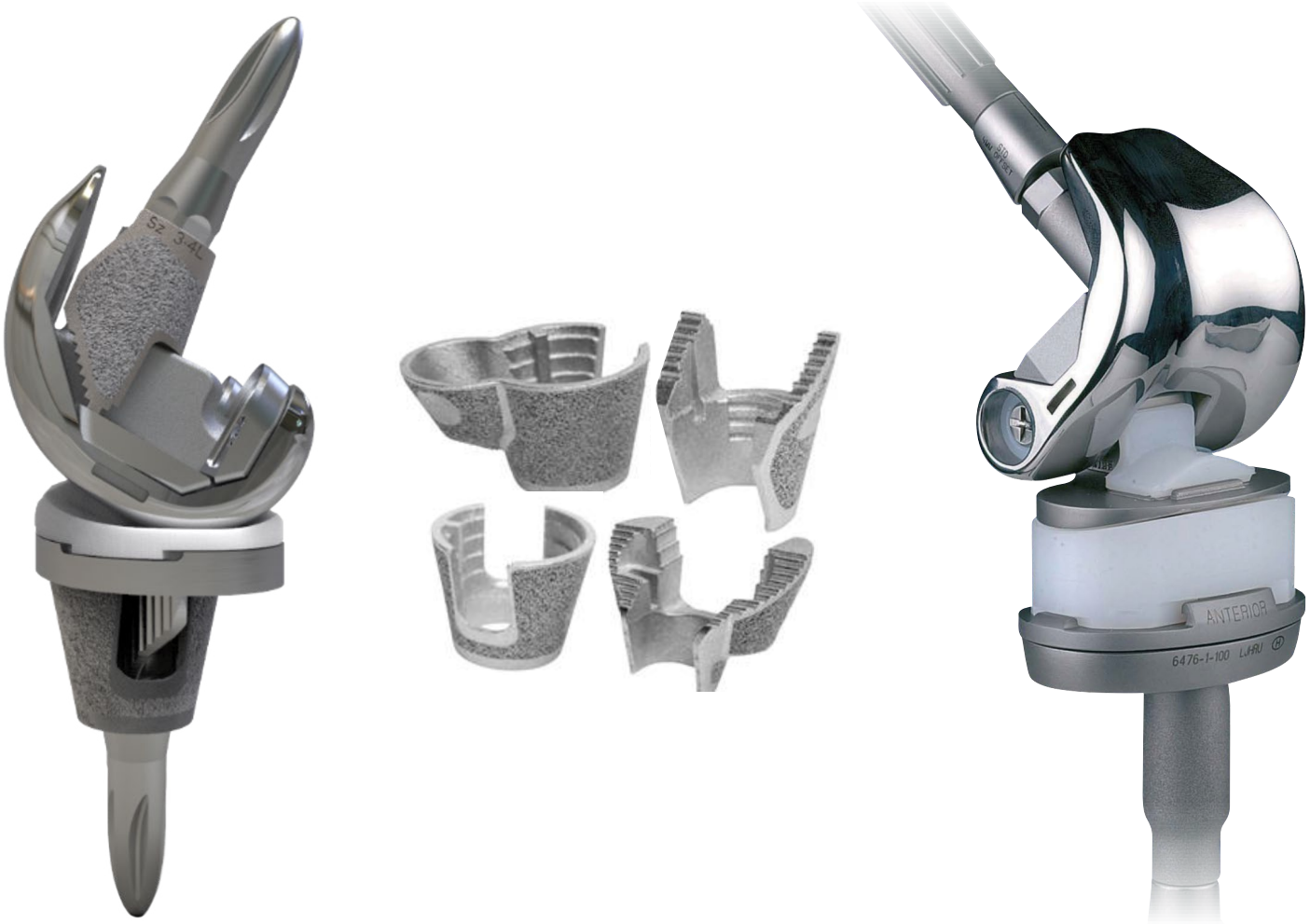
stryker

Stryker's Revision Knee
clinical evidence



Executive summary

The prevalence of primary and revision total knee arthroplasty (TKA) is increasing worldwide due to increased longevity and osteoarthritis.[1] As a technically demanding procedure, revision TKA is reported to produce inferior results to primary knee arthroplasty, with a higher risk of complications.[2] Revision rates after primary arthroplasty are low, but the number of patients who have undergone TKA suggests a significant revision healthcare burden.[3] The clinical compendium focuses on short-term, mid-term and long-term survivorship and functional data for Triathlon® TS, Triathlon Tritanium Cones and the Modular Rotating Hinge systems.

Triathlon TS

The goals of revision TKA include reconstructing bony defects to restore the anatomical joint line and achieving a well-fixed, stable joint that helps improve the patient's quality of life. The Triathlon Revision system is designed to provide simplicity in achieving joint stability and fixation. The Triathlon Revision system provides patented implants and instrumentation designed to properly locate the joint line and balance the knee consistently, as well as reaming instrumentation to allow for accurate preparation of metaphyseal fixation.[4-7] The Triathlon Revision system focuses on stability, joint line, fixation and balance.

Stability – The anatomic location of the Triathlon TS femoral boss reduces the need for offsetting to provide flexion stability; additionally, Triathlon TS's insert geometry allows for varus/valgus stability with rotational freedom.[8-9]

Joint line – Triathlon TS is designed to facilitate joint line restoration, which aids in reducing issues such as decreased motion, decreased extensor strength, anterior knee pain and mid-flexion instability.[4, 25]

Fixation – Cone preparation and implants provide an intimate, line-to-line fit, which allows for accurate Triathlon Tritanium Cone Augment positioning and initial fixation.[10-14]

Balance – The single radius is designed to restore the knee's single center of rotation during active flexion, allowing for constant ligament balance and enhanced stability in flexion.[15-20]

Triathlon TS Cone Augments

Triathlon Revision features a reamer-based system of Tibial and Femoral Triathlon TS Cone Augments, which are designed to provide stability in revision cases where metaphyseal bone loss management is necessary.[7] The Triathlon TS Cone Augments are designed to promote metaphyseal fixation without constraining subsequent implant positioning. The combination of solid and porous structures allows for reduced cone augment cross sections while still meeting fatigue strength requirements.[11,12,21]

Modular Rotating Hinge

The Modular Rotating Hinge (MRH) has been designed for knees with severe joint destruction and/or ligament instability where a condylar-style implant may not be appropriate. MRH has been on the market for over 30 years showing proven clinical outcomes.[22] Built on the clinical success of Triathlon TS and the Modular Rotating Hinge (MRH), the posterior hinge mechanism design was incorporated into the Triathlon Hinge.

