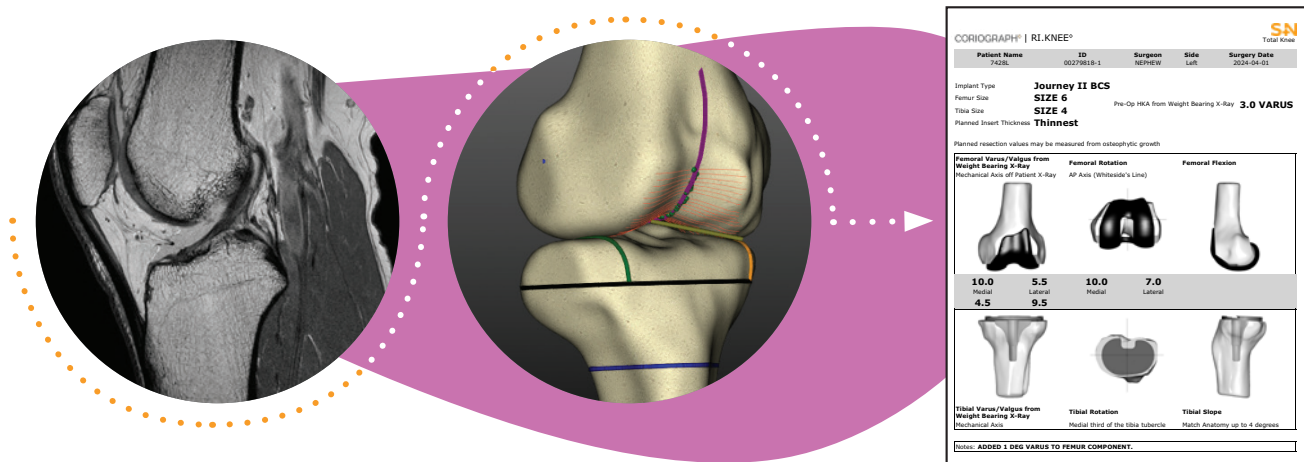
Align tibia in 2° varus

Executing Personalized Alignment with JOURNEY[®] II TKA and CORI[®] Surgical System

CORI Surgical System offers users several tools to accurately and efficiently achieve their desired alignment target.

Pre-operative planning using CORIOGRAPH[®] Pre-operative Planning and Modeling Services

- Patient specific pre-operative plan based on the selected alignment philosophy, including Functional and Kinematic Alignment
- Designed to enhance intra-operative efficiency in TKA
- Built on 15+ years of clinical expertise and over 350,000 image-based surgery plans³²



Accurately shape-match native bone with intra-operative adjustments in real time³³

- Intra-operative mapping, visualization and planning of tibia, femur, and trochlea position
- Multiple visualization options available across all three anatomical planes
- Special points for visualization of anatomic landmarks and intra-articular pathology (e.g., cartilage loss, wear patterns)



³²With the use of the handpiece; As demonstrated in cadaveric and sawbone studies

Measured Resection using Handheld Robotics

- Accurate execution with a handheld burr³⁴⁻³⁸
- The Visualize Cut screen displays a real-time bone model, enabling surgeons to:
 - Compare planned versus actual resections (if using hybrid technique with cut block)
 - Verify cut depth and angular alignment relative to plan



Objectively assess joint laxity with CORI Digital Tensioner

- Measure joint laxity without making a femoral or tibial cut^{39,40}
- Automatic data capture when a predefined force is reached and maintained throughout range of motion (ROM)
- Allows surgeons to define the target force setting (50±10N, 100±10N, or 150±10N) shown to support consistent alignment tension³⁹⁻⁴¹



Notes

This image shows a full page of white paper with horizontal grey ruling lines. The word "Notes" is printed at the top left. There are 21 horizontal lines in total, creating 20 equal-sized rows for writing.

Products may not be available in all markets because product availability is subject to the regulatory and/or medical practices in individual markets. Please contact your Smith+Nephew representative or distributor if you have questions about the availability of Smith+Nephew products in your area. For detailed product information, including indications for use, contraindications, precautions and warnings, please consult the product's applicable Instructions for Use (IFU) prior to use.

