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Triathlon® Tritanium® Total Knee System

Clinical evidence

Volume 2.5

Executive summary

Cemented total knee arthroplasty (TKA) has been the gold standard in knee arthroplasty for many years. Despite its long history, it is not the ideal solution for all TKA candidates.[1,2,34,38] As patients requiring TKA have become younger,[2,10,34] higher demand and heavier,[10,23,36,38,40] a more durable bone-implant interface is needed to withstand the added mechanical stress to help decrease component loosening and help improve implant survivorship in this challenging patient demographic.[11,38] Cementless TKA fixation is gaining a resurgence in popularity due to its potential to preserve bone stock, avoid cement debris and achieve lasting biologic fixation of the implant to the bone.[2] In this clinical and economic summary, we will review the clinical outcomes, implant fixation and cost-effectiveness of the Triathlon Tritanium Total Knee System.

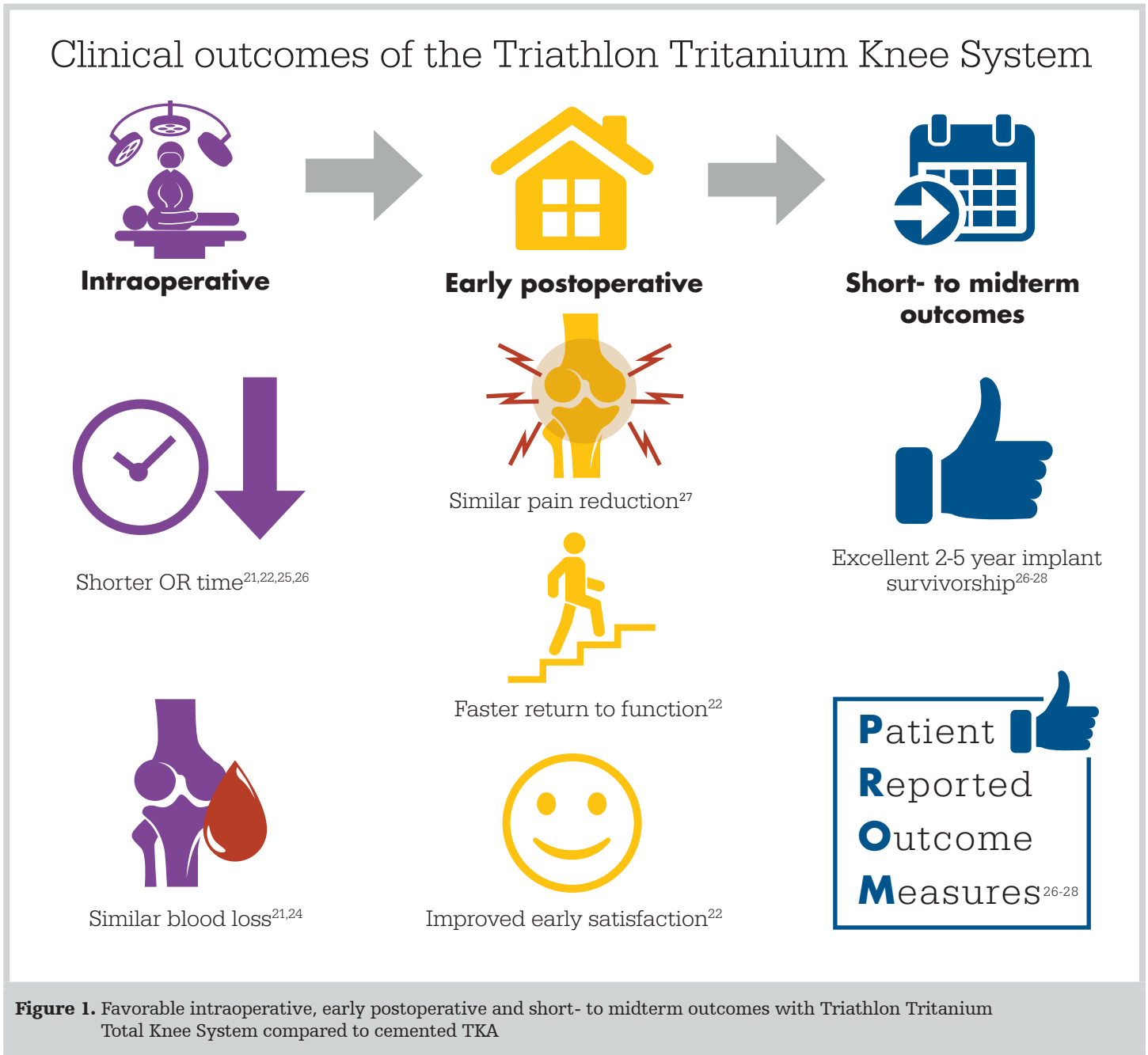


Figure 1. Favorable intraoperative, early postoperative and short- to midterm outcomes with Triathlon Tritanium Total Knee System compared to cemented TKA

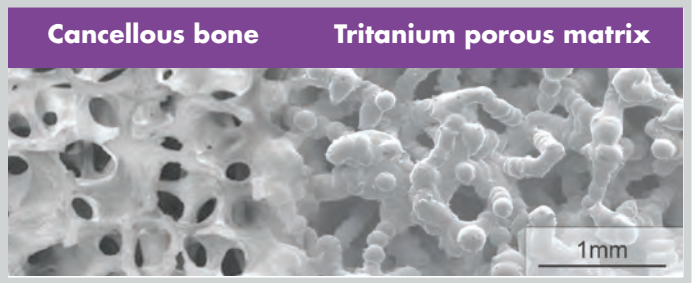
Triathlon Tritanium
Clinical evidence

Introduction

The introduction of bone cement (polymethylmethacrylate, PMMA) in the 1960s played a significant role in the success of joint replacement procedures.[3] Cemented stem fixation in total hip arthroplasty (THA) became widely used in young and old patients and for both primary and revision procedures. Inconsistent results were seen with different implant designs and cement techniques that were more common than previously expected.[4] Cementless THA has grown in popularity in many parts of the world[7-9] due to its relative ease and efficiency in implantation[6] and for meeting the need for biologic fixation to decrease aseptic loosening.[5]

The need for TKA in younger, heavier and more active adult patients has been steadily increasing over the years.[10] Due to a higher risk of revision seen in this challenging group of patients,[11] an implant design that allows for initial biologic fixation to avoid aseptic loosening and provide long-term implant survivorship,[12] as previously seen with cementless THA, may help address the changing TKA patient demographic.[13]

The failure of early generations of cementless TKA implant designs, while all shown to be correctable, has led to the limited acceptance of this fixation method.[14,15] However, there is a renewed interest in cementless TKA with improvements in cementless technology and the availability of new biomaterials to help promote biologic fixation for better implant longevity.[14] The American Academy of Orthopaedic Surgeons (AAOS) evidence-based clinical practice guideline found strong evidence supporting the use of cemented or cementless tibial component fixation due to similar functional outcomes and rates of complication and reoperation.[26] In its 2020 annual report, the National Joint Registry in the U.K. supports the long-term outcome of cementless femoral components.[7] The American Joint Replacement Registry (AJRR) in their 2020 annual report specified the use of cementless fixation in primary TKA among males <65 years old showed slight favorability in cumulative percent revision, which reached statistical significance, but does not account for other potential confounders at six-year follow-up.[9]