Triathlon Revision Knee System

Survivorship

Gwam, C, et al. "Short- to mid-term outcomes of revision total knee arthroplasty patients with total stabilizer knee system." Journal of Arthroplasty, 2017[23]

Hitt. K. et al., "Improved health-related quality of life and clinical outcomes using a contemporary revision total knee system." EFORT Congress 2016, Poster #1577.[24]

Function

Samson et al., "Optimizing posterior condylar offset and joint line restoration in revision total knee arthroplasty using a contemporary implant system." Techniques in Orthopaedics, 2019[25]

Hamilton et al. "Aseptic revision knee arthroplasty with total stabilizer prostheses achieve similar functional outcomes to primary total knee arthroplasty at 2 years: a longitudinal cohort study." The Journal of Arthroplasty, 2017[26]

Hossain et al. "Early clinical and radiological outcomes of the metaphyseally fixed totally stabilized knee prosthesis in primary total knee arthroplasty." Journal of Knee Surgical, 2019[27]

Triathlon TS Cone Augments

Survivorship

Behery et al. "Survivorship and radiographic evaluation of metaphyseal cones with short cemented stems in revision total knee arthroplasty." The Journal of Arthroplasty, 2022[28]

Mahan, Chad, et al. "Metaphyseal cones in revision total knee arthroplasty with cemented and cementless stems: excellent survivorship with caveats about stem fixation." Orthopaedic Proceedings, 102-B, 7 October 2020.[29]

Denehy et al. "Metaphyseal fixation using highly porous cones in revision total knee arthroplasty: minimum two year follow up study." The Journal of Arthroplasty, 2019[30]

Modular Rotating Hinge

Survivorship

Wignadasan et al. "Long-term results of revision total knee arthroplasty using a rotating hinge implant." The Knee, 2021[22]

Kowalczewski et al. "Primary rotating-hinge total knee arthroplasty: good outcomes at mid-term follow-up." The Journal of Arthroplasty, 2014[31]

Survivorship

Short-to-midterm outcomes of revision total knee arthroplasty patients with a total stabilizer knee system[23]

Authors: Chukwuweike U. Gwam, Morad Chughtai, Anton Khlopas, Nequesha Mohamed, Randa K. Elmallah, Arthur L. Malkani, Michael A. Mont.

Publication: Journal of Arthroplasty, Vol 32 (8), pages 2480-2483.

Goal of trial: To evaluate device survivorship, patient-reported outcomes, postoperative complications and radiographic outcomes of patients who underwent revision TKA using Triathlon TS Revision Knee System.

Materials and methods: Individuals who underwent revision total knee arthroplasty using the new total stabilizer knee system were analyzed in two hospital databases. Ninety-three patients from two hospitals had rTKA with Triathlon TS, with an average age of 65 and a four-year follow-up period. Survival was assessed using Kaplan-Meier survival curves, KSS was collected pre- and postoperatively and radiographic evaluation was conducted using the Knee Society Roentgenographic Assessment and Scoring System.

Results: After 2-7 years (mean four years), aseptic survivorship was 96%, and all-cause survivorship was 94%. The mean KSS was 86, and the mean functional KSS was 52 at final follow-up. The mean postoperative flexion was 106 degrees, and extension was 2 degrees. On radiographic examination, there was no evidence of increasing radiolucency or osteolysis, excluding aseptic and all-cause failures.

Table 1. Aseptic survivorship of posterior-stabilized implants in revision total knee arthroplasty

Author	Year	No. of knees	Aseptic survivorship
Meijer et al.	2013	69	1 y, 95%
			2 y, 92%
			5 y, 95%
Greene et al.	2013	119	5 y, 100%
Lee et al.	2013	79	8 y, 93%
Dalury and Adams	2012	26	6 y, 100%
Peters et al.	1997	57	40 mo, 94%
			99 mo, 75%

Conclusion: This study demonstrated favorable survivorship, improvements in range-of-motion and clinical outcomes, a low rate of complications and no further radiographic failures (at a mean four-year follow-up) in revision TKA patients who used this revision system.

Survivorship

Improved health-related quality of life and clinical outcomes using a contemporary total knee system[24]

Authors: K. Hitt, E. Smith, C. Della Valle, D. Campbell, K. Robinson.

Journal: Baylor Scott and White, Temple TX, Tufts Medical Center, Boston MA.

Goal of trial: The goal of this study was to look at the pain, function and overall health outcomes of patients who had a single radius revision TKA system and compare them to a Short Form-6D quality of life analysis.

Materials and methods: This data was collected as part of a multicenter, prospective, post-market investigation. One hundred eighty-one revision TKA cases were analyzed using the Triathlon TS Revision System. The research cohort consisted mostly of first-time revision patients with osteoarthritis.

Clinical and patient-reported outcomes including the Knee Society Score (KSS), Lower Extremity Activity Scale (LEAS), Short Form 36 (SF-36) and Hospital for Special Surgery (HSS) Patella score were evaluated preoperatively and at 6 weeks, 6 months, 1 year and 2 years postoperatively. A student's t-test was used to examine the statistical significance of postoperative improvements.

Additionally, SF-6D scores were obtained by transforming SF-36 scores using a method proposed by Brazier et al., and the KSS was used to assess effect magnitude and clinical association with patient pain and function.

Results: Overall, the study population displayed significant postoperative improvements in both clinical and patient-reported outcomes, as seen in Figures 1 and 2.

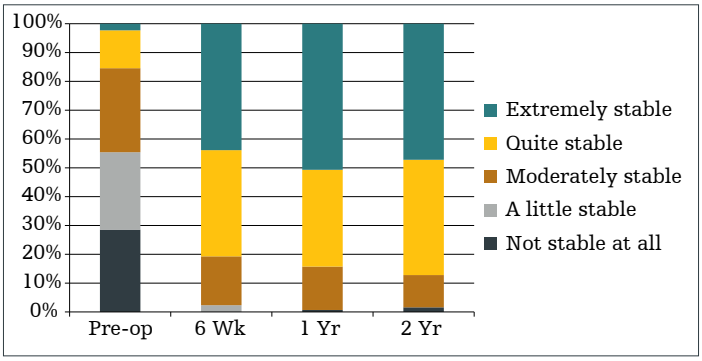


Figure 1. Significant improvements ($p<0.0001$) seen in patient reported evaluation of stability through 2 years postoperative.

