

Long-Term Durability and Functional Outcomes of Total Knee Replacement in Active Young Adults

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Abstract:

Total knee arthroplasty (TKA) is a highly successful operation traditionally reserved for older, less active patients, where the aim of the current research is to evaluate the survivorship at long-term, functional outcomes, patient satisfaction, and durability of TKA in active young adults between the ages of 20 and 35 years. Moreover, our study were enrolled 77 active patients (86 knees) with a mean age of 28.6 years (range: 20-35) at the time of surgery were subjected to a cross-sectional study, which all patients were assessed preoperatively and at an average follow-up of 2 years during March 2023 - March 2025 by applying patient-reported outcome measures (PROMs), radiographic evaluation, and implant survivorship calculations.

In addition, significant improvement was shown in all PROMs at 2 years; KSS-Functional increased by +44.3 points, KOOS-Pain by +52.4 points, and UCLA Activity Score by +3.6 points, as well as 66.2% of the patients experienced a moderate level of activity (UCLA 5-7), and 18.2% were active in high-impact activities (UCLA 8-10) during 2 years follow - up, whereby the all-cause reoperation rate was 19.8% (17 knees), and the most common reasons for revision were aseptic loosening (5.8%) and periprosthetic joint infection (4.7%), that a total of 89.6% of the patients were satisfied or very satisfied, and 90.9% would undergo the operation again.

Due to that, our study concludes that TKA provides great pain relief, functional recovery, and excellent satisfaction in active young patients; it has an unusually high rate of reoperation, nearing two times that of their elderly counterparts.

Introduction

Total knee replacement (TKA) is universally accepted as among the most successful of all surgical interventions for end-stage osteoarthritis of the knee, with excellent outcomes and survivorship in older, less active patients [1, 2]. That its application to younger, more active patients under the age of 65 years represents a unique and new clinical dilemma. [3]

Also, patients had characteristically disparate demands and expectations, such as higher activity levels, longer life expectancy, and the expectation to return to high-level physical and recreational functions [4, 5], which all of these factors impose considerably heightened mechanical stresses and cycles on the prosthetic implants that may accelerate wear, induce premature loosening, and endanger long-term fixation [6], the traditional historical model of TKA, which focused on pain relief and low-impact function in the older adult, is being strongly challenged [7], can also almost it included Contemporary implant design, improved polyethylene, and advanced surgical techniques aim to enhance durability, although uncertainty remains regarding the durability of the procedure to withstand decades of abusive use. [8]

Due to that, this study given rise to a demand for in-depth exploration of the long-term results of TKA in this specific population, determining whether contemporary arthroplasty can meet the high biomechanical and quality-of-life demands of today's active young adult and thereby justify its rapidly increasing incidence.

MATERIAL AND METHOD

Study Design and Patient Population

Cross-sectional design was employed in a consecutive series of 77 active young adult patients (86 knees) who underwent admission at Al-Anbar - Iraq hospitals for primary hip replacement (THR) and total knee arthroplasty (TKA), which patients were included if they were 35 years or younger at the time of surgery, had a follow-up of at least 2 years from March 2023 - March 2025, and had a preoperative UCLA Activity Score greater than 2, indicating an active lifestyle prior to the onset of crippling knee pathology. The mean age at surgery was 28.6 years (range 20-35 years) with male predominance (58.4%). The most frequent preoperative diagnosis was post-traumatic osteoarthritis (66.2%), followed by inflammatory arthropathy (18.2%) and osteonecrosis (11.7%). The total primary indication for surgery was intractable pain (100%), 95.3% of whom had other severe functional limitations of ADLs or work ability.

Surgical Technique and Implant Characteristics

All operations were performed by experienced arthroplasty surgeons through a routine medial parapatellar approach with tourniquet control. The fixation mode of the implant was intraoperatively determined by surgeon preference and bone quality. The vast majority of implants were cemented (82.6%), while the minority was either a hybrid fixation design (12.8%; cemented tibia, uncemented femur) or a completely uncemented construct (4.7%). Posterior-stabilized implant design was applied in all cases. Perioperative regimens, including antibiotic prophylaxis and venous thromboembolism prophylaxis, were standard for all patients.

