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Original Research

Short- and Long-Term Outcomes in Patients With Lower Extremity Amputations Undergoing Total Hip and Knee Arthroplasty

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ABSTRACT

Background: Joint replacement following amputation is scarcely reported. The primary aim of this study was to evaluate patient-reported outcomes (PROMS) and revision rates among lower extremity amputees undergoing total hip (THA) or knee arthroplasty (TKA).

Methods: This was a retrospective cohort analysis of lower extremity amputees undergoing THA/TKA between August 2002 and August 2022 in a single tertiary center. Demographic and clinical data were collected from prospectively populated surgical databases and patient electronic records. PROMS included Oxford Knee Score, Oxford Hip Score, and 5-level EuroQol 5-dimension questionnaires. Twenty-three TKAs and 21 THAs were performed in 38 patients. The mean age at arthroplasty procedures was 59.8 (24-87) years. The mean clinical follow-up duration for THA and TKA was 9.1 and 4.5 years, respectively. Seven TKAs and 6 THAs were ipsilateral to the amputated side.

Results: The 10-year revision rates were 9.5% (2/21) and 5.9% (1/17) in the TKA and THA cohorts, respectively. TKA revisions occurred due to aseptic loosening. Six (26%) TKA cases experienced stump complications. Overall PROMS completion was 61.9% (13/21) and 64.7% (11/17) in TKA and THA patients, respectively. The average Oxford Hip Score/Oxford Knee Score of THA and TKA cohorts were 40.8 and 34.2, respectively. EuroQol 5-dimension questionnaire visual analog scores were higher in the THA cohort than those in the TKA cohort without statistical significance (59.1 vs 50.5, $P = .214$). The overall survival rate for the study was 94.7% at 5 years (36/38).

Conclusions: TKA/THA in lower extremity amputees can be successful, with low revision rates and good prosthesis function. Potential pitfalls highlighted include prosthesis malalignment, postprocedural rehabilitation, and stump complications.

Introduction

The indications for lower extremity amputations include trauma, complications of diabetes or peripheral vascular disease, infection, malignancy, and congenital abnormalities [1]. The prevalence of osteoarthritis has been shown to be significantly greater for both the knee and hip in the traumatic leg amputee population [2].

Evidence supports that lower extremity amputation increases the likelihood of developing nonamputated side joint osteoarthritis, in both atraumatic and traumatic cases, while joints on the amputated side characteristically demonstrate osteoporosis [3–5]. This has been attributed to altered gait mechanics and increased physiological loading of the intact limb [4,6–8]. Total hip arthroplasty (THA) and total knee arthroplasty (TKA) within the amputee population are poorly reported.

The first documented arthroplasty case in patients with lower extremity amputations was reported in 1953 [9], and subsequently, there has been a sparsity of publications on the subject [10–13]. The literature describes a variety of challenges in the management of patients with lower extremity amputation requiring TKA and THA, particularly patient positioning, implant alignment, and

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postoperative rehabilitation [9,14,15]. There remains paucity of data analyzing outcomes in lower extremity amputees receiving THA and TKA.

Therefore, the aim of the present study was to report a single-center study analyzing the complication profile, revision rate, and patient-reported outcomes (PROMS) in lower extremity amputees receiving subsequent total hip and knee replacement surgeries. In addition, we detail the surgical technique and approach to rehabilitation. We hypothesize that hip and knee arthroplasty in lower extremity amputees may yield good short- and long-term outcomes, with acceptable prosthesis function.

Material and methods

We performed a total of 45 THA (21) and TKA (24) procedures, on 39 patients with previous lower extremity amputation, during the study period. One patient who underwent TKA had irretrievable records and was hence excluded from the data set. Twenty-three (52.3%) of the remaining cases were TKAs, and 21 (47.7%) THAs. No patients were lost to follow-up, and 8 (20.5%) had deceased before the end of the study period. The mean age of TKA and THA patients at the time of arthroplasty was 63 (37-87) and 57 (24-84) years, respectively. For the entire cohort, the mean age was 59.8 (24-87) years, and 27 (69.2%) patients were men. Table 1 outlines the baseline patient demographics and clinical data at the time of arthroplasty procedure and describes details regarding amputation.

We conducted a retrospective cohort analysis of all patients with lower extremity amputation receiving subsequent THA or TKA, between August 2002 and August 2022, at a tertiary orthopedic arthroplasty center.

We included all patients with lower extremity amputations undergoing subsequent THA or TKA over a 20-year period, between July 2002 and July 2022. Patients with congenital amputation were included in our definition of lower extremity amputation. Patients with amputation below the ankle malleoli or those undergoing THA or TKA before amputation were excluded. Patients with incomplete data sets, long-term follow-up outside of the institution, and irretrievable records were also excluded.