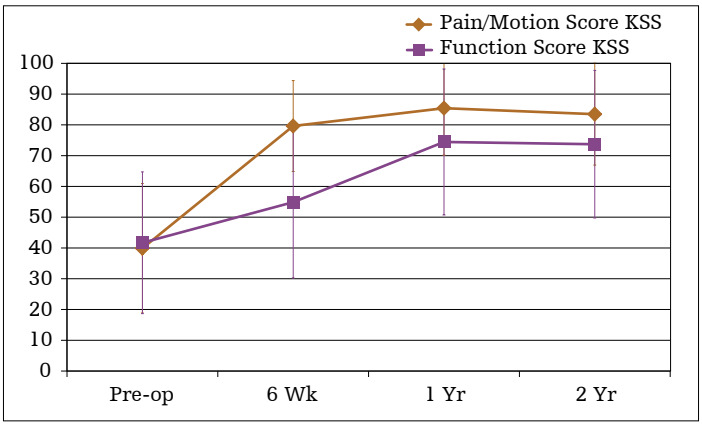


Figure 2. KSS pain and function over time

Conclusion: Patients receiving the Triathlon TS Revision Knee System displayed statistically significant improvements in pain, knee function and activity in early follow-up, with continued improvements through two years.

Function

Aseptic revision knee arthroplasty with total stabilizer prostheses achieves similar functional outcomes to primary total knee arthroplasty at 2 years: a longitudinal cohort study[26]

Authors: David Hamilton, Phillip Simpson, James Patton, Colin Howie, Richard Burnett

Publication: Journal of Arthroplasty, 2017

Goal of trial: The goal of this study was to examine patient-reported functional outcomes in the initial 2 years following surgery for revision TKA and compare the data with existing (published) data for primary TKA.

Materials and methods: Between 2010 and 2012, 53 total stabilizer implants were prospectively evaluated in sequential aseptic revision total knee arthroplasties performed at a single UK orthopaedic teaching hospital. The findings were compared to those of a previous study involving 212 TKAs performed by the same surgical group. Those undergoing primary TKA for osteoarthritis were included in this comparative cohort. In all patients, the surgeon's method was to use cemented, cruciate-retaining, fixed-bearing implants. In this study, the comparator group assessed the functional outcomes of a cohort of primary TKAs using identical outcome evaluations at equivalent time periods, allowing for direct comparison.

Results: Longitudinal changes in all four outcome measures were statistically significant at $P < .001$ (repeated measures ANOVA), highlighting the positive effect of revision arthroplasty on the patient's pain and physical function (Figures 1-4). Post-hoc analysis revealed statistically significant variations in all four outcome metrics between early assessment periods (preop, 6 weeks and 26 weeks postoperative); however, subsequent changes over time were not statistically different from the 6-month time point. The result data for this revision cohort were compared to a previously reported cohort of 212 primary TKA patients treated by the same surgeons with equivalent outcome assessments at comparable time points. The study found that a consecutive cohort of aseptic revision TKA patients had high levels of functional performance in the first two years after surgery. In terms of range of motion, pain report, patient-reported outcome score and timed functional performance, postoperative outcomes were comparable to those obtained after primary knee arthroplasty.

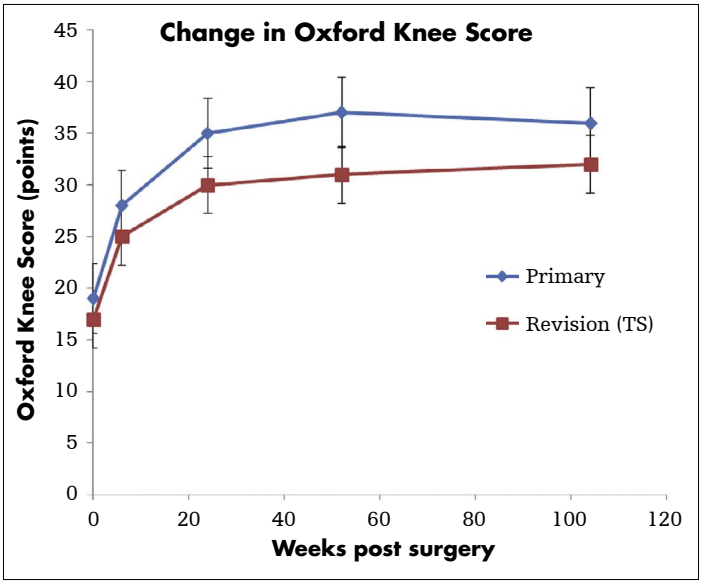


Figure 1. Oxford Knee Score (OKS; comparators with 95% confidence intervals [CIs]).

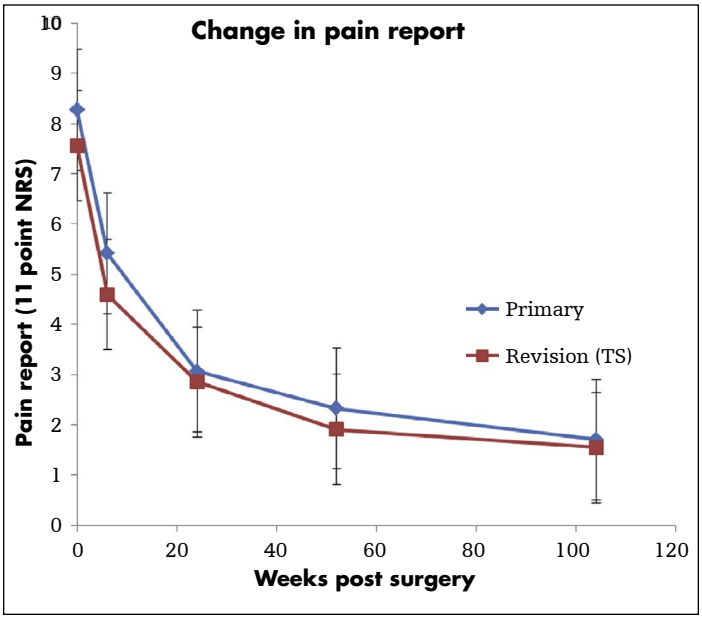


Figure 2. Pain scores (comparators with 95% CIs). NRS, numerical rating scale.