Advantages of cementless TKA compared to cemented TKA that have been shown in the literature include:

1. shorter surgical times[21,22,25,26]
2. comparable blood loss[21,24]
3. comparable pain relief[21,27]
4. improved patient satisfaction[22]
5. improved clinical outcomes[22,24]
6. potential long-term implant survivorship in challenging patient demographics[34,35,39,40,41,44] and potential cost-savings[57]

Triathlon Tritanium combines the kinematics of Triathlon with the latest in highly porous biologic fixation technology. The innovation behind the Tritanium Tibial Baseplate and Metal-Backed Patella components are enabled by Stryker's proprietary AMagine Additive Manufacturing and SOMA, Stryker Orthopaedic Modeling Analytics technology. The Triathlon Tritanium cementless TKA implant was introduced with otherwise similar design features to its cemented counterpart, which has demonstrated over 10 years of good track record.[12]

Clinical outcomes following TKA are critical in assessing an implant's performance. The introduction of highly porous surfaces that promote biologic fixation has shown encouraging results and has led to a renewed interest in cementless fixation.[12] However, concerns of blood loss, prolonged or persistent pain, patient satisfaction and limited long-term survivorship and outcomes data with some cementless TKA implant designs persist.[12]

Compared to the cemented Triathlon TKA system, the Triathlon Tritanium TKA shows favorable intraoperative outcomes (significantly shorter tourniquet[25] and operating room (OR) time[21,22,25,56] and similar blood loss[21,24]) and early postoperative outcomes (similar pain reduction,[27] faster return to function[22] and improved patient satisfaction[22]). Encouraging early- and midterm implant survivorship and good clinical and radiographic outcomes have also been reported in clinical studies.[26-28]

Intraoperative and early postoperative clinical outcomes

In a prospective randomized controlled trial, Nam and colleagues compared groups that were implanted with a cemented Triathlon cruciate retaining (CR) TKA or a cementless peri-apatite (PA) beaded Triathlon femoral component and Tritanium tibial baseplate; the patella was not resurfaced in either cohort. All patients were permitted to be full weight bearing, start range of motion as tolerated and ambulated on the day of surgery. One-hundred forty-seven (67 cemented and 80 cementless) patients were followed for two years.[21] No significant difference was noted in estimated blood loss despite pneumatic tourniquet used only in the cemented cohort.[21] Total operative time was significantly shorter in the cementless cohort compared to the cemented cohort **(Table 1)**.

Table 1: Comparison of intraoperative and perioperative variables between cemented and cementless cohorts[21]

	Cemented (n=65)	Cementless (n=76)	p-value
Operative time (min)	93.7 ± 16.7	82.1 ± 16.6	**0.001**
Estimated blood loss (mL)	185.2 ± 134.9	183.3 ± 146.7	0.9
Preoperative hemoglobin (g/dL)	13.6 ± 1.3	14.2 ± 1.4	**0.01**
Postoperative hemoglobin (g/dL)	11.1 ± 1.2	11.6 ± 1.4	**0.03**
Change in hemoglobin (g/dL)	-2.5 ± 0.9	-2.6 ± 1.4	0.5

There was no difference in postoperative pain at four to six weeks and at two-year follow-up and no difference in Oxford Knee Score (OKS), Knee Society Score (KSS - pain and function) or Forgotten Joint Score (FJS) between both cohorts at all postoperative time points.[21] One revision due to periprosthetic infection was reported in the cemented cohort, and no revisions were reported in the cementless cohort. In addition, radiographic review showed no evidence of component loosening or subsidence in either group.[21]

A faster return to function and improved early patient satisfaction was seen by Sharpe and colleagues when comparing cementless versus cemented TKA in a prospective non-randomized multicenter study.[22] Patients in the cementless cohort (373 knees in 319 patients) received the Triathlon Tritanium Tibial Baseplate and Metal-Backed Patella with Triathlon PA femoral component while the comparator (146 knees in 133 patients) received the cemented Triathlon Total Knee System.[22] OKS, new American Knee Society Score (KSS-2011) and Short Form 12 (SF-12) were collected through the one-year postoperative follow-up. Their findings, as presented in Figures 2 and 3, show that while cementless and cemented fixation provided similar positive outcomes at one year, cementless TKA may provide faster return to function, corresponding to increased patient satisfaction in the early postoperative period.[22]

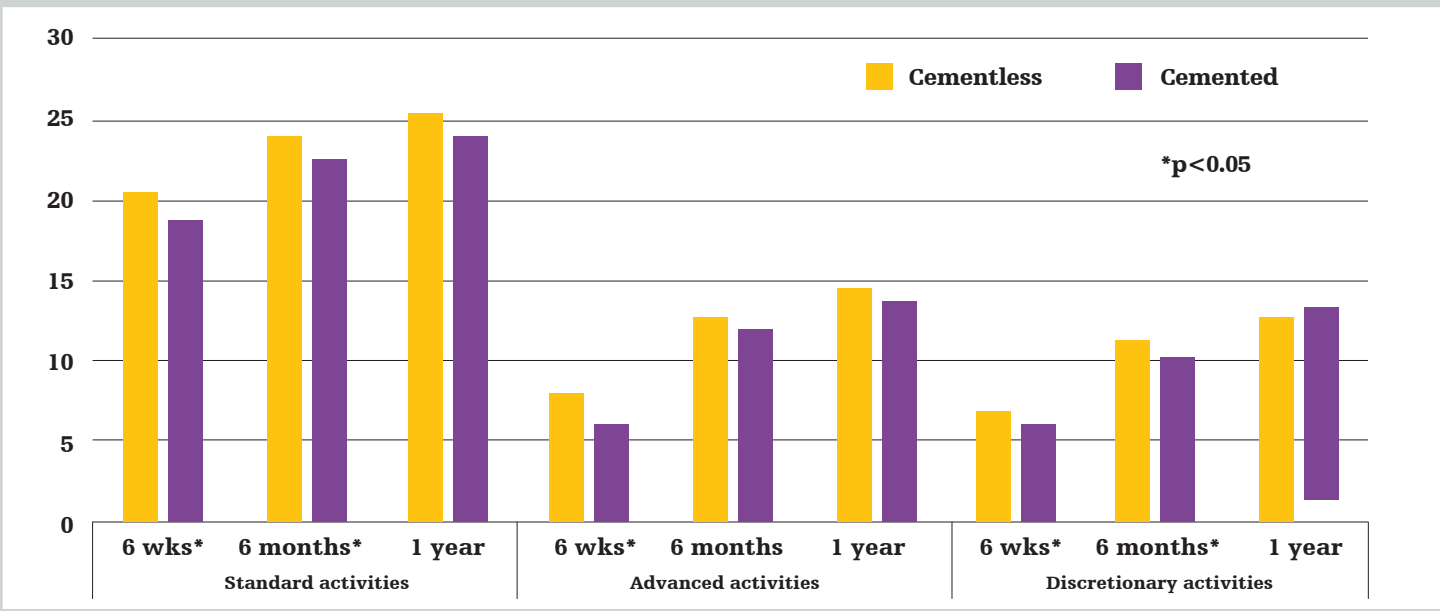


Figure 2. KSS-2011 function subscales[22]

