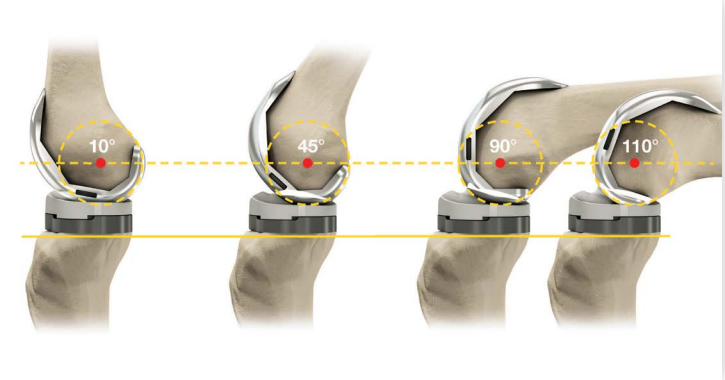
Stability and kinematics **with Triathlon**

Triathlon total knee arthroplasty (TKA) has demonstrated favorable outcomes in terms of stability[1-4], kinematics[3-4], and long-term functional outcomes[5-6] in clinical evidence around the world.

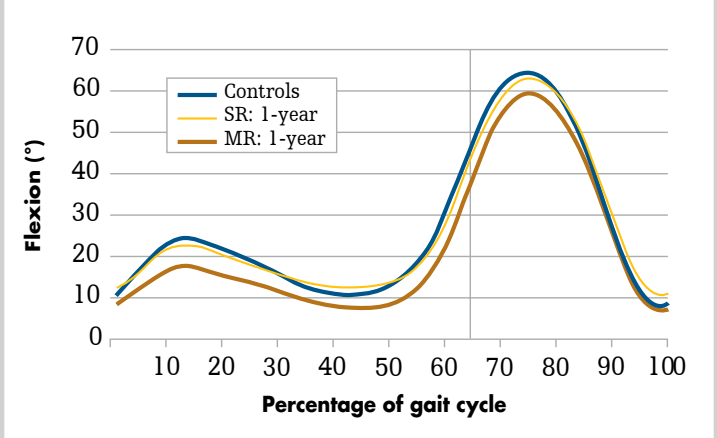
Stability

The Triathlon single radius is designed to restore the knee's single center of rotation during active flexion, where most motion occurs.[7-8] This allows for constant ligament tension and stability in flexion.[1-4]



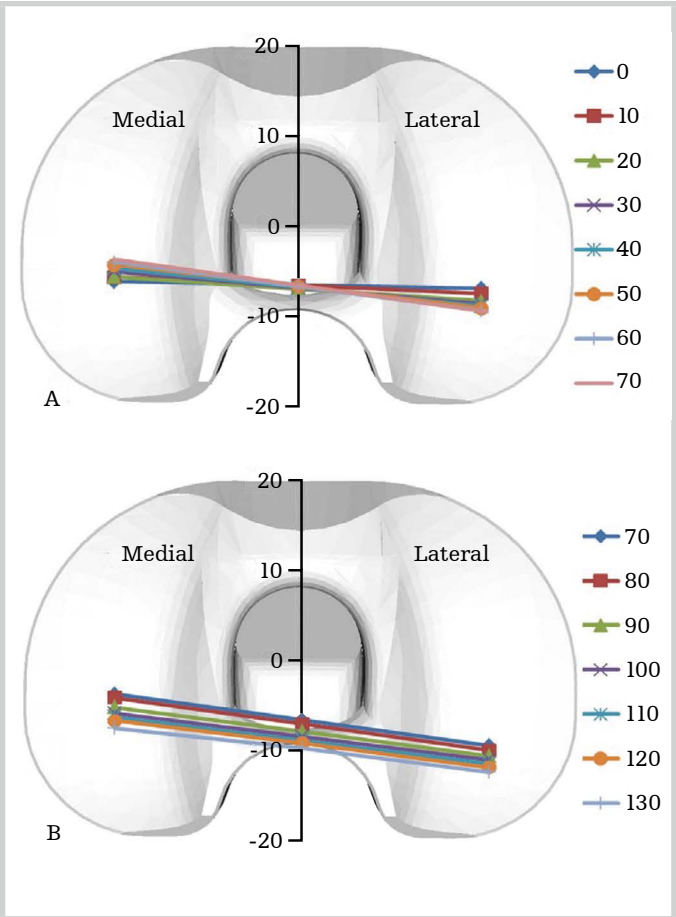
Kinematics

In a gait study, patients with Triathlon TKA experienced kinematics that more closely mimicked that of the healthy control patients than another contemporary TKA design.[4]



Gait data: flexion one year after TKA

In a separate fluoroscopic study, patients with Triathlon TKA showed femoral rollback and a medial pivot pattern while going into flexion.[3]



The movement of femoral flexion axis during deep knee flexion (A: 0°–70° flexion, B: 70° to maximum flexion).

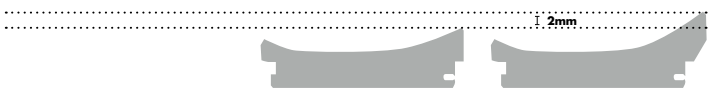
Functional outcomes

In a 10-year follow up study on 462 TKAs in 426 patients, Triathlon TKA showed high implant survivorship.[5] Patients had well maintained improvement in Patient Reported Outcome Measures (PROMs) and patient satisfaction rates of 88%.[5]

Options for different PCL conditions

The Triathlon Cruciate-Retaining (CR) Femoral Component is compatible with different tibial inserts based on PCL viability. The Triathlon Condylar Stabilized (CS) Tibial Insert has an anterior-lip designed to provide anterior stability and is an alternative for patients with an incompetent or sacrificed PCL.