Smith & Nephew, Inc.
1450 Brooks Road
Memphis, Tennessee 38116
USA

www.smith-nephew.com

©Trademark of Smith+Nephew
All Trademarks acknowledged
©2026 Smith+Nephew
38236 V2 08/26

References

- 1.** Hungerford DS, Krackow KA. Total joint arthroplasty of the knee. *Clin Orthop Relat Res.* 1985;192:23-33.
- 2.** Almaawi A, Hutt J, Masse V, Lavigne M, Vendittoli P. Impact of mechanical and restricted kinematic alignment on Knee anatomy in Total Knee Arthroplasty. *J Arthroplasty.* 2017;32(7):2133-2140.
- 3.** Scott CEH, Howie CR, MacDonald D, Biant LC. Predicting dissatisfaction following total knee replacement. *J Bone Joint Surg Am.* 2010;92-B(9):1253-1258.
- 4.** Johal P, Williams A, Wragg P, Hunt D, Gedroyc W. Tibio-femoral movement in the living knee. A study of weight bearing and non-weight bearing knee kinematics using 'interventional' MRI. *J Biomech.* 2005;38(2):269-276.
- 5.** MacDessi SJ, Griffith-Jones W, Harris IA, Bellemans J, Chen DB. Coronal Plane Alignment of the Knee (CPAK) classification. *Bone Joint J.* 2021;103-B(2):329-337.
- 6.** Berend ME, Ritter MA, Meding JB, et al. Tibial Component Failure Mechanisms in Total Knee Arthroplasty. *Clin Orthop Relat Res.* 2004;428:26-34.
- 7.** Green GV, Berend KR, Berend ME, Glisson RR, Vail TV. The Effects of Varus Tibial Alignment on Proximal Tibial Surface Strain in Total Knee Arthroplasty: The Posteromedial Hot Spot. *J Arthroplasty.* 2002;17(8):1033-1039.
- 8.** Moreland JR. Mechanisms of Failure in Total Knee Arthroplasty. *Clin Orthop Relat Res.* 1988;226:49-64.
- 9.** Ritter MA, Faris PM, Keating M, Meding JB. Postoperative Alignment of Total Knee Replacement. Its Effect on Survival. *Clin Orthop Relat Res.* 1994;299:153-156.
- 10.** Fang DM, Ritter MA, Davis KE. Coronal alignment in total knee arthroplasty: just how important is it? *J Arthroplasty.* 2009;24(6 Suppl):39-43.
- 11.** Perillo-Marcone A, Barrett DS, Taylor M. The Importance of Tibial Alignment Finite Element Analysis of Tibial Malalignment. *J Arthroplasty.* 2000;(15)8:1020-1027.
- 12.** Berger RA, Crossett LS, Jacobs JJ, Rubash HE. Malrotation Causing Patellofemoral Complications After Total Knee Arthroplasty. *Clin Orthop Relat Res.* 1998;356:144-153.
- 13.** Miller MC, Berger RA, Petrella AJ, Karmas A, Rubash HE. Optimizing Femoral Component Rotation in Total Knee Arthroplasty. *Clin Orthop Relat Res.* 2001;392:38-45.
- 14.** Singerman R, Pagan HD, Peyser AB, Goldberg VM. Effect of Femoral Component Rotation and Patellar Design on Patellar Forces. *Clin Orthop Relat Res.* 1997;334:345-353.
- 15.** Akagi M, Matsusue Y, Mata T, Asada Y, Horiguchi M, Iida H, Nakamura T. Effect of rotational alignment on patellar tracking in total knee arthroplasty. *Clin Orthop Relat Res.* 1999;Sep(366):155-163.
- 16.** Koh DTS, Woo YL, Yew AKS, Yeo SJ. Kinematic aligned femoral rotation leads to greater patella tilt but similar clinical outcomes when compared to traditional femoral component rotation in total knee arthroplasty. A propensity score matched study. *Knee Surg Sports Traumatol Arthrosc.* 2021 Apr;29(4):1059-1066.
- 17.** Iriuchishima T, Ryu K. A Comparison of Rollback Ratio between Bicruciate Substituting Total Knee Arthroplasty and Oxford Unicompartmental Knee Arthroplasty. *J Knee Surg.* 2018;31(6):568-572.
- 18.** Murakami K, Hamai S, Okazaki K, et al. Knee kinematics in bi-cruciate stabilized total knee arthroplasty during squatting and stairclimbing activities. *J Orthop.* 2018;15(2):650-654.
- 19.** Grieco TF, Sharma A, Dessinger GM, Cates HE, Komistek RD. In Vivo Kinematic Comparison of a Bicruciate Stabilized Total Knee Arthroplasty and the Normal Knee Using Fluoroscopy. *J Arthroplasty.* 2018;33(2):565-571.