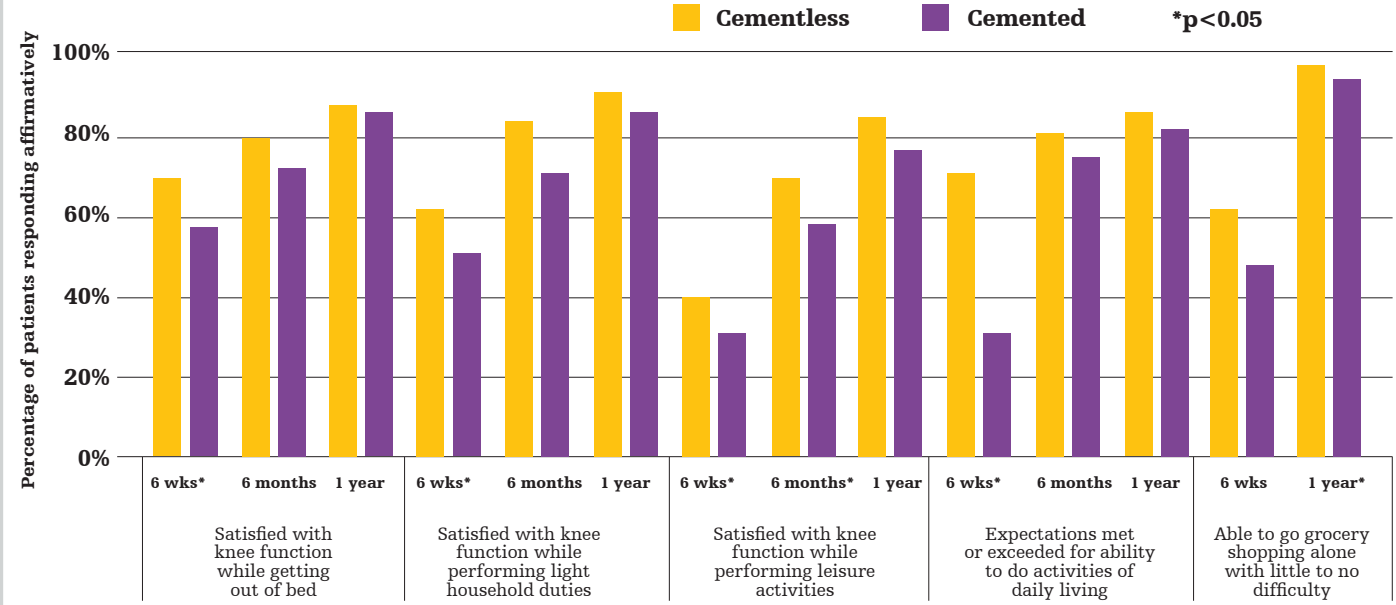


Figure 3. Individual functional questions within KSS and OKS[22]

Improved early clinical outcomes, shorter tourniquet time with cementless TKA and similar blood loss between cementless and cemented TKA was reported by Miller et al. in a retrospective matched case-control study of 400 primary TKAs, where 200 patients implanted with a Triathlon PA beaded femoral component, posterior stabilized (PS) Triathlon Tritanium Tibial Baseplate and a cementless patellar component were compared to a matched cohort of 200 patients from a prospective total joint registry implanted with a cemented TKA component of the same design.[24] Cohorts were matched by age, body mass index (BMI) and preoperative KSS. The mean follow-up in the cementless group was 2.4 years (range, 2-3.5 years) and in the cemented group was 5.3 years (range, 2-10.9 years). Blood loss was not significantly different between cohorts (355 ml, SD=276.1 versus 557 ml, SD=409.1, p=0.27).[24] Patients in the cementless cohort showed better improvement in their clinical outcome scores at two years (Table 2).[24] A single case of aseptic tibial loosening was reported in the cementless group, while five cases of aseptic loosening were reported in the cemented group (0.5% vs 2.5% p=0.09).[24]

Table 2: Comparison of outcome scores in matched cementless vs. cemented TKA.[24]

Outcome score	Cemented TKA	Cementless TKA	p-value
KSS function score	70.2 ± 22.3	76.0 ± 20.4	.016
Change in function score	26.04 ± 26.6	35.6 (±19.8)	.0014
KSS knee score	91.6 ± 9.8	94.1 ± 6.1	.0076
Change in knee score	52.4 ± 16.7	53.8 ± 13.8	.385

Favorable early- to midterm clinical outcomes and survivorship

Since Triathlon Tritanium Tibial Baseplate was launched in 2013, favorable early- to midterm performance of this device is starting to be generated and published from multiple centers.

Table 3: Triathlon Tritanium Tibial Baseplate and Metal-Backed Patella (MBP) midterm survivorship

Survivorship	Reference
100% at 3 years[c]	Cohen et al.[25]
99.5% at mean 4 years[c]	Harwin et al.[27]
98% at mean 4.5 years[b]	Harwin et al.[62]
100% at minimum 2 and 5 years[b]	Grau et al.[61]
99.5% at minimum 5 years[a]	Tarazi et al.[28]
99.2% at minimum 5 years[a]	Restrepo et al.[41]
98.9% at 5 years[a,b]	Bhowmik-Stoker et al.[69]

[a]Tibial baseplate, [b]MBP, [c]Tibial baseplate and MBP

In a large series comparing two cementless implants, PA beaded (805 patients) and highly porous titanium-coated tibial and patella components (219 patients), Harwin et al. compared survivorship, KSS, range of motion (ROM), complications and radiographic findings between the two groups and found that at a mean follow-up of 4.4 years (range, 2-9 years), all-cause implant survivorship was 99.5% for both groups.[27] No significant differences were noted in pain, function or ROM for either group. Complication rate and number of revisions were also similar in both cohorts.[27]

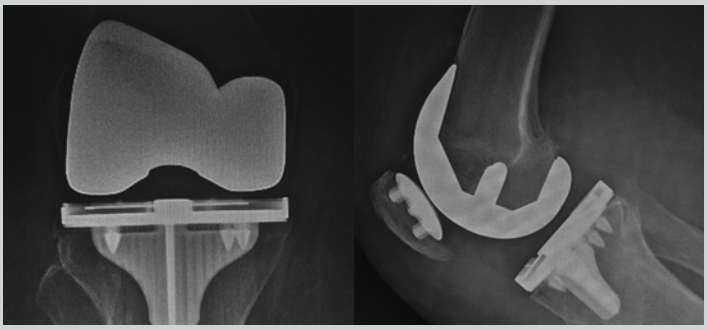


Figure 4. Anteroposterior and lateral view of the knee after total knee arthroplasty with the Triathlon Tritanium Cementless Total Knee System