An in vivo investigation compared the intra-operative kinematics of CR, CS, and PS Triathlon inserts. For patients without intact PCLs, the Triathlon CS Inserts had a stable kinematic pattern that was similar to the Triathlon PS Insert.[20]



	Triathlon CR Insert	Triathlon CS Insert
Flexion	150°	150°
Internal/ external rotation	±20°	±20°

Functional outcomes for Triathlon Inserts

A retrospective study compared the post-operative function of patients with a Triathlon CR Tibial Insert when the PCL was competent with those who had a Triathlon CS Tibial Insert when the PCL was attenuated.[9] Patients with Triathlon CS Tibial Inserts had equivalent PROMs and patient satisfaction at 1-year compared to those with Triathlon CR Tibial Inserts. There was a small difference in the Physical Composite Scale scores on Short Form-12(SF-12 PCS), however, the difference did not reach minimum clinical importance.[9]

Postoperative functional measures according to the CS vs. CR insert study[9]

PROM	CS (n=54)	CR (n=364)	*p* value*
OKS, mean (SD)	33.2 (9.9)	34.6 (93)	0.30
EQ-5D, z mean (SD)	0.66 (0.25)	0.70 (0.26)	0.30
SF-12 PCS, mean (SD)	38.1 (12.1)	41.2 (10.2)	0.04
SF-12 MCS, mean (SD)	48.0 (8.8)	47.8 (8.1)	0.86
Pain VAS, mean (SD)	64.5 (27.1)	70.6 (27.8)	0.14

In a separate study with minimum 2-year follow up of patients with a sacrificed PCL, patients who received a Triathlon CS Tibial Insert demonstrated excellent clinical outcomes that were comparable to the results obtained with the Triathlon PS Tibial Insert.[10] There were no statistically significant differences in Knee Society pain/motion scores, Knee Society function scores, or lower extremity activity scale (LEAS) at 1-and 2-year follow up.[10] Historically, traditional CR TKA designs tended to have decreased range of motion (ROM) compared to a PS design.[11] In this study, both Triathlon CS and PS designs achieved ROM of 124.4 and 125.1 with no statistically significant difference between the two groups.[10]

The 5-year follow up from the same trial also showed excellent clinical outcomes of the Triathlon CS design that were comparable to the results obtained with the Triathlon PS design.[12] Excluding two reoperations necessitated by traumatic events, implant survivorship for both Triathlon CS and PS designs was 100% at a 5-year follow up.[12]

Functional outcomes for Persona MC vs. PS

The Persona TKA allows both standard CR and Medial Congruent (MC) Inserts to articulate with the same femoral component.[13] There is currently no long-term data supporting the outcome of this new MC insert. PCL-sacrificed patients undergoing TKA using Persona MC inserts showed no statistically significant differences in KSS and Oxford Knee Score (OKS) comparing to the Persona PS Insert at minimum 2-year follow up. This study reported a statistically but not clinically significant higher ROM of 123° for the MC group vs. 120° for the PS group.[14]

The Triathlon TKA also allows both CR and CS Tibial Inserts to articulate with the same femoral component. Both Triathlon CS and Triathlon PS groups reported excellent and comparable clinical, functional, and radiographic outcomes with no statistical differences in ROM (CS: 126°; PS:127°).[10] The 5-year follow up of the same study reported no statistically significant difference in ROM for Triathlon CS and Triathlon PS groups (CS: 125°; PS: 125°).[12]

Mixed reviews on medial congruent TKA designs

A variety of different medial congruent TKA designs have been introduced to facilitate a medial pivot kinematic pattern after TKA. There is currently no consensus in the literature on how medial congruent TKA designs affect patient outcomes post-operatively.[15-18] Additionally, a study using sensor-embedded tibial trials discovered that intraoperative medial pivot pattern did not govern post-operative clinical success.[19]

Clinical outcomes of medial congruent vs. contemporary TKA designs

Source	Device & manufacturer	Outcome
Haddad et. al.[15]	SAIPH by MatzOrtho Triathlon by Stryker	Medial congruent TKA showed no statistically significant differences in Knee Society Score, OKS, or gait at 1-year follow up.
Samy et al.[16]	EVOLUTION by MicroPort Persona by Zimmer Biomet	Medial congruent TKA showed no statistically significant difference in ROM at 1-year follow up. FJS was statistically significantly higher for the medial congruent TKA compared specifically to the Persona design.
Yuan et al.[17]	Advance by Wright Medical NexGen LPS-Flex by Zimmer Biomet	Medial congruent TKA showed no statistically significant differences in changes in Hospital for Special Surgery Knee Score (HSS knee) or Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores from pre to post-operation.
Kim et al.[18]	Advance by Wright Medical PFC Sigma by DePuy	Medial congruent TKA showed significantly lower knee score, lower ROM, and lower patient satisfaction at minimum follow up of 11 years.

Conclusion

Many design modifications in TKA have aimed to enhance clinical outcomes, but not all implant design modifications have successfully demonstrated enhanced outcomes.[15-18] Since its first clinical use in 2004, Triathlon has demonstrated excellent stability[1-4], kinematics[3-4], and long term functional outcomes[5-6] in data from around the world.

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