- 20.** Smith LA, Nachtrab J, LaCour M, et al. In Vivo Knee Kinematics: How Important Are the Roles of Femoral Geometry and the Cruciate Ligaments? *J Arthroplasty.* 2021;36:1445-1454.
- 21.** Murakami K, Hamai S, Okazaki K, et al. In vivo kinematics of gait in posterior stabilized and bicruciate-stabilized total knee arthroplasties using image-matching techniques. *Int Orthop.* 2018;42(11):2573-2581.
- 22.** Mayman DJ, Patel AR, Carroll KM. Hospital Related Clinical and Economic Outcomes of a Bicruciate Knee System in Total Knee Arthroplasty Patients. Poster presented at: ISPOR Symposium; 19-23 May, 2018; Baltimore, Maryland, USA.
- 23.** Nodzo SR, Carroll KM, Mayman DJ. The Bicruciate Substituting Knee Design and Initial Experience. *Tech Orthop.* 2018;33(1):37-41.
- 24.** Di Benedetto P, Vidi D, Colombo, Buttironi MM, Cainero V, Causero A. Pre-operative and post-operative kinematic analysis in total knee arthroplasty: A pilot study. *Acta Biomed.* 2019;90:91-97.
- 25.** Takubo A, Ryu K, Iriuchishima T, Tokuhashi Y. Comparison of Muscle Recovery Following Bi-cruciate Substituting versus Posterior Stabilized Total Knee Arthroplasty in the Asian Population. *J Knee Surg.* 2017;30(7):725-729.
- 26.** Noble PC, Scuderi GR, Brekke AC, et al. Development of a New Knee Society Scoring System. *Clin Orthop Relat Res.* 2012;470(1):20-32.
- 27.** Noble PC, Gordon MJ, Weiss JM, Reddix RN, Condit MA, Mathis KB. Does total knee replacement restore normal knee function? *Clin Orthop Relat Res.* 2005(431):157-165.
- 28.** Kaneko T, Kono N, Mochizuki Y, Hada M, Toyoda S, Musha Y. Bicruciate substituting total knee arthroplasty improved medio-lateral instability in mid-flexion range. *J Orthop.* 2017;14(1):201-206.
- 29.** Hyodo K, Kanamori A, Kadone H, Takahashi T, Kajiura M, Yamazaki M. Gait Analysis Comparing Kinematic, Kinetic, and Muscle Activation Data of Modern and Conventional Total Knee Arthroplasty. *Arthroplasty Today.* 2020;6(3):338-342.
- 30.** Hada M, Mizu-Uchi H, Okazaki K, et al. Bi-cruciate stabilized total knee arthroplasty can reduce the risk of knee instability associated with posterior tibial slope. *Knee Surg Sports Traumatol Arthrosc.* 2018;26(6):1709-1716.
- 31.** Smith+Nephew 2012. JRN2 KneeSim Analysis Memo.
- 32.** Smith+Nephew 2020. Internal Report. EA/RECON/VISIONAIRE/001/v6.
- 33.** Smith+Nephew 2020. Optimus TKA Accuracy Verification Internal Report. TR1700 REVA.
- 34.** Kaper BP, Villa A. Accuracy and Precision of a Handheld Robotic-guided Distal Femoral Osteotomy in Robotic-assisted Total Knee Arthroplasty. *European Knee Society Arthroplasty Conference; 2019; Valencia, Spain.*
- 35.** Vaidya NV, Deshpande AN, Panjwani T, Patil R, Jaysingani T, Patil P. Robotic-assisted TKA leads to a better prosthesis alignment and a better joint line restoration as compared to conventional TKA: a prospective randomized controlled trial. *Knee Surg Sports Traumatol Arthrosc.* Feb 2022;30(2):621-626.
- 36.** Bollars P, Boeckxstaens A, Mievis J, Kalai S, Schotanus M, Janssen D. Preliminary experience with an imagefree handheld robot for total knee arthroplasty: 77 cases compared with a matched control group. *European Journal of Orthopaedic Surgery & Traumatology.* 2020;30(4):723-729.
- 37.** Negrín R, Duboy J, Iñiguez M, et al. Robotic-assisted vs conventional surgery in medial unicompartmental knee arthroplasty: a clinical and radiological study. *Knee Surg Relat Res.* Feb 12 2021;33(1):5.
- 38.** Batailler C, White N, Rinaldi FM, Neyret P, Servien E, Lustig S. Improved implant position and lower revision rate with robotic-assisted unicompartmental knee arthroplasty. Article. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA.* 2019;27(4):1232-1240.
- 39.** Smith+Nephew 2022. Internal Report. 10059269.
- 40.** Smith+Nephew 2022. Internal Report. TR100123.
- 41.** Smith+Nephew 2022. Internal Report. TR100116, Rev B.