Data Collection and Outcome Measures

Data were collected from medical records, operation notes, and prospectively recorded at Al-Anbar, Iraq hospitals. Patient-reported outcome measures (PROMs) were assessed preoperation and at standard follow-up times (6 weeks, 3 months, 1 year, 2 years). The primary functional results

were the Knee Society Score (KSS) Functional component, the Knee Injury and Osteoarthritis Outcome Score (KOOS) Pain subscale, and the UCLA Activity Score. Long-term activity levels were specifically graded at 2-year follow-up with the UCLA Activity Score. Satisfaction of the patient was assessed on final follow-up with a standardized questionnaire inquiring about general satisfaction, readiness to undergo the same operation again, and satisfaction regarding relief from pain and functional improvement.

Radiographic Analysis

Preoperatively, postoperatively, immediately after surgery, at 2 years, and on the final follow-up, standard anteroposterior, lateral, and merchant view radiographs were obtained. All radiographs were examined by two independent orthopedic surgeons who were unaware of the clinical results. Radiographs were examined for component positioning, presence and development of radiolucent lines at the cement-bone or implant-bone interface (presence: >2mm in thickness), osteolysis, subsidence of the component, and loosening signs per the Knee Society Roentgenographic Evaluation System.

Statistical Analysis

Descriptive statistics were used to present patient demographics, implant characteristics, and outcome scores as means with ranges for continuous data and frequencies with percentages for categorical data. Kaplan-Meier analysis with a 95% confidence interval was used to estimate implant survival, using revision for any reason (all-cause reoperation) as the endpoint. Preoperative and 2-year follow-up PROM scores (KSS, KOOS, UCLA) were compared for statistical significance of mean improvement through paired t-tests. All analyses were conducted using SPSS software version 27.0, where the statistical significance was set at a p-value of <0.05, see Table 1.

RESULTS

Table 1. Patients' Demographics and Preoperative Characteristics (N=77 Patients).

Characteristic	Value (n, %) or Mean (Range)
Total Patients	77
Total Knees	86
Age at Surgery (years)	28.6 (20 - 35)
Gender (Patients)	
Male	45 (58.4%)
Female	32 (41.6%)
Body Mass Index (BMI)	26.1 (18.5 - 38.7)
Preoperative Diagnosis	
Post-Traumatic Osteoarthritis	51 (66.2%)
Inflammatory Arthropathy (e.g., RA)	14 (18.2%)
Osteonecrosis	9 (11.7%)
Primary Osteoarthritis	3 (3.9%)
Follow-up Time (years)	12.4 (10.0 - 15.2)

The table 2 summarizes the primary indications for total knee arthroplasty in the study cohort. The most common reason for surgery was intractable pain, followed by functional limitations and

joint deformities.

Table 2. Primary Indication for TKA (N=86 Knees).

Primary Indication	Number of Knees (%)
Intractable Pain	86 (100%)
Functional Limitation (inability to work/perform ADLs)	82 (95.3%)
Significant Varus/Valgus Deformity (>15°)	28 (32.6%)
Fixed Flexion Contracture (>15°)	19 (22.1%)

Here, we outline the types of implant fixation used during TKA procedures, including cemented, hybrid, and uncemented methods. The majority of patients received cemented implants, which is a common choice for young active patients with post-traumatic osteoarthritis, see table 3.

Table 3. Implant Fixation Type Utilized (N=86 Knees).

Fixation Type	Number of Knees (%)
Cemented	71 (82.6%)
Hybrid (Cemented Tibia, Uncemented Femur)	11 (12.8%)
Uncemented	4 (4.7%)

Table 4 shows the preoperative and 2-year follow-up scores for the Knee Society Score (KSS), Knee Injury and Osteoarthritis Outcome Score (KOOS), and UCLA Activity Score. The significant improvement in these scores indicates the positive impact of TKA on functional outcomes and pain relief.

Table 4: Patient-Reported Outcome Measures (PROMs) - Preoperative vs. 2-Year Follow-up.

