RESEARCH ARTICLE

Amputation after Multiple Times Failed Total Knee Arthroplasties: The Last Resort

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Abstract

Objectives: The study assessed the clinical and functional outcomes of transfemoral amputations following TKA complications, shedding light on a procedure often considered in extreme cases.

Methods: In this retrospective study, six patients undergoing above-knee amputation due to TKA complications were analysed. Diagnosis of periprosthetic joint infection relied on clinical presentation and the Musculoskeletal Infection Society Definition (2011). Patient demographics, comorbidities, and surgical interventions were meticulously recorded. The study aimed to contribute valuable insights into the intricacies of managing complications post-TKA.

Results: The study cohort, constituting 0.002% of total TKA cases, exhibited a mean age of 78.8 years. Comorbidities, predominantly diabetes, were prevalent. The duration between TKA and amputation averaged 6.3 years. Surgical interventions, including revisions, debridements, and aspirations, were numerous, reflecting the complexity of managing complications. All patients underwent above-knee amputation using a single-stage approach, with careful consideration of the surgical site's condition. Post-amputation care, including stump care and prosthetic leg options, was tailored to individual patients' needs. Patients were diligently followed for a minimum of 12 months. Stump wounds healed without requiring revisions, and prosthetic limbs were successfully applied to three patients. Mobility status and disability scores, evaluated through the Sickness Impact Profile (SIP), showed significant improvement.

Conclusion: The study highlights periprosthetic joint infection as the primary cause of multiple failed procedures leading to amputation. Microbiological findings identified common pathogens, including Staphylococcus aureus and Pseudomonas aeruginosa. Challenges posed by biofilm formation underscored the complexities of antibiotic treatment. Transfemoral amputation emerges as a feasible option for patients with multiple failed TKAs, particularly in cases of persistent infection. The decision-making process should encompass a thorough consideration of the number of failed procedures, cost-benefit analysis, and various psychosocial and economic factors. Further research and extensive multicentric studies are imperative to validate and expand upon these findings.

Level of evidence: IV

Keywords: Amputation, Arthrodesis, Knee arthroplasty, Multiple failed procedures, Periprosthetic joint infection

Introduction

Total knee arthroplasty (TKA) is one the most successful orthopaedic surgeries but not without complications. One of the most dreaded and complex complications is the periprosthetic joint infection and its management.[1] Persistent infection and its consequences are very challenging to treat. Amputation although seems a devastating end point but acts as a lifesaver and single-time solution.[2] The increased number of failed attempts for limb salvage causes not only physical insult but also economic and emotional trauma to the patients. Multiple revision arthroplasties, resection arthroplasties or arthrodesis surgeries have a failure rate in the cases of periprosthetic joint infections (PJI).[3] Along with these other auxiliary procedures like multiple

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myocutaneous flaps, skin grafting, debridements, drainage and vacuum-assisted closure (VAC) systems add to the morbidities of the patient. Amputation should be offered to patients only after assessing the physical condition, mental state and multiple failed attempts of limb salvage. The rate of amputation in primary TKA is minuscule but it increases in revision surgeries. Due to a lack of consensus and lacunae in literature, there are no established guidelines on when amputation should be performed following TKA. This study shared the experience of transfemoral amputation performed following complications of TKAs. This study assessed the clinical and functional outcomes of transfemoral amputation following TKA complications considering the psychological factor and the financial aspect. This study would contribute to the literature, which would ultimately result in the formulation of guidelines dictating the factors/scoring system for amputation following the complication in TKA.