Conclusion: Patients who had revision TKA for aseptic failure with semi-constrained total stabilizer implant made substantial improvements in the OKS, pain ratings, knee flexion and timed functional performance in the first two years after surgery. The early functional outcomes are remarkably similar to those reported for primary arthroplasty, demonstrating that high levels of patient function can be achieved following revision knee arthroplasty with semi-constrained devices.

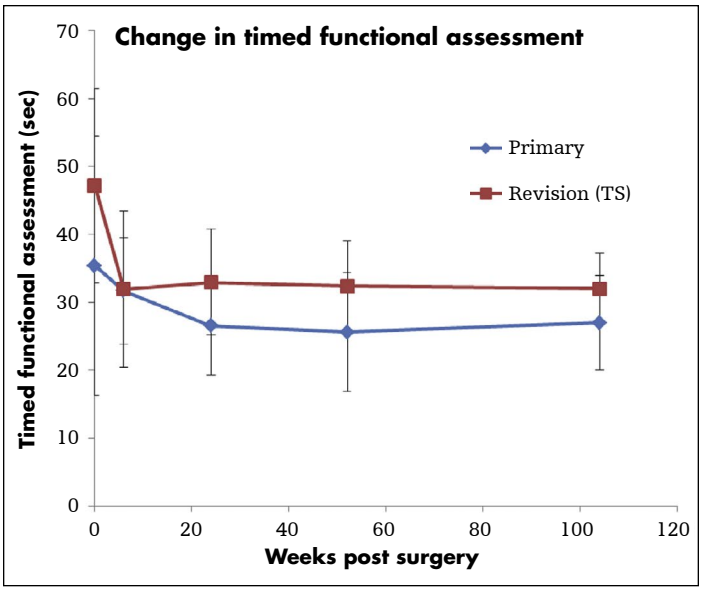


Figure 3. Timed functional performance (comparators with 95% CIs).

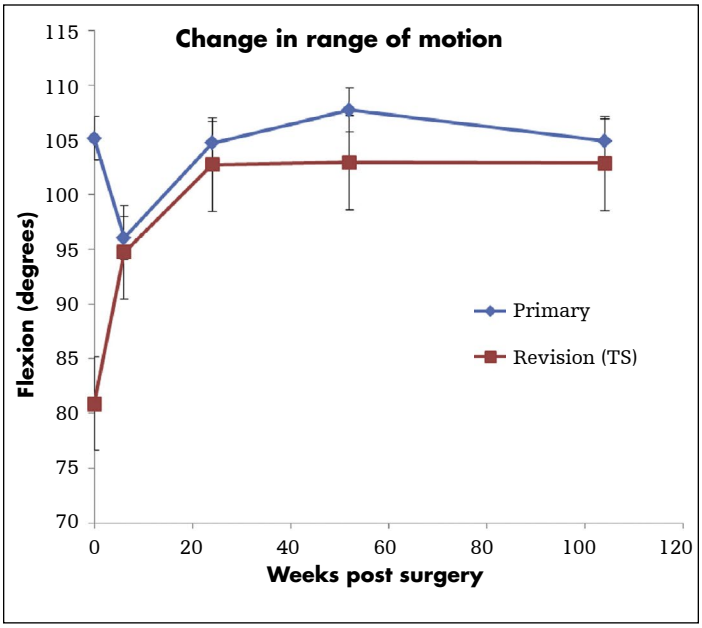


Figure 4. Range of motion (comparators with 95% CIs).

Function

Optimizing posterior condylar offset and joint line restoration in revision total knee arthroplasty using a contemporary implant system[25]

Authors: Samson, Anthony; Hamilton, David, F.; Loh, Brian; MacPherson, Gavin; Burnett, Richard.

Publication: Techniques in Orthopaedics, 2019

Goal of trial: To present a variation of the standard surgical technique for the Triathlon TS system that has been developed and utilized at Edinburgh Royal Infirmary and to describe their focus on joint line (JL) restoration and posterior condylar offset (PCO) through evaluation in Triathlon TS procedures performed with this philosophy.

Materials and methods: Prospective data were collected for rTKA to Triathlon TS implant from 2011 to 2015 from a single surgeon using the described operative technique. Pre- and postoperative radiographs were reviewed to evaluate JL and PCO ratio. Functional outcomes and satisfaction were reported preoperatively and 12 months postoperatively with the Oxford knee score (OKS).

Results on OKS and satisfaction: In total, 29 patients with an average age of 72.9; JL ratio reflects a statistically significant change preoperative to postoperative of 0.06 ($p=0.001$). PCO ratio reflects a statistically significant change of 0.15 ($p<0.001$).

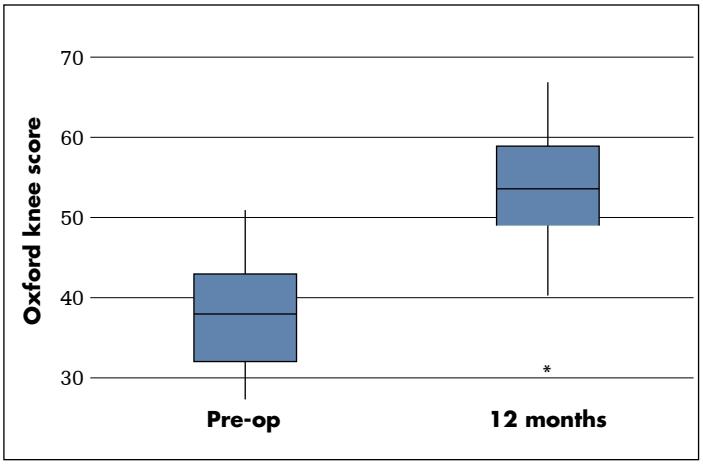


Figure 1. Oxford Knee Score pre- and post-surgery: Difference in preoperative and 12 months postoperative Oxford Knee Scores.

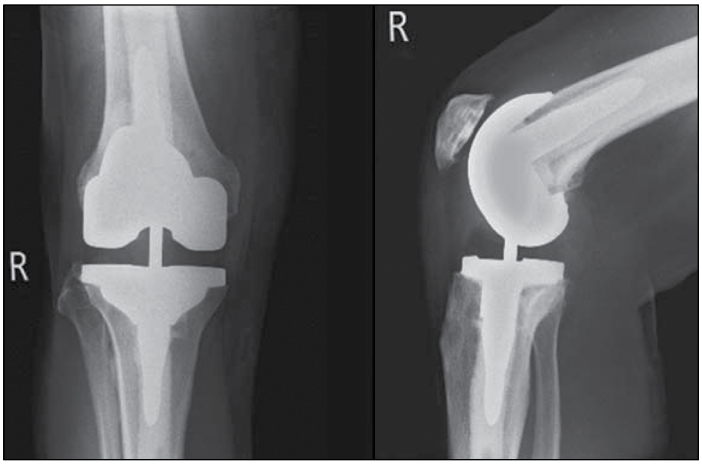


Figure 2. Revision total knee arthroplasty with zonal fixation utilizing short cemented stems.