Prior to commencing data collection, the study was reviewed by the local research and ethics committee, and based on the Health Research Authority “Defining Research” leaflet, it was concluded that the project is classed as service evaluation and did not require approval from an institutional review board. Verbal consent from the patient was obtained prior to follow-up questionnaire completion. Cases were identified from the institution’s prospectively populated surgical database using International Classification of Disease - 10 codes and manual review by 2 of the authors (R.G., S.M.). Demographic and clinical data were extracted from selected patients' electronic medical records (Evolve, Belfast, Northern Ireland). Patients were contacted via email and telephone to complete the Oxford Knee Score (OKS), Oxford Hip Score (OHS), and 5-level EuroQol 5-dimension questionnaires (EQ5D). These outcome measures were selected due to their proven validity and utility in previous publications on the subject. THA and TKA demographic and clinical data were split and recorded separately. Within these groups, arthroplasty surgery on the same side as previous amputation is described as “ipsilateral” THA/TKA, whereas arthroplasty surgery on the opposite side to previous amputation is described as “contralateral” THA/TKA.

Demographic and clinical data included age, sex, body mass index, American Society of Anesthesiologists score, and smoking status. Comorbidities were graded utilizing the age-adjusted and standard Charlson Comorbidity Index. Amputation indication, type, level, date, and laterality were recorded. Arthroplasty procedure date, laterality, indication, and implant choice were documented. In cases of ipsilateral TKA, residual tibial length was noted. Perioperative outcomes included intraoperative complications, length of hospital stay, and reoperation rate. Ambulation (without aid, 1 or 2 sticks, frame, wheelchair), range of motion (degrees), postoperative complications (including the presence of stump complications), and pain at 6- to 10-week follow-up were recorded. Stump complications were defined as cellulitis, abscess, wound breakdown, or dehiscence. Long-term outcome measures included revision rates, mortality, and years lived postoperatively, OKS, OHS, and EQ5D questionnaires.

Table 1
Demographic information of included patients at the time of arthroplasty.

Demographics	TKA	THA	*P* value
Patients (total)	21	17	
Gender			
Men	16 (76.2%)	11 (64.7%)	
Women	5 (23.8%)	6 (35.3%)	
Mean age	62.9	56.6	.130
Smoking			
Current	2 (9.5%)	2 (11.8%)	
Ex-smoker	2 (9.5%)	0 (0%)	
Never	17 (81.0%)	15 (88.2%)	
ASA			
ASA 0	0 (0%)	0 (0%)	
ASA 1	10 (47.6%)	5 (29.4%)	
ASA 2	6 (28.6%)	9 (53.0%)	
ASA 3	3 (14.3%)	2 (11.8%)	
ASA 4	2 (9.5%)	1 (5.8%)	
ASA 5	0 (0%)	0 (0%)	
Mean BMI	30.2	26.6	.044
Age-adjusted CCI (average)	2.7	1.9	.219
Standard CCI (average)	0.9	0.7	
Indication for amputation			
Trauma	12 (57.1%)	9 (53.0%)	
Sarcoma	1 (4.8%)	3 (17.6%)	
Infection	4 (19.0%)	4 (23.5%)	
PVD	1 (4.8%)	0 (0%)	
Failed procedure/pain	2 (9.5%)	0 (0%)	
Congenital	1 (4.8%)	1 (5.9%)	
Amputation side			
Right	12 (57.1%)	8 (47.1%)	
Left	9 (42.9%)	8 (47.1%)	
Bilateral	0 (0%)	1 (5.9%)	
Amputation level			
Hindquarter	0 (0%)	2 (11.8%)	
Above knee	1 (4.8%)	8 (47.1%)	
Through knee	1 (4.8%)	1 (5.9%)	
Below knee	18 (85.6%)	6 (35.2%)	
Below knee (congenital)	1 (4.8%)	0 (0%)	

ASA, American Society of Anesthesiologists; BMI, body mass index; CCI, Charlson comorbidity index; PVD, peripheral vascular disease.

The OKS questionnaires were obtained at an average of 9.1 years following arthroplasty. The OHS questionnaires were obtained at an average of 12.2 years following arthroplasty. Subjects were asked to complete an OHS, OKS, or both as appropriate, considering their procedural history. All data were independently verified by a detailed review of hospital operative reports, anesthesia records, and clinical records.