Materials and Methods

This retrospective study was performed over a period of 6 years. The study included patients who underwent above-knee amputation due to the consequences of total knee arthroplasty surgery complications. The patients suffering amputation due to any other cause apart from complications of TKA were excluded from the surgery. The aetiology may vary from persistent infection, trauma, vascular disease, etc. The periprosthetic joint infection was suspected on clinical presentation varying from swelling, redness, pain/tenderness, restriction of movement, and fever and diagnosed according to the modified definition of Musculoskeletal Infection Society Definition [Figure 1].[4]

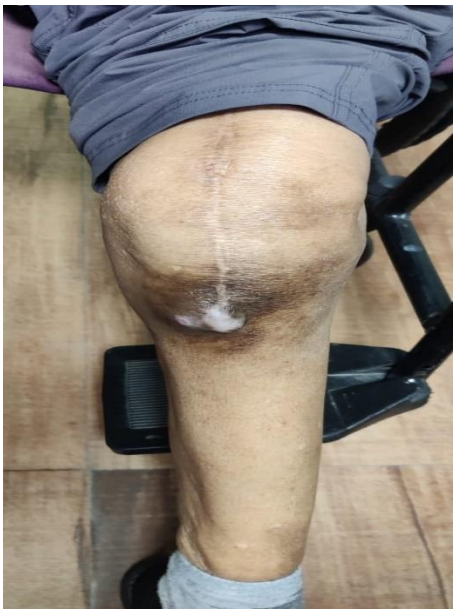

Figure 1. Clinical picture depicting swelling at the suture line

Data collection

The demographic data of such patients including age, sex, year of primary TKA and aetiology and comorbidities were recorded. The data was retrieved from the patient files and physical or telephonic meetings with the patients.

Surgical intervention

The information regarding the complications suffered after the primary surgery was noted. The number of procedures including revision surgeries, debridement, incision & drainage (I & D), knee aspirations, myocutaneous flap or skin graft procedures or any other surgical intervention pertaining to the management of TKA complications were recorded. The duration from primary TKA to revision arthroplasty and age at amputation was also noted. The surgical site/knee condition before the amputation was assessed especially considering sinus and pin site infections.

The details of the interventions were sought after and relevant details were included in the study. The patients who underwent other surgical procedures unrelated to the TKA were also recorded.

Multiple culture reports over the period were also recorded.

Surgical procedure

All patients were planned for above-knee amputation considering the surgical scars, pin site infection, stem length and osteomyelitis in the femur. Single-stage amputation was planned with fish mouth closure over the drain [Figure 2]. The femur bone was resected around 3-4 cm proximal to the skin incision. Myoplasty was performed in all the cases. The wound was closed in layers with silk suture 2.0 and compression bandages. Suture removal was performed after 2 weeks. Dressing of wounds was done in cases of wound gaps or delayed healing. Coconut oil was applied over the healed suture line.

The amputation stump care, high protein diet and physiotherapy were done in all the patients. Only after 3 months, after assessing the amputation stump, the prosthetic leg option was given to the patients considering their general health condition and wound site.

Figure 2. Clinical picture of an amputated stump with a corrugated drain

Postoperative follow-up

Patients were followed up for at least 12 months. The complications suffered due to the amputation and prosthetic leg were also included in the study. Postoperatively, mobilisation status (with or without walking aid) was also assessed.

The disability scoring at the end of the minimum follow-up was performed using the Sickness impact profile (SIP) score. The score was compared at the pre-amputation stage and 12-month follow-up. The psychological factors pre-amputation stage were evaluated through a questionnaire depicting the satisfaction level of the patients from all the knee replacements and complication management.

Statistical analysis

The quantitative data was tabulated and assessed using the SPSS 22.0 version. The range, standard deviation and mean values were calculated. P-value (<0.05) was considered significant. The qualitative data was tabulated in [Table 1].