Conclusion: The technique of short cemented stems allows femoral flexion and posterior translation thereby increasing the PCO while maintaining JL. The data demonstrates a significant improvement in OKS and very high patient satisfaction scores at one year.

Function

Early clinical and radiological outcomes of the metaphyseal fixed total stabilized knee prosthesis in primary total knee arthroplasty[27]

Authors: Fahad Hossain, Sujith Konan, Babar Kayani, Christina Kontoghiorghe, Toby Barrack, Fares Sami Haddad

Publication: The Journal of Knee Surgery, 2019

Goal of study: To assess whether the use of contemporary TS implant with its metaphyseally-fixed components would be associated with inferior outcomes compared with conventional standard primary posterior stabilized (PS) implants.

Materials and methods: After a minimum follow-up of 24 months, 38 consecutive primary TKAs performed utilizing the metaphyseally-fixed TS implant and 76 matched receiving primary main PS TKA were reviewed. The average duration of follow-up was 61.1 months (24-102). Only participants with osteoarthritis were included in the study. The Oxford Knee Score (OKS) and range of motion (ROM) were used to measure clinical results. At six weeks, the femorotibial angle (FTA) was measured during radiographic assessment, followed by an examination of bone-implant interface lucencies at final follow-up.

Results: By the final follow-up, preoperative ROM had improved significantly from 87.8 to 95.1 in the TS and PS groups, respectively. There was no difference in ROM between the groups either preoperatively or at final follow-up. Similarly, at the final follow-up, preoperative OKS had improved from 22.9 to 42.7 to and 21.7 to 43.3 in the TS and PS groups, respectively. When the two groups were compared, there was no difference in OKS preoperatively and postoperatively. On radiographic examination at six weeks, there was a statistically significant difference in the mean total FTA between the two groups. Nonetheless, all patients had their FTA restored to within 3 degrees of the expected angles of 175 to 178 degrees. The American Knee Society Roentgenographic Assessment Tool revealed no progressive bone-cement or cement-implant interface lucencies in either group at the final follow-up.

Table 1. Demographic data for both cohorts

	TS group	PS group	p-Value
Age[a]	67.6 ± 12.4 (36-84)	66.1 ± 12.1 (39-80)	0.25
Gender			
Male	16 (42.1%)	31 (40.8%)	0.89
Female	22 (57.9%)	45 (59.2%)	
Body mass index (kg/m^2)[a]	31.2 ± 4.8 (26.4-45.0)	30.3 ± 4.4 (23.1-42.0)	0.37

Abbreviations: PS, posterior stabilized; SD, standard deviation; TS, totally stabilized
[a]Values expressed as mean ± SD with range in parentheses

Table 2. Mean pre- and postoperative clinical and radiographic findings for both cohorts

Mean scores ± SD, (range)	TS group	PS group	p-Value
Pre-op ROM	87.8 ± 24.0 (20-125)	95.1 ± 11.1 (80-120)	0.24
Post-op ROM	114.1 ± 12.3 (90-140)	112.0 ± 12.8 (90-145)	0.45
Pre-op OKS	22.9 ± 8.5 (12-40)	21.7 ± 7.5 (12-43)	0.35
Post-op OKS	42.7 ± 4.0 (29-48)	43.3 ± 2.6 (39-48)	0.73
Post-op total femorotibial valgus angle	176.1° ± 1.1 (178.8-173.3)	175.5° ± 1.1 (177.2-174.8)	0.008

Abbreviations: OKS, Oxford Knee Score; PS, posterior stabilized; ROM, range if motion; SD, standard deviation; TS, totally stabilized

Conclusion: The use of the metaphyseally-fixed TS implant in the primary TKA setting is associated with comparable clinical and functional outcomes to that of standardized PS design implants. The use of such constraint is not associated with any significant complications in the early postoperative period. While the absence of progressive lucencies at final follow up is reassuring in the study, longer-term follow up is required to assess the survivorship and revision burden in the use of such contemporary constrained stemless designs in primary TKA surgery.

Survivorship

Survivorship and radiographic evaluation of metaphyseal cones with short cemented stems in revision total knee arthroplasty[28]

Authors: Omar A. Behery, Elaine Z. Shing, Ziqing Yu, Bryan D. Springer, Thomas K. Fehring, Jesse E. Otero

Publication: The Journal of Arthroplasty, 2021

Goal of study: The purpose of this study is to evaluate the survivorship and radiographic outcomes of a single design of metaphyseal cones used in conjunction with short cemented stems.

Materials and methods: A retrospective analysis was conducted of revision total knee arthroplasty (rTKA) patients using porous titanium femoral or tibial cones in conjunction with short cemented stems (50-75 mm). Minimum follow-up was two years. Survivorship, complications and a modified Knee Society Radiographic score were analyzed.

Results: Forty-nine rTKAs were included in the study (12 femoral cones, 48 tibial cones). Varus-valgus constraint was used in 28 and a hinged bearing was used in 3 of these constructs. The majority were index rTKAs of primary components (86%), performed for aseptic loosening (51%) and reimplantation following staged treatment for infection (37%). Median follow-up was 39 months. Using a modified Knee Society Radiographic score, all constructs were classified as stable. Postoperatively four rTKAs were complicated by recurrent infection (8%), periprosthetic fracture 2 (4%) and superficial wound infection 1 (2%). Seven rTKAs (14%) required reoperation. The majority of reoperations were debridement and irrigation with implant retention for infection. Metaphyseal cone constructs with short cemented stems demonstrated 100% survivorship free of revision for aseptic loosening without evidence of radiographic loosening in any case.