Promising clinical outcomes at five years were reported by Tarazi and colleagues.[28] They reviewed a prospectively collected database and identified 228 patients who underwent TKA with Triathlon Tritanium baseplate implants. These patients were evaluated clinically at a minimum of five years. Implant survivorship of this cohort of patients was 99.5%. Improvements in both Knee Society pain and function scores as well as improvements in range of motion were reported.[28]

Similar findings were demonstrated by Restrepo et al., who collected data on 296 TKA cases using Triathlon Tritanium.[41] They reported a 99.2% survivorship for aseptic loosening of the 3D-printed tibial component at a minimum five years follow-up. Patients also reported a statistically significant improvement in their Knee injury and Osteoarthritis Outcome Score (KOOS JR) and the physical and mental health component scores of the Veterans Rand (VR)/12 Item Short-Form Health Survey (SF-12).[41]

Regardless of implant fixation methods, complications involving the patella still account for nearly 10% of TKA failures, and the metal-backed patella design has historically shown unacceptably high revision rates.[61,62] Two separate studies evaluated the survivorship, clinical and radiographic outcomes of the Triathlon Tritanium MBP. A single high-volume surgeon reported on 261 patients who underwent cementless TKA. After a mean follow up of 4.5 years, he reported high rates of patellar implant survivorship (98%) and low complication rates.[62] Grau and colleagues identified 388 cementless MBP TKA cases with minimum two years follow-up and 80 with minimum five years follow-up from their hospital-based registry. Using the Knee Society Total Knee Arthroplasty Roentgenographic Evaluation and Scoring System, they demonstrated biologic fixation of the patellar component present in all except one case at two years (99.6%) and at five years (97.7%).[61] No component was revised for aseptic loosening.[61]

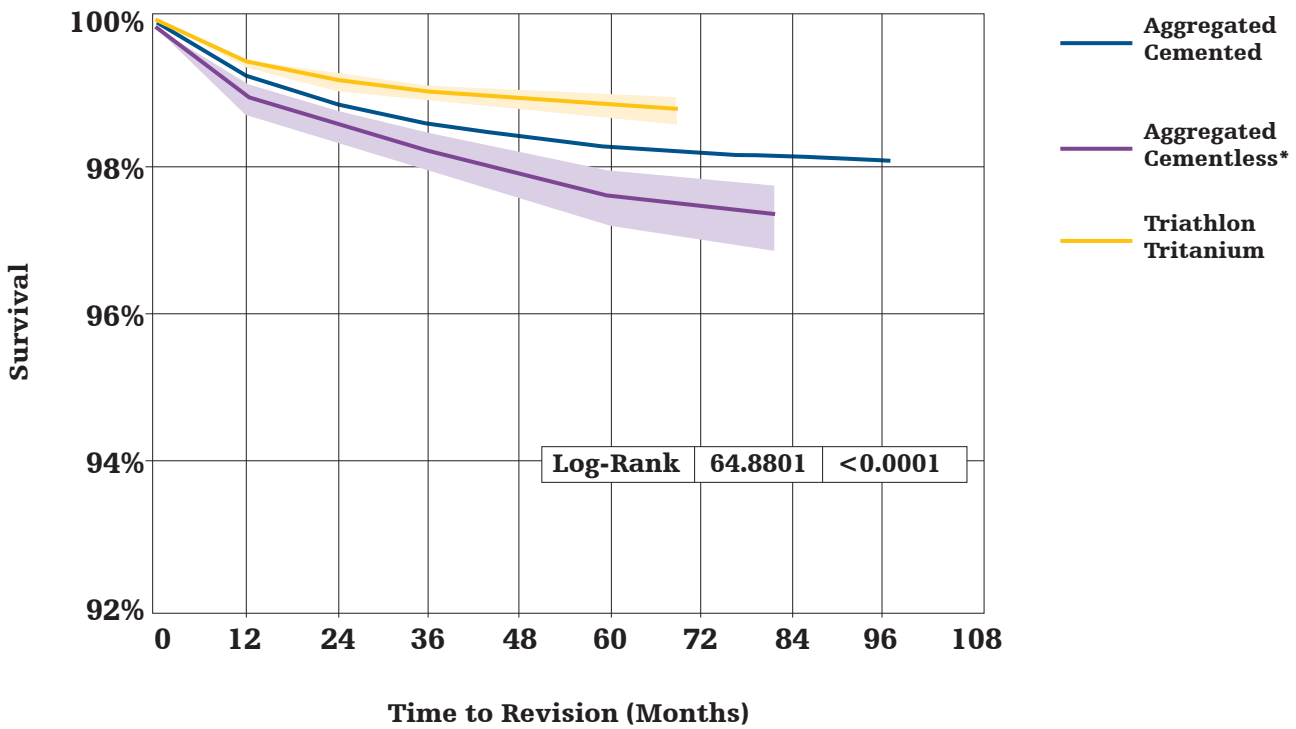
National registry data provides an independent perspective and valuable real-world evidence on the performance of orthopaedic devices. The strength of registries lies in the large volume of implants captured from diverse healthcare settings that include community and academic hospitals, ambulatory surgery centers and private practice settings.[70]

The mid-term performance of the Triathlon Tritanium tibial baseplate[68] and Metal-backed patella (MBP)[69] was recently investigated using data from the American Joint Replacement Registry (AJRR).

Triathlon Tritanium tibial baseplate cases (N=37,105) submitted to AJRR from November 6, 2012 to December 4, 2020 from 428 institutions were identified. These cases were compared to all other "Aggregated Cementless" as well as "Aggregated Cemented" knee cases. Available data from the Centers for Medicare and Medicaid Services (CMS) were merged with AJRR data to generate Kaplan Meier (K-M) survivorship and patient time incidence rate (PTIR) per 1000 years.[68] The Social Security Death Index was cross referenced. Cases are noted as survived unless otherwise reported to AJRR.[68] Implant survivorship free of revision was 98.9% CI [98.7%, 99.0%], with the Triathlon Tritanium baseplate, 97.6% CI [97.3%, 98.0%], in the aggregate cementless group, and 98.3% CI [98.3%, 98.3%] in the cemented knee group at 60-month follow-up ($p<0.001$). PTIR was 3.07 (2.74, 3.43), 4.89 (4.22, 5.67), and 3.72 (3.65, 3.79) for 3D TKA, aggregate cementless and cemented knee groups. This corresponds to a revision rate of 0.31% per year, 0.49% per year, and 0.37% per year for the 3D TKA, aggregate cementless, and cemented knee groups, respectively ($p<0.001$). [Table 4][68]

Table 4: Summary of Triathlon Tritanium tibial baseplate survivorship by K-M and PTIR estimates[68]

Group	Total implanted (N)	K-M Survivorship (CI)	PTIR per 1000 years (CI)
Triathlon Tritanium	37,105	98.9 (98.7, 99)	3.07 (2.74, 3.43)
Aggregate cementless	9,505	97.6 (97.3, 98)	4.89 (4.22, 5.67)
Aggregate cemented	725,417	98.3 (98.3, 98.3)	3.72 (3.65, 3.79)



*Aggregated cementless constructs = AJRR aggregate cases excluding Triathlon Tritanium

Figure 5. K-M survival curves, Triathlon Tritanium vs. Aggregated Cementless* vs. Aggregated Cemented[68]

This work is the first midterm report of the 3D TKA from a large national registry. Results show that Triathlon Tritanium tibial baseplates had slighlty favorable PROMS and survivorship at 5 years over aggregate cementless, and cemented knees implanted at the same institutions in the same period.[68] The 3D TKA group had 98.9% survivorship at 60 month-follow up and a PTIR of 0.31% revision/year, which was significantly better than the matched groups. More critically, confidence intervals for the 3D TKA group did not overlap with other groups indicating a clear distinction in results. Cementless knee groups also had no clinical differences in reasons for revision related to fixation such as aseptic loosening.[68]

A similar analysis was performed on the Triathlon Tritanium MBP using data from AJRR merged with CMS. 28,257 cases from 656 surgeons across 369 sites were identified and included in the analysis. MBP survivorship at a mean follow-up of 2.6 years (longest follow-up of 6 years) is summarized in Table 5.