All patients were discussed in the multidisciplinary team meeting prior to the surgery. For patients with ipsilateral TKA, careful preoperative planning was undertaken to ensure adequate bone stock remained in the residuum to accommodate a prosthesis. The patient is set up supine with a horizontal padded bar placed under the knee to allow the knee to rest in flexion. Intramedullary alignment using traditional jigs can be used with a short rod if the residual tibia allows. For patients with a more proximal amputation, patient-specific instrumentation jigs and robot-assisted surgery can be used. Figure 1 shows a cemented, primary total knee replacement and demonstrates the challenges of tibial alignment in

Figure 1. Postoperative radiograph of a right-sided, cemented total knee replacement, following a traumatic below-knee amputation 10 years previously. A short intramedullary alignment rod has been used; however, the jig was unstable intraoperatively due to poor bone stock.

the below-knee amputee. Figure 2 shows a postoperative radiograph in a patient with a congenital amputation receiving a computer-aided design and computer-aided manufacture replacement, with a very short residual tibia.

Regarding ipsilateral THA, preoperative templating is vital to ensure the stem, and if used, the cement mantle is proximal to the resection level. Technical challenges are principally related to hip dislocation and femoral positioning, particularly for THA after above-knee amputation (AKA) where rotation of the femur is challenging. The use of a Heygroves bone holding forceps (Surtex, Surrey, England) at the subtrochanteric level can be used to aid femoral rotation and act as a guide for rotational alignment. Figure 3 demonstrates a complex primary total hip replacement in a patient with ipsilateral AKA and prosthesis.

Preoperatively, patients undergo consultation with their own prosthetic service to make them aware of the surgery and that they will typically not be able to wear a prosthesis until the wound is healed. Patients are discharged after wound examination and first dressing change. Upon discharge, patients are reviewed in orthopedic clinic after 6-8 weeks, alongside regular orthotics input.

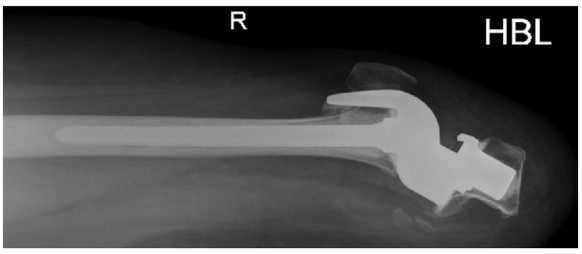

Figure 2. Postoperative radiograph of a total knee replacement indicated for degenerative osteoarthritis in a patient with a congenital below-knee amputation.

Figure 3. Follow-up radiograph in a patient undergoing complex left total hip replacement surgery, with an orthotics-fitted prosthesis.

Statistical analysis was performed using t-tests for continuous variables. Statistical significance was determined as $P < .05$ a priori.

Results

Trauma was the most common indication for amputation in TKA (12/21, 57.1%) and THA (9/17, 53.0%) patient groups. Below-knee amputation was most prevalent in the TKA cohort (18/21, 85.6%), whereas AKA was most prevalent in the THA cohort (8/17, 47.1%). The THA cohort demonstrated greater variation in amputation level.

Table 2 describes details regarding arthroplasty. Contralateral joint replacement predominated in both TKA (16/23, 69.6%) and THA (14/21, 66.6%) groups. Degenerative osteoarthritis was the main indication for joint replacement across the entire cohort (34/44, 77.3%).

Table 3 delineates perioperative, short-term and long-term PROMS. Mean clinical follow-up time in the TKA group was 4.5 years, compared to 9.1 years in the THA group. The average age at PROMS completion was 70.1 years (TKA) and 66.8 years (THA). The average time from arthroplasty to study PROMS completion was 9.6 years (TKA) and 12.2 years (THA). The 6 TKA complications were all in separate patients and included medial joint line inflammation requiring steroid injections, atrial fibrillation, 2 infected prosthetics, and a fall on ward with fracture in the neck of femur. The 4 THA complications were neuroma, partial sciatic nerve injury, and 2 tendinopathies requiring steroid injections (iliopsoas tendon sheath and ischial tuberosity attachments). All 6 patients with stump complications following TKA, including ulceration and edema, experienced delays to ambulation due to pain, infection, and delayed fitting of prosthesis.

Ten-year revision rates were 9.5% (2/21) and 5.9% (1/17) in the TKA and THA cohorts, respectively. The indication for revision in both TKA revisions was aseptic loosening. Both cases of implant failure were inpatients with standard, cruciate-retaining condylar knee replacements. One member of the THA cohort underwent revision for adverse reaction to metal debris. All 3 revisions were on

Table 2
Details of arthroplasty in THA and TKA cohorts.