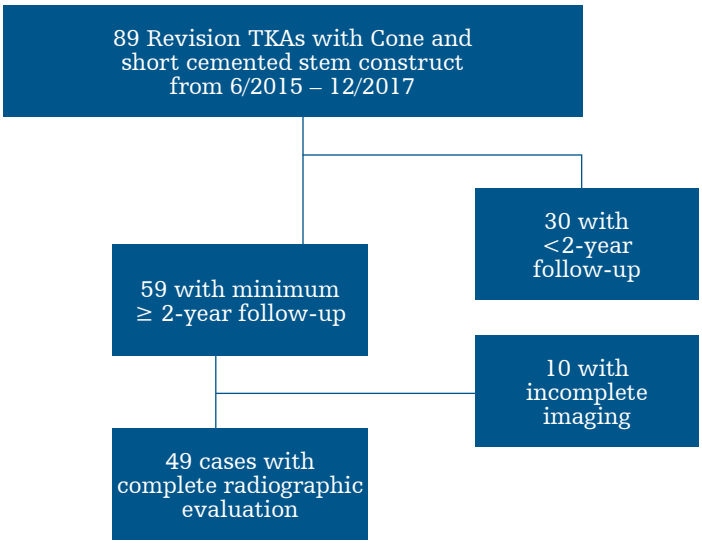


Table 1. Characteristics of index revision total knee arthroplasty with the cone and short cemented stem construct

Index revision characteristics	Sample (n=49)
Indication	
Aseptic loosening	25 (51%)
PJI reimplantation	18 (37%)
Instability	5 (10%)
Polyethylene liner mechanical failure	1 (2%)
Total knee arthroplasty revised	
Primary TKA	42 (86%)
Revision TKA	7 (14%)
Components revised	
Femoral component	46 (94%)
Tibial component	48 (98%)
Cemented stem	19 (39%)
Press-fit stem	1 (2%)
Cone use	
Femoral cones	12 (24%)
Tibial cones	48 (98%)
Postoperative weight-bearing protocol	
Non-weight bearing	1 (2%)
Weight-bearing as tolerated	48 (98%)
Use of implant constraint	
Posterior stabilized	18 (37%)
Varus-valgus constraint	28 (57%)
Hinge	3 (6%)
Operative time (h), median ± SD (range)	3 ± 0.6 (2.1-4.2)

Abbreviations: PJI, periprosthetic joint infection; SD, standard deviation; TKA, total knee arthroplasty

Table 2. Intraoperative and Postoperative Complications of the Cone and Short Cemented Stem Revision Construct

Outcome	Sample (n-49)
Complications (n=7)	14%
Infection	4 (8%)
Wound complications	1 (2%)
Instability	0 (0%)
Aseptic loosening	0 (0%)
Postoperative and periprosthetic fracture	2 (4%)

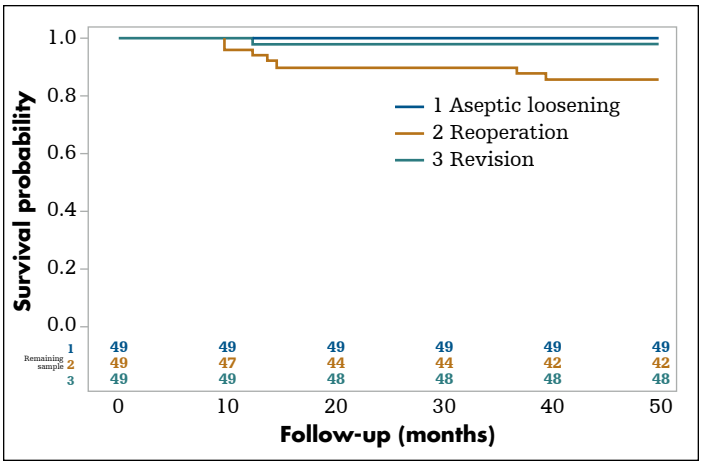


Figure 1.

Table 3. Reoperations and indications following index revision total knee arthroplasty

Case ID	First reoperation (n=7)	Second reoperation (n=5)	Third reoperation (n=1)
1	DAIR at 37 mo	DAIR at 45 mo	
2	Polyethylene exchange for arthrofibrosis at 15 mo	Repeat Polyethylene exchange at 32 mo	
3	Debridement of superficial abscess at 10 mo	DAIR at 28 mo	DAIR at 51 mo
4	DAIR at 14 mo	DAIR at 37 mo	Above-knee amputation at 40 mo
5	Extensor mechanism reconstruction for extensor lag at 10 mo	ORIF periprosthetic femur fracture at 39 mo	
6	Femoral component (no cone) revision: aseptic loosening at 12 mo		
7	DAIR at 40 mo		

Table 4. Radiographic modified Knee Society Score review of the cohort of cone and short cemented stem revision constructs

Outcome	Sample
Femoral cone and short cemented stems	n = 12
Radiographic Knee Society Score Category	
Stable (≤8)	Reviewer 1: 12 (100%), Reviewer 2: 11 (92%), Reviewer 3: 12 (100%)
Closely observe (9-19)	Reviewer 2: 1 (8%)
Loose (≥20)	None
Tibial cone and short cemented stems	N = 48
Radiographic Knee Society Score Category	
Stable (≤9)	Reviewer 1: 45 (94%), Reviewer 2: 48 (100%), Reviewer 3: 48 (100%)
Closely observe (10-22)	Reviewer 1: 3 (6%)
Loose (≥23)	None

Conclusion: The results demonstrated excellent outcomes with the use of metaphyseal cones with short cemented stems at mid-term follow-up. This construct avoids the use of long-stem fixation with associated extraction difficulty, end of stem pain and potential for malposition at the joint line.

Survivorship

Metaphyseal cones in revision total knee arthroplasty with cemented and cementless stems: excellent survivorship with some caveats about stem fixation[29]

Authors: Chad Mahan, Brenna Blackburn, Lucas A. Anderson, Christopher L. Peters, Christopher E. Pelt, Jeremy M. Gililland

Publication: Orthopaedic Proceedings, 2020

Goal of trial: To evaluate the authors' experience with 3D printed titanium metaphyseal cones with both short cemented and longer cementless stems from a clinical and radiographic perspective.

Materials and methods: 136 3D manufactured titanium metaphyseal cones were implanted. The average patient age was 63, with 48% being female. The average BMI was 33, with an ASA class of 2.5. There were 42 femoral cones used, with 28 cemented and 14 cementless stems. There were 94 tibial cones with 67 cemented and 27 cementless stems used. The choice for stem fixation was surgeon dependent and in general cones were utilized for AORI type 2 and 3 bone defects on the femur and tibia. Short cemented stems on both the femur and tibia were the most prevalent fixation PROMS scenario, followed by cemented stem fixation on the tibia and cementless fixation on the femur. At the last follow-up (minimum one-year) clinical data such as revision, complication and PRO were gathered. Long-standing radiographs were analyzed for cone biological fixation and coronal and sagittal alignment. To compare demographics between patients with malalignment, descriptive statistics were employed. To estimate the probability of malalignment by stem type, adjusted logistic regression models were conducted.