Table 5: Summary of Triathlon Tritanium MBP survivorship by K-M and PTIR estimates[69]

Device	Total implanted (N)	K-M Survivorship (CI)	PTIR per 100 years (CI)
Triathlon Tritanium MBP	28,257	98.97 (98.8, 99.12)	0.29 (0.26, 0.33)

The design of the Triathlon MBP was developed to address past failures of metal-polyethylene dissociation by enhancing the bond between the two components.[70] The architecture on the back side, combined with a direct compression molding process, is designed to minimize the potential for dissociation.[71]

This analysis based on AJRR and CMS data on the first 3D-printed metal-backed patellar component is encouraging, as it suggests excellent survivorship at mean 2.6 year and a maximum 6-year follow-up in a large patient cohort.[69]

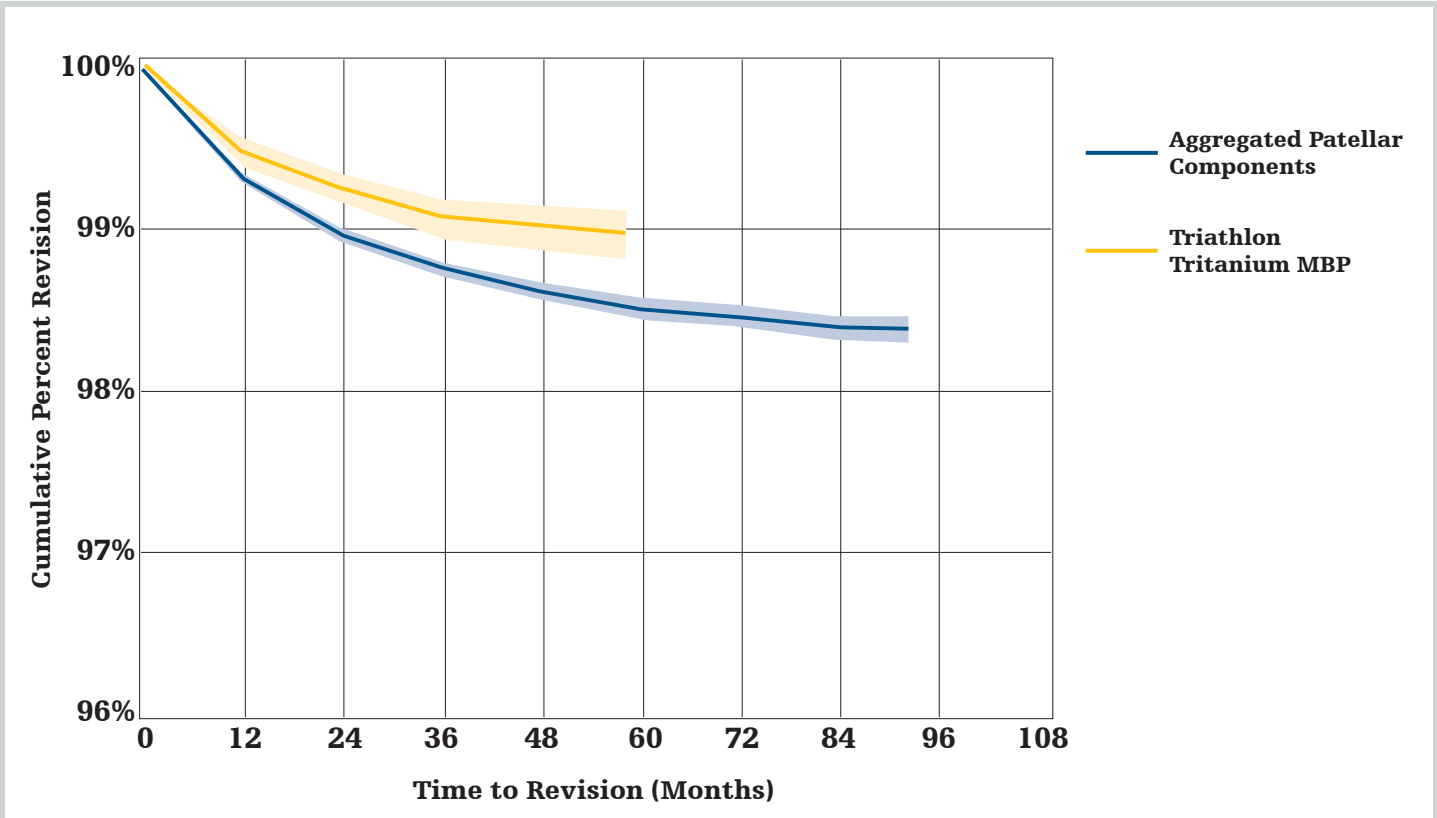


Figure 6. Kaplan-Meier survival curve for the Triathlon MB Patella compared to all other AJRR Patellar components in primary TKA cases.[69]

Encouraging outcomes in challenging patient demographics

Young and active adult patients

Age can be a major factor that affects the outcome of primary TKA. Various national joint replacement registries have shown that the revision rate increases with decreasing age.[7,8,30] Aseptic loosening and instability were identified as reasons for revision in younger patients due to their higher activity level leading to greater stress on the implant.[32] One study reported 4.7x higher risk of aseptic revision within one year of TKA in patients less than 50 years of age.[33]

Mont and colleagues reported 100% survivorship in patients <50 years of age undergoing cementless primary TKA at a single high-volume institution. Twenty-nine patients (31 knees) with a mean age of 45 years (range, 34-49 years) received a PA beaded femoral component (PS) and cobalt chrome (CoCr) tibial baseplate or a Triathlon Tritanium Tibial Baseplate when it became available; patellae were resurfaced.[34] At a mean four-year follow-up (range, 2-6 years), no failures or revision surgeries were performed and no radiographic evidence of component loosening or progressive radiolucency was reported.[34] Patients also demonstrated excellent functional outcome scores and ROM.[34]

Triathlon Tritanium TKA has demonstrated excellent survivorship, functional outcomes and satisfaction in both young[34] and elderly[35] adult patients. This versatility should help the orthopaedic surgeon address some of the challenges that have been identified with both age groups.