Table 1. Descriptive data of the study population

S.no	1	2	3	4	5
Age at primary TKA /sex	72 yrs/M	68 yrs /M	61 yrs /M	65 yrs /F	58 yrs /M
Primary diagnosis	Osteoarthritis knee	Rheumatoid arthritis knee	Osteoarthritis knee	Rheumatoid arthritis	osteoarthritis
Primary implant	Primary TKA Freedom Knee system®	Primary TKA Legion knee system®	Primary TKA Freedom knee system®	Primary TKA PFC Sigma® with screw-cement construct for medial tibial defect	Primary TKA Freedom knee system®
Comorbidities	Hypertension and coronary artery disease	Diabetes mellitus, Chronic kidney disease	Hypertension, Asthma, Diabetes mellitus	Severe aortic valve stenosis and coronary artery disease.	Peripheral vascular disease, diabetes mellitus
Duration before revision arthroplasty	8 months	1.5 years	1 year	1.2 years	1.8 years
2-stage revision	One	Twice	Twice	One	One
Arthrodesis	Yes (with Charnley compression clamp)	No	No	No	Yes (with compression plating system)
Auxillary (debridement/Incision and drainage)	4 times I&D. 4 times debridement	6 times I & D, 2 times debridement and VAC application	8 times I & D, 4 times debridement and VAC application	2 times knee aspiration	3 times debridement with VAC application, 3 times I & D, multiple times knee aspiration
Flap	Yes	Yes	Yes	no	no
Microbiology	Staphylococcus aureus, MRSA, E. coli	Staphylococcus aureus, Citrobacter, MRSA	Pseudomonas aeruginosa, E.coli, Staphylococcus aureus	MRSA, Pseudomonas aeruginosa	Staphylococcus aureus, Klebsiella pneumoniae
Remarks	Pin site infection, No sinus	Poor general health condition, on dialysis, Gross knee swelling	Multiple sinuses from the knee	ASA grading 4, Left anterior descending artery 80% occlusion, right coronary artery 80 % occlusion	Multiple sinus, diabetic foot with gangrenous changes in toes. Pin site discharging sinus present
Age at amputation	78 yrs	76 yrs	79 yrs	68 yrs	62 yrs
Complications	none	Delayed wound healing with a small ulcer at the suture line	none	none	Delayed wound healing
Prosthesis	yes	no	yes	no	no
Walking status	Walking independently with a cane	Wheelchair mobilisation	Walking independently with a cane	Walking with the help of a walker	Walking with walker
SIP					
Pre-	62	65	63	63	61
Post-	26	34	30	22	28

Table 1. Continued

6	66 yrs /F	Osteoarthritis	Primary TKA Freedom knee system®	Hypertension, diabetes mellitus, hypothyrsoidism	1.6 years	One	No	6 times debridement with VAC application, 3 times I & D	Yes	Pseudomonas aeruginosa, Staphylococcus aureus, E.coli	Swelling and pus discharging sinus at surgical site	75 yrs	none	yes	Walking independently with a cane	58	30

Results

Demographic

The study included 6 patients (4 males and 2 females). This constituted 0.002% of the total TKA performed during the period. The mean age of the patients in the study was 78.8 years (range 72-85). The mean age at which primary TKA performed was 66.9 years (range 62-78 years). Two patients had rheumatoid arthritis whereas the rest of the patients had osteoarthritis. The total number of primary TKA and revision arthroplasties performed during this period was 4126 and 186 respectively.

All the patients had some combination of comorbidities including diabetes mellitus being the most common [Table 1]. All the patients were well managed for comorbidities before embarking on TKA.

All the patients underwent primary TKA without any need for augments or stems except one patient required screw with cement construct with tibial stem in view of severe varus deformity, osteoporosis and rheumatoid arthritis. All the patients had tri-compartment knee arthritis with varus or flexion deformity.

Surgical interventions

All the patients suffered a periprosthetic joint infection in due course. The mean duration of the revision procedure was 8.4 months (6-18 months). The mean duration between primary TKA and amputation was 6.3 years (4-12 years). The average number of surgical procedures before final amputation was 6 (range 3-8). There was the presence of active discharging sinus at the surgical site in 3 patients and pin site infection in two patients [Figure 3]. All the patients had uneventful immediate post-operative periods.

Two patients had delayed wound healing requiring no intervention. The wound healed over 2 months with a small ulcer (0.5x0.5 cm) at the suture line in one patient.