Results: Patient-reported outcomes improved modestly, with pre-op KOOS increasing from 44 to 59 post-op and PF-CAT increasing from 33 to 37 post-op. PROMs pain ratings dropped from 54 to 44 after surgery. In either the coronal or sagittal plane, 36% of individuals were misaligned. Malaligned patients were more likely to be female. After controlling for age, gender and BMI, there was a substantially higher probability of coronal plane malalignment with cementless femur and tibia stems compared to cemented stems. When patients with mixed stems were compared to those with cemented stems, there was no statistically elevated risk. Sagittal plane misalignment was more prevalent with short cemented stems, but neither coronal plane nor sagittal plane misalignment with either stem type was not associated with poor clinical results. Cone survival was high overall, with only two cones removed due to infection.

Conclusion: Metaphyseal titanium cones provide reliable fixation in revision TKA. However, PROs in this complex patient population show only modest improvement consistent with other variables such as co-morbidities and poor baseline physical function. Small cone inner diameter may adversely influence cementless stem position leading to coronal plane malalignment. Short cemented stems are subject to greater sagittal plane malalignment with no apparent influence on clinical outcome.

Survivorship

Metaphyseal fixation using highly porous cones in revision total knee arthroplasty: minimum two year follow up[30]

Authors: Kevin M. Denehy, Sarag Abhari, Viktor E. Krebs, Carlos A. Higuera-Rueda, Linsen T. Samuel, Assem A. Sultan, Michael A. Mont, Arthur L. Malkani

Publication: The Journal of Arthroplasty 34 (2019) 2439-2443

Goal of trial: The purpose of this study is to review the survivorship, clinical results and complications of revision TKA using highly porous 3D printed titanium metaphyseal cones.

Materials and methods: A review of 62 revision TKAs using metaphyseal tibial cones, with 15 cases utilizing both tibial and femoral cones. The mean age of the patients was 66 years who had a mean follow-up of 27 months. There were 38 women and 24 men, who had a mean body mass index of 33.

Results: Revision-free survival of the cones was 90.2%. If the infection was excluded, survivorship was 100%. There were no cases of aseptic loosening. The mean Knee Society Score (KSS) improved from 51 points preoperatively to 80 points at the time of the latest follow-up. The mean Knee Society Functional Score improved from 48 points preoperatively to 68 points.

Table 1. Patient demographics

Total number of patients	62
Age	66 (32-84)
Body mass index	33 (18.3-62)
Gender distribution	38 females/24 males
Mean follow-up (mo)	26.5

Table 2. AORI bone loss clarification

AORI grade	Tibia (no. of patients)	Femur (no. of patients)
I	1	23
IIA	25	23
IIB	31	15
III	5	1

AORI, Anderson Orthopedic Research Institute

Table 3. Indications for revision TKA

Indications for revision	No. of patients
Aseptic loosening	25 (40%)
Instability	16 (26%)
Infection	13 (21%)
Failed TKA (unspecified etiology)	4 (6%)
Contracture	2 (4%)
Arthrofibrosis	1 (2%)
Periprosthetic fracture	1 (2%)

TKA, total knee arthroplasty

Table 4. Postoperative complications requiring additional surgery

Postoperative complications	No. of patients
Periprosthetic infection	10 (16%)
Contracture requiring arthroscopic debridement	2 (3%)
Contracture requiring manipulation under anesthesia	1 (2%)
Patellar instability	1 (2%)
Quadriceps tendon tear	1 (2%)
Total complications	15 (24%)

Conclusion: Metaphyseal fixation is important for survivorship in revision TKA which can be challenging due to cancellous and structural bone loss encountered at the time of revision. Prosthetic joint infection continues to be the leading cause of failure in revision TKA. The use of highly porous titanium metalphyseal cones produced from 3-dimensionally printed technology used in the study demonstrated excellent short-term results with no cases of aseptic loosening.

Survivorship

Long-term results of revision total knee arthroplasty using a rotating hinge implant[22]

Authors: Warran Wignadasan, Justin S. Chang, Barbar Kayani, Christina Kontoghiorghe, Fares S. Haddad

Publication: The Knee 28 (2021) 72-80

Goal of trial: The aim of this study is to establish long-term functional outcomes, radiographic results and survivorship after revision TKA with a rotating hinge implant.

Materials and methods: This is a retrospective study of prospectively collected data of 41 consecutive patients undergoing revision TKA with Stryker's Modular Rotating Hinge components and minimum 10-year follow-up. The study included 22 females (53.7%) and 19 males (46.3%) with a mean age of 66 ± 8.5 years. Clinical outcomes recorded included the Oxford Knee Score (OKS) preoperatively and at the latest follow-up. Range of motion, implant survivorship and complications were also recorded. Predefined radiological outcomes were obtained using plain radiographs.

Results: Overall, the study found that using a rotating hinge prosthesis for revision TKA improves functional outcomes at long-term follow-up. As compared to preoperative values, patients reported significant improvements in OKS at the most recent follow-up. Similarly, all treatment groups maintained their range of motion at the most recent follow-up, with a mean maximal active knee flexion of 111.5 ± 9.3 degrees. These findings are comparable to those reported in earlier trials utilizing rotating hinge components for revision TKA at intermediate follow-up. The reported implant survival after revision TKA with rotating hinge components varies greatly. In this study, implant survivability was 90.2% 10 years after surgery, which is higher than previously reported in the literature.

Conclusion: The use of a contemporary rotating hinge prosthesis for revision TKA can result in good long-term clinical and functional outcomes at 10-year follow-up with excellent survivorship. The most common indications for use are aseptic loosening and prosthetic joint infection. These implants provide a reliable solution to significant instability and bone loss. Surgeons should have a low threshold to use these versatile implants in complex revision knee arthroplasty.