Patients with BMI 30-40

Obesity affects about 35% of the U.S. population and has been steadily increasing over the years.[36] The increased prevalence of obesity has been linked to the rapidly increasing demand for joint arthroplasty procedures, especially TKA.[37] In 1995, 42% of patients who underwent TKA were considered obese, and in 2005, this number increased to 60%.[36] This presents a challenge, as TKA in the morbidly obese has been associated with greater perioperative complications.[36]

In a study of over 5000 primary TKAs implanted using cemented components, patients with BMI ≥ 35 kg/m^2 were found to have an almost two times greater risk for aseptic tibial component failure.[38] Cemented TKAs also showed an increase in failure rates due to aseptic loosening in obese patients despite well-aligned knees.[38] The following studies offer data that demonstrate cementless TKA may be a good option in the obese patient.

Sharpe and colleagues compared outcomes and implant survivorship of cementless TKA between two groups of patients stratified by BMI in a multicenter prospective study. Cementless TKA patients were stratified based on BMI, < 30 kg/m^2 (non-obese) or BMI 30 to < 40 kg/m^2 (obese). OKS, KSS-2011, SF-12 and SF-6D transformed health utility scores were collected through two years.[39] An interesting finding was that in the obese cohort, patients reported higher satisfaction scores at the sixth postoperative week and experienced a significant improvement in function as early as six

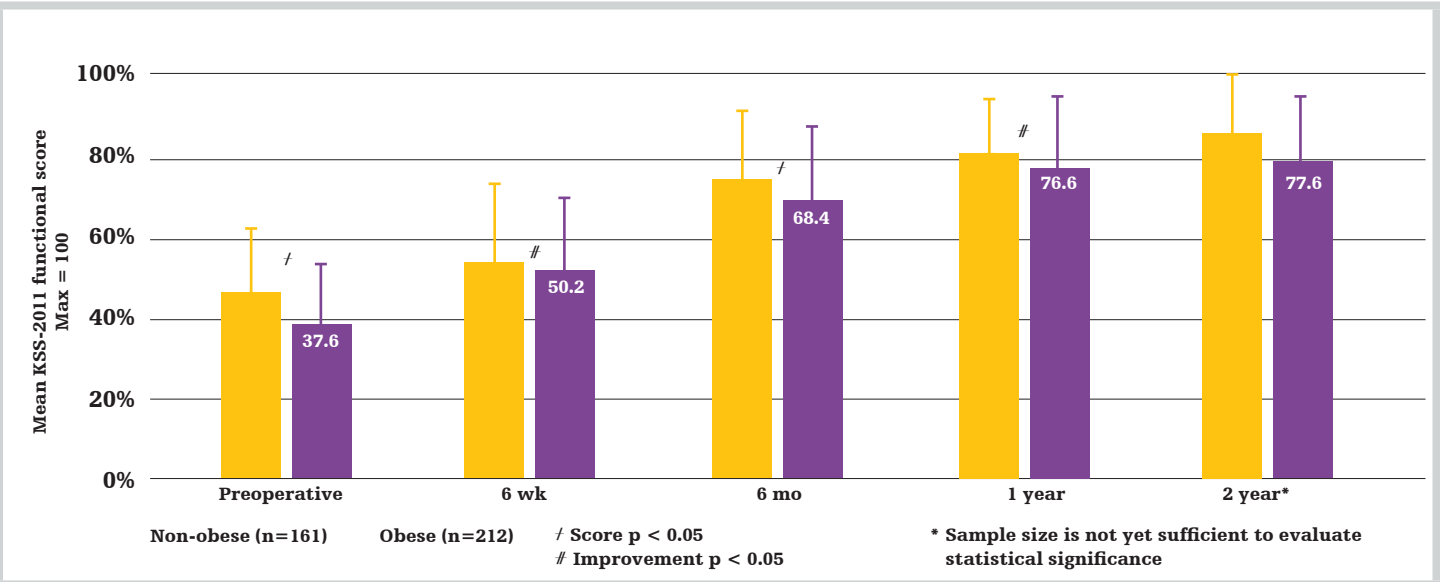


Figure 7. Cementless cohort KSS-2011 functional score by BMI

weeks postoperative, which was sustained through two years of follow-up. No statistically significant difference in adverse events or implant survivorship were seen between the cemented and cementless groups.[39]

In a retrospective study comparing cemented versus cementless primary TKA with a PS design in morbidly obese (BMI ≥40) patients, Sinicrope and colleagues extracted demographic, clinical, surgical, radiographic, postoperative complications and survivorship in 193 patients. At a minimum follow-up of five years, five failures requiring revisions were reported in the cementless group including one for aseptic tibial loosening (0.9%), while 22 failures requiring revisions were reported in the cemented group, including 16 cases of aseptic loosening (18.8%).[40] A statistically significant difference in survivorship (p=0.02) was noted with aseptic loosening as the endpoint; 99.1% implant survivorship in the cementless group versus 88.2% in the cemented cohort at eight years **(Figure 8)**. These results led the authors to conclude that **"the use of cementless TKA in morbidly obese patients with the potential of durable long-term biologic fixation and improved survivorship appears to be a promising alternative to mechanical cement fixation."**[40]

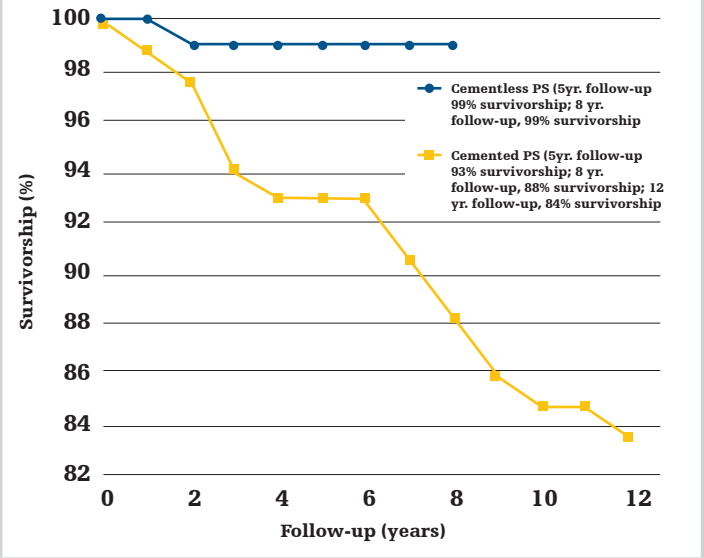


Figure 8. Kaplan-Meier survival curve of primary TKA in morbidly obese patients with aseptic loosening as the endpoint.[40]

Harwin, et al. were able to show no significant difference in component survivorship when comparing patients of varying BMI (less than 30 kg, 30-40 kg/m^2, 40-50 kg/m^2). They reported 99% survivorship (CI:0.997 to 0.983) at mean 27 months follow-up in 708 cementless TKAs using Triathlon Tritanium.[41]

Patients with rheumatoid arthritis

Rheumatoid arthritis (RA) is a systemic inflammatory disease that is characterized by chronic inflammation and progressive deterioration of joint function resulting in pain and disability.[42] In 2005, RA was estimated to affect 1.3 million adults in the U.S.[43] TKA is a treatment option in patients with RA but can be challenging due to higher incidence of poor bone quality, synovitis and disuse muscular atrophy. In this subset of patients, cemented TKA is the usual recommended approach, but only a limited number of studies have evaluated the safety and efficacy of cementless TKA in patients with RA.