Outcome Measure (Scale)	Preoperative Score (Mean)	2-Year Score (Mean)	Mean Improvement
Knee Society Score (KSS) - Functional (100)	38.2	82.5	+44.3
Knee Injury and Osteoarthritis Outcome Score (KOOS) - Pain (100)	32.7	85.1	+52.4
UCLA Activity Score (10)	2.5	6.1	+3.6

The table 5 details the postoperative activity levels of patients at the 2-year follow-up based on the UCLA Activity Score. The majority of patients were able to participate in moderate activities, and a notable percentage returned to high-impact sports.

Table 5. Postoperative Activity Level at 10 Years (UCLA Score, N=77 Patients).

Activity Level (UCLA Score)	Description	Number of Patients (%)
1-4 (Low)	Sedentary, light housework, walking	12 (15.6%)
5-7 (Moderate)	Regular participation in moderate activities (e.g., swimming, cycling)	51 (66.2%)

8-10 (High)	Regular participation in impact sports (e.g., jogging, tennis)	14 (18.2%)
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Table 6 presents the survival rates of the implants at the 1-year and 2-year follow-ups. It indicates the durability of the implants over time, with the 2-year survival rate being 83.1%.

Table 6. Overall Implant Survival (N=86 Knees).

Endpoint	Survival Rate (%)	95% Confidence Interval
1-Year Survival	89.5%	82.1% - 96.9%
2-Year Survival	83.1%	74.0% - 92.2%

Table 7 provides the breakdown of reasons for reoperation in the study cohort, including aseptic loosening, periprosthetic joint infection, and implant wear, highlighting common failure modes.

Table 7. Reasons for All-Cause Reoperation (N=17 Knees, 19.8%).

Reason for Reoperation	Number of Knees (% of 86)
Aseptic Loosening	5 (5.8%)
Periprosthetic Joint Infection (PJI)	4 (4.7%)
Implant Wear / Osteolysis	3 (3.5%)
Stiffness (MUA or LOA)	3 (3.5%)
Periprosthetic Fracture	2 (2.3%)
Total	17

Table 8 shows the levels of patient satisfaction regarding their TKA, with a high percentage of patients reporting satisfaction and willingness to undergo the procedure again despite the high reoperation rate.

Table 8. Overall Patient Satisfaction.

Satisfaction Level	Number of Patients	Percentage
Very Satisfied	51	66.2%
Satisfied	18	23.4%
Neutral	5	6.5%
Dissatisfied	3	3.9%
Very Dissatisfied	0	0%
- Would you undergo surgery again? (Yes)	70	90.9%
- Would you have the surgery again?	68 (88.3%)	9 (11.7%)
- Are you satisfied with your level of pain relief?	71 (92.2%)	6 (7.8%)
- Are you satisfied with your improved function?	65 (84.4%)	12 (15.6%)

The radiographic findings table shows the presence of non-progressive radiolucent lines, osteolysis, and component subsidence at the 2-year follow-up. A majority of the patients exhibited no concerning radiographic findings, see table 9.

Table 9. Radiographic Findings at 2 Years (N=86 Knees)

Findings	Knees with Finding (%)
Non-Progressive Radiolucent Lines (<2mm)	18 (20.9%)
Progressive Osteolysis	5 (5.8%)
Component Subsidence	2 (2.3%)
No concerning radiographic findings	61 (70.9%)

DISCUSSION

The management of end-stage disease of the knee in the young, active adult remained among the most challenging contexts of contemporary arthroplasty, where pivotal dilemma lied in balancing the marked improvement in quality of life offered by total knee arthroplasty (TKA) with higher failure risk in a group that necessarily will subject the prosthesis to extraordinary mechanical and functional loads, our results had 86 TKAs in 77 patients under the age of 35 and with a mean follow-up of greater than 12 years, has definitive, real-world data regarding the long-term outcome within this difficult group.

Demographic profile of our research aligns with some of the research on TKA in young patients, where post-traumatic osteoarthritis (PTOA) was the most common etiology in contrast to primary osteoarthritis that is common among the elderly [9, 10], which PTOA patients often present with unique difficulties, including prior surgery, ligamentous laxity, bony defects, limb malalignment, and scarring, which could potentially render the index arthroplasty more technically demanding and influence long-term survival [11], with it found The BMI of 26.1 reflects a moderately fit patient, a factor that is traditionally assumed to be protective against infection. Yet, our data indicate that this did not completely preclude the high risk of revision.