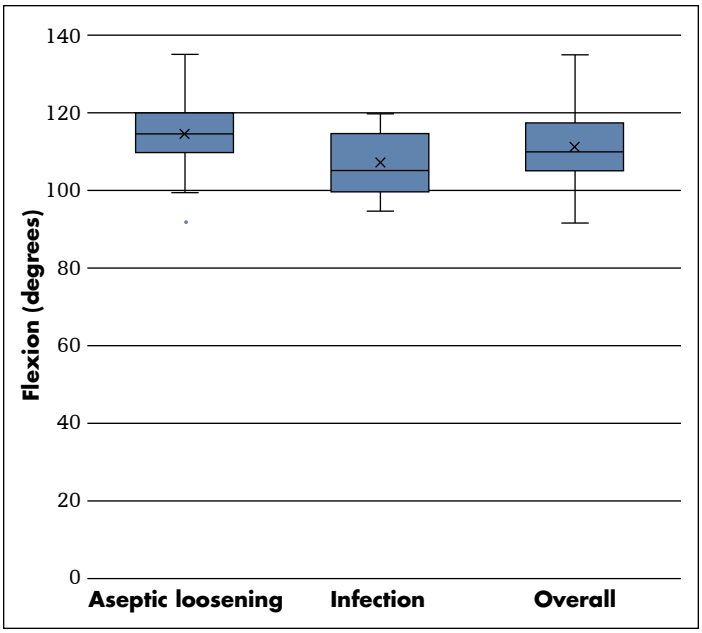


Figure 1. Boxplots showing postoperative ROM for patients undergoing revision TKA with a rotating hinge implant, including subgroup analysis for aseptic loosening and prosthetic joint infection.

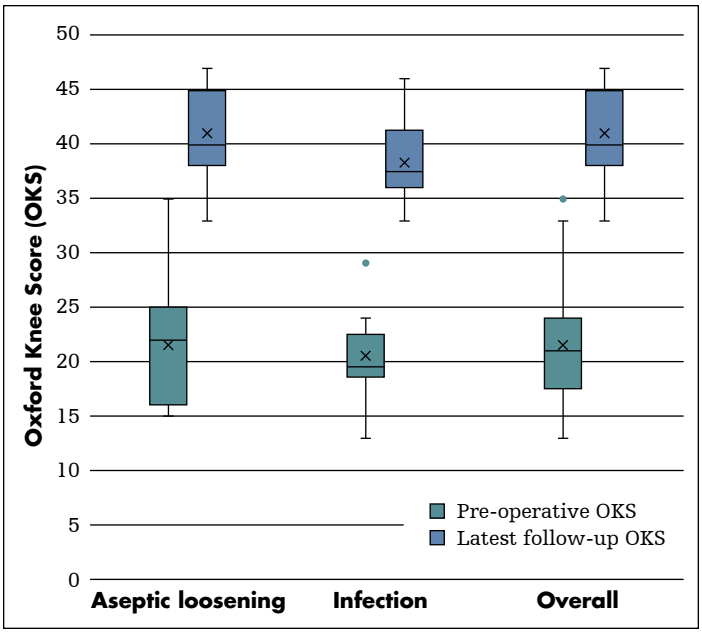


Figure 2. Boxplots showing pre- and postoperative Oxford Knee Scores (OKS) for patients undergoing revision TKA with a rotating hinge implant, including subgroup analysis for aseptic loosening and prosthetic joint infection.

Survivorship

Primary rotating-hinge total knee arthroplasty: good outcomes at mid-term follow-up[31]

Authors: Jacek Kowalczewski, Dariusz Marczak, Marek Synder, Marcin Sibinski

Publication: The Journal of Arthroplasty 29 (2014) 1202–1206

Goal of trial: To evaluate the clinical and radiologic outcomes of primary knee replacements using a rotating-hinge knee prosthesis in 12 knees with a minimum follow-up of 10 years.

Materials and methods: Between 2001 and 2003, 12 primary TKAs using Stryker's Modular Rotating Hinge system were performed in 12 patients. The patients' mean age at the time of the operation was 67.5 years. The decision to use a hinge was based on the preoperative physical and radiographic findings taking each patient's weight, expectations, age and activity level under consideration. All patients were followed-up at 6 weeks, 3, 6 and 12 months; and then every year. All were evaluated using the Knee Society Clinical Rating System (KSS) and The Western Ontario and McMaster Universities Arthritis Index (WOMAC) for clinical assessment.

Results: All implants were stable and functional at the time of follow-up. There was a substantial increase in the WOMAC and KSS scores (see Table 1). There was a decrease in mobility impairment; none of the patients required a mobility aid after 2 months postoperatively except for one patient with rheumatoid arthritis who still used his forearm crutches because of his contralateral hip pain. At the latest follow-up, all patients demonstrated full extension and flexion of at least 80 degrees. The difference between the pre- and postoperative range of motion was statistically significant. Manipulation was not required in any of the patients. There were no postoperative deaths, revisions for loosening or infections.

Table 1. Patient demographics, The Knee Society and WOMAC scores and mobility aid use

				KSS		WOMAC		Ambulation	
No.	**Age**	**Sex**	**Diagnosis**	**preop[c]**	**postop[d]**	**preop[c]**	**postop[d]**	**preop[c]**	**postop[d]**
1	75	Female	RA[a]	32	84	37.5	86.5	Sedentary	None
2	64	Male	OA[b]	47	85	55.3	81.1	Forearm crutches	None
3	55	Male	RA[a]	27	93	24.2	86.7	Forearm crutches	None
4	59	Female	OA[b]	17	92	43.5	88	Forearm crutches	None
5	58	Male	OA[b]	18	94	38.6	84.8	Forearm crutches	None
6	80	Female	OA[b]	8	83	53.8	88.6	Forearm crutches	None
7	55	Female	RA[a]	13	90	24.2	86.7	Forearm crutches	None
8	77	Female	RA[a]	11	84	37.5	76.5	Forearm crutches	None
9	71	Female	OA[b]	8	84	35.6	86.4	Forearm crutches	None
10	43	Male	RA[a]	28	72	47.0	74.1	Underarm crutches	Forearm crutches
11	83	Female	OA[b]	0	89	25.8	83.3	Sedentary	None
12	83	Male	OA[b]	0	84	25.8	83.3	Underarm crutches	None

[a] RA, rheumatoid arthritis
[b] OA, osteoarthritis
[c] preop – preoperatively
[d] postop – postoperatively

Conclusion: To summarize, at a minimum follow-up of 10 years, none of the modular rotating-hinge components were revised and none appeared to be loose radiographically. This series was limited to complex primary cases and demonstrated that rotating hinge prostheses are a viable option for primary TKA in cases of MCL deficiency and severe stiffness with advanced joint destruction. The patients experienced significant improvement in function, pain and ROM of the operated knees.

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