Prosthesis details	TKA		THA
Cases (total)	23	Cases (total)	21
Side of arthroplasty		Side of arthroplasty	
Right	10 (43.5%)	Right	9 (42.9%)
Left	13 (56.5%)	Left	12 (57.1%)
Laterality (when compared to amputation side)		Laterality (when compared to amputation side)	
Ipsilateral	7 (30.4%)	Ipsilateral	6 (28.6%)
Contralateral	16 (69.6%)	Contralateral	14 (66.6%)
Ipsilateral and contralateral (bilateral amputee)	0 (0.0%)	Ipsilateral and contralateral (bilateral amputee)	1 (4.8%)
Primary arthroplasty		Primary arthroplasty	
Yes	22 (95.7%)	Yes	21 (100.0%)
No (revision)	1 (4.3%)	No (revision)	0 (0.0%)
Arthroplasty type (TKA)		Fixation	
Posterior stabilizing	4 (17.4%)	Uncemented	16 (76.2%)
Cruciate retaining	14 (60.9%)	Cemented	2 (9.5%)
Constrained	2 (8.7%)	Hybrid	3 (14.3%)
Hinge	2 (8.7%)	Reverse hybrid	0 (0.0%)
Unknown	1 (4.3%)	Unknown	0 (0.0%)
Arthroplasty indication		Arthroplasty indication	
Degenerative OA	19 (82.6%)	Degenerative OA	15 (71.3%)
Posttraumatic OA	4 (17.4%)	Posttraumatic OA	3 (14.3%)
		Arthrodesis of joint	1 (4.8%)
		Avascular necrosis	1 (4.8%)
		Metastases	1 (4.8%)
Time from amputation to arthroplasty (average years)	30.9 (0.8-81.8)	Time from amputation to arthroplasty (average years)	19.5 (1-63.1)

OA, osteoarthritis.

contralateral implants. One THA patient underwent reoperation: exploration and neurolysis of the right sciatic nerve for a partial sciatic nerve palsy noted postoperatively. Follow-up PROMS was completed by 66.7% (14/21) of TKA and 64.7% (11/17) of THA cases. Four patients in both cohorts were deceased, 2 patients in both cohorts were uncontactable, and 2 patients in the TKA cohort refused to complete questionnaires.

The average OHS and OKS of THA and TKA cohorts were 40.8 and 34.2, respectively. Within the THA group, the average OHS was 40 for ipsilateral cases and 41 for contralateral cases ($P = .754$). Within the TKA group, the average OKS was 34.4 for ipsilateral cases and 34.1 for contralateral cases ($P = .958$). Average EQ5D Viual Analogue Scale results were 59.1 for the THA cohort and 50.5 for the TKA cohort, with no statistically significant difference ($P = .214$).

Discussion

Our study demonstrates that lower extremity amputees undergoing hip and knee arthroplasty can gain good functional outcomes with an acceptable complication profile. To our knowledge, this is the largest study reporting TKA and THA outcomes among lower extremity amputees in the general population.

Our 10-year revision rates were 8.7% (2/23) and 4.8% (1/21) in the TKA and THA cohorts, respectively. These are higher than those in the general population, with the 2021 data from the National Joint Registry in England and Wales demonstrating that, on average, 4.3% of primary hip replacements and 4.1% of primary knee replacements are revised within 10 years [16]. It has been suggested that, due to unequal load distribution, contralateral implants in lower limb amputees are more subject to failure [11,17]. Our 2 TKA revisions were indicated due to aseptic loosening, and all 3 revisions were performed on implants contralateral to lower extremity amputation, supporting this theory. A study conducted by Amanatullah et al. produced similar results, where 7.7% of patients with contralateral below-knee amputation undergoing TKA required revision for aseptic loosening within 1 year [10]. It is evident that contralateral TKA implants are subject to atypical ambulatory forces; consideration of supplementary fixation of the

Table 3
TKA and THA reported outcomes.

Outcomes	TKA	THA
Cases (total)	23	21
Patients (total)	21	17
Reoperations (within 6 months)	1 (4.3%)	1 (4.8%)
Revisions	3 (13%)	1 (4.8%)
Postoperative complications	6 (26.1%)	4 (19.0%)
Clinical follow-up period (average)	4.5 (0.1-12.4)	9.1 (0.8-24.9)
Years lived after arthroplasty if deceased (average)	11.1 (4.9-18.3)	8.5 (0.9-17.7)
Progress at 6-8 weeks of follow-up		
(A) Ambulation status		
No adjuncts	14 (60.9%)	14 (66.7%)
One stick	2 (8.7%)	3 (14.3%)
Two sticks	6 (26.1%)	2 (9.5%)
Frame	1 (4.3%)	2 (9.5%)
Wheelchair	0 (0.0%)	0 (0.0%)
(B) Range of motion-flexion (average)	96.1	NA
Postoperative stump complications (within 6 months)	6 (26.1%)	2 (9.5%)
Patients completing PROMS	13 (61.9%)	11 (64.7%)
Age at PROMS completion (average)	70.1 (53-89)	66.8 (43-90)
Oxford Knee Score/Oxford Hip score (average)	34.2 (8-47)	40.8 (32-47)