One hundred twenty-two patients (126 TKAs) diagnosed with RA were enrolled by Patel et al. in a study to investigate implant survivorship and clinical outcomes. Patients were not excluded because of subjective view of poor bone stock. All patients were implanted with a cementless PA beaded femoral component and CoCr tibial baseplate. Patella resurfacing was done on all patients using PA-coated patellae. From June 2013 and onwards, a Triathlon Tritanium Tibial Baseplate was used, and patellae were resurfaced with a highly porous-coated, metal-backed prosthesis.[44] At a mean follow-up of four years (range, 2-8 years), excellent implant survivorship was reported (99.2%) in patients with RA. Clinical and patient-reported outcomes at final follow-up were excellent with no surgical complications reported. Radiographic review revealed no radiolucency or loosening, although one patient was revised due to tibial baseplate subsidence. This study has demonstrated that cementless TKA may be an option for patients with RA.[44]

Radiostereometric analysis (RSA)

Radiostereometric analysis (RSA) is an accurate 3D imaging technique that uses two simultaneous calibrated radiographs to precisely monitor changes in implant position over time. Implant migration over the first two postoperative years has been shown to be predictive of aseptic loosening and migration that is less than 0.2 mm in the second-year postoperative period indicates stable fixation.[45] RSA allows prediction of loosening with small sample sizes and is being advocated as an important tool for introducing new and innovative implants to the orthopaedic market.[45]

Figure 9. Two simultaneous calibrated radiographs are used to precisely monitor changes in implant position over time

Initial stability

Given the importance of stable primary fixation,[46] the keel and four bullet cruciform pegs on the Tritanium baseplate were designed to reduce micromotion and liftoff.[47-48] The SOMA database of bone morphology was used to optimize the depth and placement of the pegs.[49]

Using RSA technology, Sporer and colleagues sought to investigate the press-fit fixation of Triathlon Tritanium Tibia and Metal-Backed Patella to the underlying bone. Twenty-nine patients were prospectively enrolled and RSA images collected at the immediate postoperative, at six weeks, and at three-, six-, 12- and 24-month follow-up visits. Most component migration was observed over the first six postoperative weeks, after which no significant migration between the 12- and 24-month time points was observed. This demonstrates the biphasic migration pattern that has been reported for cementless components, characterized by a high initial migration followed by stabilization or a plateau of migration[50] **(Figure 10)**. This early migration pattern suggests the patella and tibia achieve fixation through the porous titanium surface.

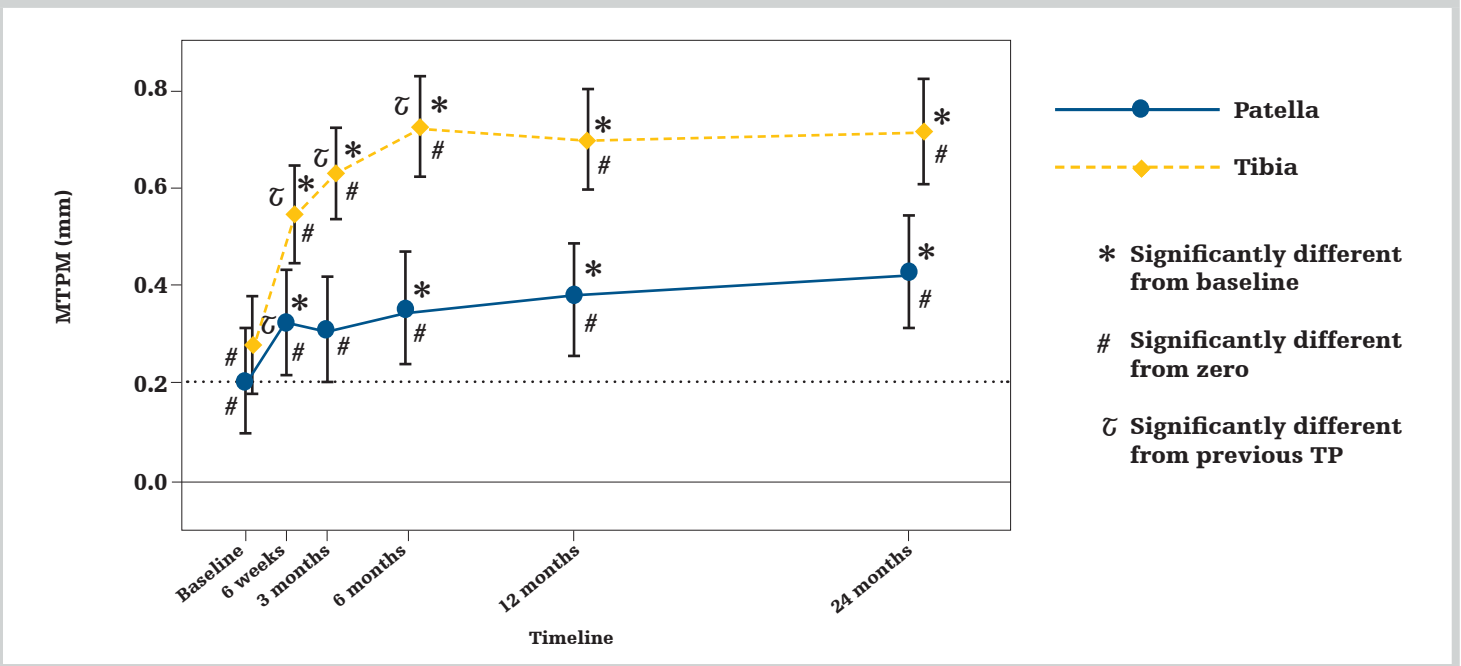


Figure 10. Plot of implant migration over time, measured by maximum total point motion, (MTPM)[50]