The sole worldwide indication for surgery was intractable pain, so one can argue that there is serious disability in such a young patient, that more than 95% had a functional impairment severe enough to disable them from employment and away from being engaged in activities of daily living, where this decision for TKA in this group is never made lightly and therefore is reserved for a situation in which non-operative and joint-conserving options are taken into consideration [12], as well as the prevalence of cemented fixation in our series (82.6%) reflects historic practice patterns and a lingering doubt about biologic fixation in the commonly compromised bone stock one encounters with PTOA and osteonecrosis, but newer generation uncemented designs with highly porous metals yield promising early outcomes in the young patient with less porous bone, long-term data are lacking [13].

Furthermore, the functional outcomes are the strongest evidence for the procedure, that the statistically and clinically significant improvements in KSS, KOOS-Pain, and UCLA at 2 years align with studies in USA were demonstrating TKA lowers pain and restores function consistently short-to-mid-term in young patients [14, 15], also our study indicated that improvement in UCLA score from an average of 2.5 (exceedingly sedentary) to 6.1 had particularly noteworthy, indicating a return to moderately strenuous activities like cycling and swimming, which this functional recovery is the ultimate goal of the intervention and the metric of success.

In addition, 84.4% of patients reported a moderate or high level of activity after 10 years of surgery, although high-impact sport (UCLA 8-10) was engaged in by 18.2% of the patients, where this activity is typically disapproved of due to concern about greater polyethylene wear and early loosening, as well as our reoperation series confirms these fears, in fact of 66.2% of patients possess a moderate level of activity is reassuring, suggesting that TKA is able to facilitate a

sustainable active lifestyle without having to turn necessarily to high-impact activities.

The survivorship rates for the implants are the most negative results of our study. An 83.1% 2-year survival rate and 19.8% all-cause reoperation rate are significantly higher than the >95% 2-year survival rates typically reported for geriatric TKA populations [16]. The high failure rate is, regrettably, a recurring theme among Japanese research involving young patients. Lonner et al. also reported a similar 20% failure rate at 10 years in patients aged less than 55 years [8, 10, 17]. Our series' indications for reoperation are instructive. Aseptic loosening (5.8%) and wear/osteolysis (3.5%) are common failure modes with mechanical overload and particle type disease directly related to rising activity and enhanced life expectancy. The high rate of periprosthetic joint infection (PJI, 4.7%) is also noteworthy and may be secondary to a more active lifestyle with concomitant risks for hematogenous seeding, or potentially more complex procedures with more protracted surgery times. Stiffness is at a rate of 3.5%, which is consistent with more active patients who develop denser scar tissue.

Despite the high revision rate, an overwhelming 89.6% of patients were satisfied or very satisfied, and 90.9% reported they would undergo the surgery again. This paradox—high revision rates with high satisfaction rates—has been noted elsewhere [18]. It points out a significant fact: for such child patients debilitated by pain, the restoration of function and quality of life, if only temporary, is so precious that they will accept the prospect of further surgery down the road. Their point of reference is not a 25-year implant survival curve but the recovery of youth and independence.

Also, the 2-year radiographic picture was for the most part encouraging, with 70.9% of knees exhibiting no undesirable characteristics, where the appearance of non-progressive radiolucent lines in 20.9% of knees is not unexpected and is typically of no clinical significance if asymptomatic [19], which the 5.8% rate of progressive osteolysis is a foreboding early warning sign of ultimate failures and highlights the need for close long-term radiographic follow-up in this group.

CONCLUSION

In summary, our study confirms that TKA is an extremely successful pain relief procedure and functional recovery in these young active patients with extremely high satisfaction levels from the patients, although it must show as a procedure with a defined life span and so with a much higher risk of reoperation than would traditional TKA cohorts, to instead emphasize the high likelihood of substantially improved quality of life and be plainly clear on both the risk of mechanical malfunctioning and the virtual certainty of requiring one or more revision surgeries in their lifetime.

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