tibial component may be relevant in this group, particularly if they have other risk factors for tibial tray loosening such as obesity [18,19]. The authors would suggest a low threshold for cross-sectional imaging preoperatively and accurate templating to ensure implants are appropriately sized. Patients in our cohort had many associated soft-tissue concerns due to scarring from previous surgeries; neurovascular status of the limb must be assessed pre-operatively. Patients with ligamentous instability of their knee will require a higher level of constraint; therefore, particular attention must be paid to the residuum and its ability to accommodate a stemmed prosthesis.

Postoperative stump complications were noted in 6 (26.1%) patients undergoing TKA. Three (42.9%) out of the 7 ipsilateral TKA cases developed stump complications. Outcome data following joint replacement in the amputee population remain limited, and to our knowledge, there are no prior studies reporting stump complication rates. The functional requirement for weight-bearing increases stump complication risk in this patient group. Regarding ipsilateral cases, rehabilitation typically involves a period of non-weight-bearing until the resolution of stump edema with subsequent prosthesis fitting; however, there are reports of successful immediate weight-bearing with close incision site surveillance [14,20,21]. The complications associated with loss of stump soft-tissue integrity are potentially serious, with particular risk of peri-prosthetic joint infection. Appropriately fitted prostheses are of paramount importance, not only to reduce the risk of stump complications but also to avoid abnormal force transfer through the joint replacement [3]. The authors conclude that there is a necessity for multidisciplinary management of these patients, including collaboration with orthotics to ensure appropriate prosthetic fitting to minimize stump complications. Surgeons can tailor their weight-bearing approach to the patient and their ability to tolerate periods of non-weight-bearing. Stump complications should be recognized as material risk and described during the consenting process.

Our study documented no significant difference between mean postoperative OHS and OKS in patients receiving ipsilateral and contralateral arthroplasty within each group. Additionally, we demonstrate acceptable mean postoperative OHS (40.8) and OKS (34.2) following total joint arthroplasty. A large series conducted by Gwynne-Jones et al. demonstrated mean postoperative OHS and OKS as 40.7 and 37.4, respectively, in a general population sample undergoing THA and TKA [22]. To our knowledge, this is the largest study utilizing these PROMS is the assessment of lower extremity amputees receiving total arthroplasty surgery. We selected the OHS/OKS as these are validated, widely utilized joint-specific PROMS that assess patients' disability following total joint replacement. Utilization of the widely established EQ5D scoring system allowed us to further measure the postoperative quality of life of this patient group.

Our study has limitations. This is a heterogenous group regarding case mix, implant manufacturer, and amputation type. However, we would argue that both THA and TKA groups had few significant differences in their demographic variables, and therefore, this adds to the applicability of our findings. Surgical technology and technique have naturally progressed throughout our study period, potentially confounding our results. The numbers in our study are small; however, compared to the previous publications, our study has good volume. PROMS completion was only 61.9% (TKA) and 64.7% (THA) in the 2 groups. Although the 8 deceased patients contribute to these figures, it is important to recognise the self-selection bias inherent in voluntary questionnaire completion. The OHS/OKS does not require clinician input and measures patients' perceptions in adjunction to surgery yet has its own limitations. The authors noted that many amputees score poorly on questions encompassing general function, for example, the ability to perform your own shopping or climb a flight of stairs. In many cases, notes specified that the ability to perform these tasks was not hindered by the joint replacement in question but by mobility problems unique to their amputation type, prosthetic-related issues, or other comorbidities. Hence, it is possible that this study underestimates the success of joint replacement in these individuals. In the absence of preoperative scores for comparison, our results are encouraging and confirm the patient-centered benefits of performing THA/TKA in appropriately selected lower extremity amputees

Conclusions

TKA and THA in patients with previous amputation can provide good function with an acceptable complication profile and revision rate. The authors would recommend all patients have a prosthetic review if undergoing ipsilateral TKA/THA to minimize the risk of stump complications postoperatively. Cross-sectional imaging preoperatively will allow for accurate templating of the joint to ensure precise implantation in a more complex anatomical setting.

Conflicts of interest

The authors declare there are no conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2023.101117.

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