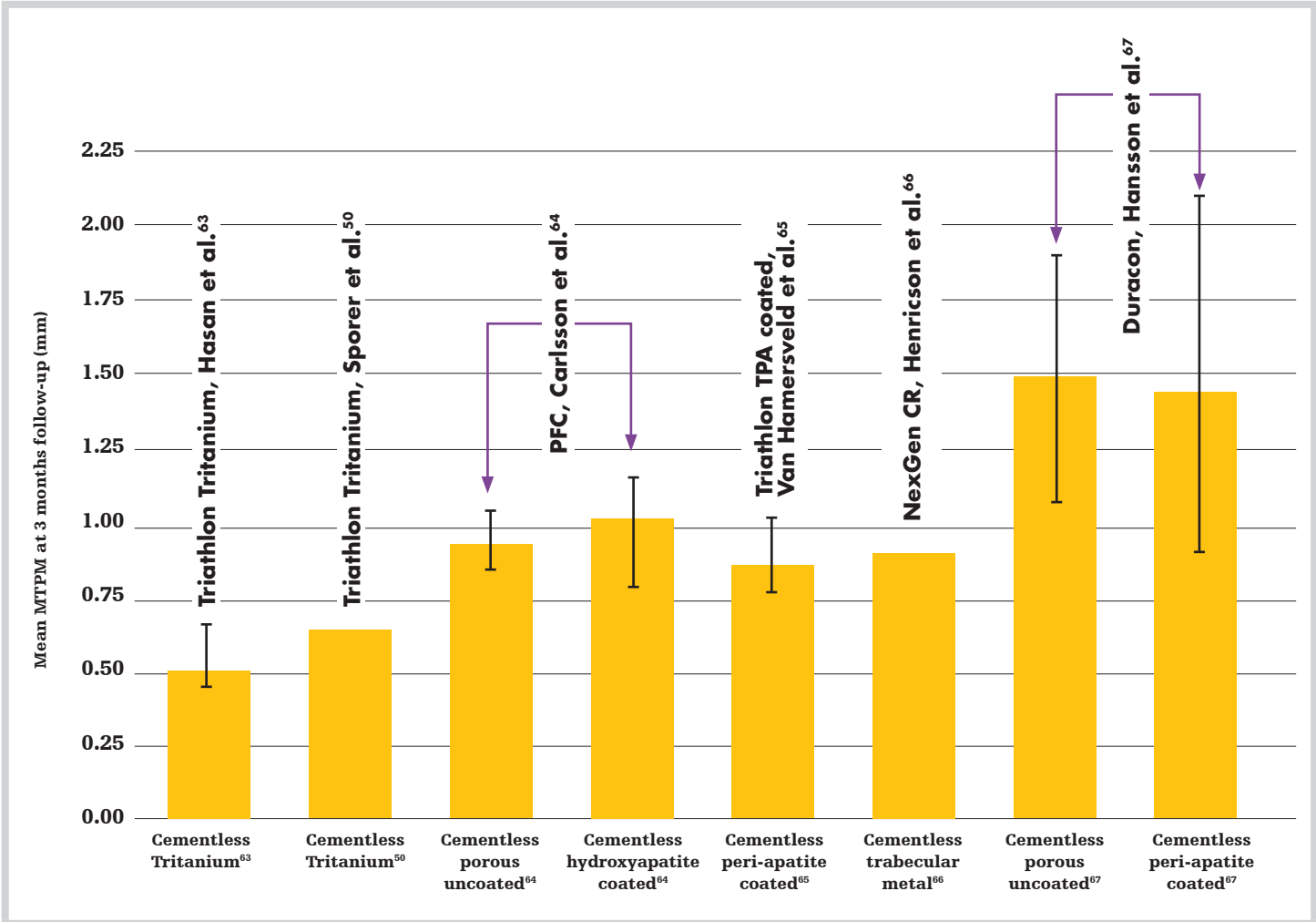


Figure 11. Mean migration (MPTM) at three months follow-up of different cementless TKA implants as reported by Hasan et al.[63] The error bars represent 95% confidence intervals as reported.[63]

A similar migration pattern was reported by Hasan and colleagues. In a randomized controlled study, they assigned patients to receive either cementless Triathlon Tritanium or Triathlon CR cemented and compared migration patterns over two years through RSA. They noted a higher migration in the cementless cohort due to a higher initial migration after which stabilization was observed.[63] The main direction of migration was subsidence in the first three months. This is consistent with other RSA studies using cementless implants.[50,63-67] When compared with other cementless designs, Triathlon Tritanium cementless TKA shows promising results as the initial migration seems to be lower **(Figure 11)**.[63]

This pattern of component migration is consistent with other longer-term RSA studies showing that stabilization of uncemented tibial components can be achieved after high initial migration.[46,51,52]

Value of cementless TKA

As the volume of total joint replacement procedures continue to increase, the costs associated with this surgical procedure continues to be an important topic of discussion and research. While implant cost has long been a focus of the expense associated with joint arthroplasty procedures,[53] other factors such as hospital length of stay and operating room costs have been identified to contribute significantly to the total cost of these procedures. As data continue to be generated, available evidence demonstrates that cementless TKA can be a potential cost-beneficial alternative to cemented TKA.

Significantly shorter OR time consistently seen with cementless TKA **(Table 6)** can be a potential factor affecting the cost of the procedure, considering that each minute of OR time in the U.S. is estimated to be worth $62 (excluding surgeon and anesthesia time)[54] and a median of £16 per minute (range, £12-£20 per minute) in the UK.[55] Differences in OR time between cemented and cementless TKA was used for cost comparison of these procedures by Lawrie and colleagues.[57] When looking at cost variables including OR time, cement, cement accessories and implants benchmarked against data from Nam et al. for OR time, using institutional and market data for costs of cement, accessories and implants, they found that the actual cost of cementless and cemented TKA are similar.[57]

The use of antibiotic-impregnated bone cement is not approved for prophylactic use in primary total joint procedures. Literature suggests that "an increasing number of surgeons in the U.S. have adopted the practice of routine addition of low-dose antibiotic to cement for use in primary knee arthroplasty."[58,59] The use of antibiotic bone cement potentially increases the cost of cemented TKA.[29,31]

Although the cost of a cementless prosthesis is traditionally greater than that of a cemented implant, other perioperative factors such as the cost of cement, other equipment/accessories (vacuum mixer, cement injection kit) and OR times[60] as well as short-term and longer-term outcomes, should be considered when evaluating cementless TKA prostheses.

Table 6: OR time significantly shorter in cementless compared to cemented TKA

Study	Cemented TKA (minutes)	Cementless TKA (minutes)	P value
Nam et al[21]	93.7 ± 16.7	82.1 ± 16.6	0.001
Cohen et al.[25]	45.6 ± 7.2	40.8 ± 6.0	0.0006
Chen et al.[56]	80.0 ± 34.3	62.3 ± 17.4	NR
Sharpe et al.[22]	83.4 ± 24.5	60.5 ± 19.4	<0.0001

NR – Not reported

Summary

The optimal fixation method in TKA continues to be debated. The collection of studies presented here on the additive manufactured Triathlon Tritanium Knee System using new biomaterials that can help promote initial biologic fixation demonstrate encouraging perioperative outcomes (comparable pain score[27] and blood loss,[21,24] shorter OR[21,22,25,56] and tourniquet time[12,24]), favorable short- to midterm implant survivorship[25-28] similar to its cemented counterpart and may be a good option for patients requiring TKA, especially younger, heavier and more active adult patients.

The cost of cementless TKA implants continues to be an important consideration, but data from various studies are starting to show the value of shorter operating room times, fewer supplies and equipment needed and better patient outcomes.

Available publications are showing the clinical and economic benefits of the Triathlon Tritanium TKA system. It offers surgeons the versatility to address the needs of a challenging subset of patients including young,[34] active and obese patients.[39-41]

Long-term data on implant survivorship is not yet available, but encouraging midterm survivorship and RSA data on the Triathlon Tritanium Baseplate and Metal-Backed Patella shows stable migration at two years consistent with biologic fixation of the uncemented components.[50]

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Notes

Joint replacement

A surgeon must always rely on his or her own professional clinical judgment when deciding whether to use a particular product when treating a particular patient. Stryker does not dispense medical advice and recommends that surgeons be trained in the use of any particular product before using it in surgery.

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