All the patients underwent 2-stage arthroplasty at least once with 2 patients undergoing 2-stage arthroplasty twice. Two patients underwent failed knee arthrodesis before final amputation. Arthrodesis was attempted with a Charlney compression clamp in one patient and a compression plate system in another patient [Figure 4]. One patient had peripheral vascular disease as well as diabetic foot with ulcers in the same limb. All the patients had multiple debridement and aspirations.

The microbiology report of the pus investigated at various time periods depicted different microorganisms even in the same patient. The most common being Staphylococcus aureus and Pseudomonas aeruginosa.

Figure 3. Clinical picture depicting multiple sinuses with active pus discharge

Figure 4. Radiograph depicting failed arthrodesis with pin tract osteolysis

Four patients required a myocutaneous flap during the revision surgeries due to large wound defects [Figure 5]. Vacuum-assisted closure (VAC) wound closure system was used in four patients during the course of debridement and revision surgeries.

At the time of amputation, 3 patients had femoral stem, and 2 patients had pin tract infections of arthrodesis system pins. The average length of the stump was 22 centimetres (15-25 centimetres) measuring from the crouch.

Figure 5. Clinical picture of the knee with the large infected wound

One patient (number 4) had one 2-stage revision arthroplasty and then stage 1 revision arthroplasty with multiple debridement under local anaesthesia [Figure 6]. The patient had severe aortic valve stenosis and coronary artery disease. The patient was managed with amputation as multiple surgeries in such high cardiac-risk patients could be fatal. The patient underwent coronary artery bypass grafting after 2 months of the amputation.

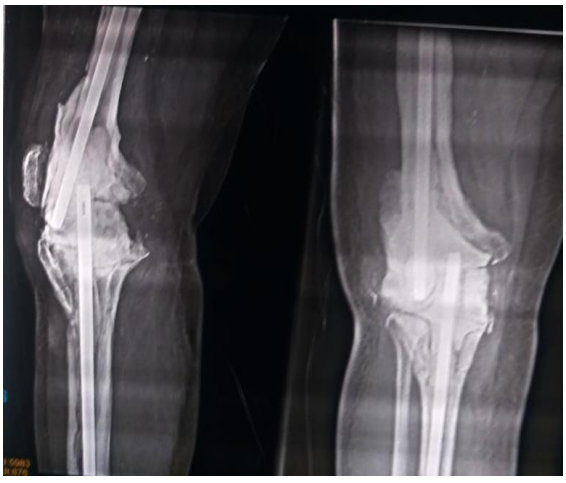

Figure 6. Radiographs showing stage 1 with femoral and tibial K-nail and cement spacer

One patient (number 5) had right lower limb peripheral vascular disease with diabetic foot and gangrenous changes in toes [Figure 7]. The patient had already undergone 2 stage revision arthroplasty, three-time debridement, multiple knee aspirations and knee arthrodesis surgery of the right knee. Considering active infection in the foot and gangrenous changes with failed knee arthrodesis surgery, above-knee amputation was performed. CT angiography was performed to decide the level of amputation.

Figure 7. Clinical picture of the leg with multiple suture lines

Rehabilitation and Follow-up

All the patients had a minimum follow-up of 12 months (12-60 months). The stump wound healed in all patients without requiring any revision surgeries. The prosthetic limb (above-knee prosthesis with conventional hip joint and pelvic band) was applied to 3 patients and was mobilised independently with the help of a cane. The rest of the patients were wheelchair-bound and were able to mobilise independently with the help of a walker except one patient (patient no 2) due to multiple joint deformities because of rheumatoid arthritis). The SIP score pre-amputation stage and 12 months post-amputation were analysed. The mean SIP score pre-amputation was 62 and at follow-up was 28.3, there was a significant improvement in the SIP score ($p<0.05$).

Economic Impact

The financial expenditure for the patients utilizing the prosthetic limb was approximately $ 720 whereas for patients utilizing the wheelchair, the amount was approximately $ 480. The average cost of the 2-stage revision arthroplasty or arthrodesis was around $ 5500 and $ 4000 respectively. There was no need for any revision surgeries in patients undergoing amputation leading to less economic and psychological burden on the patients.

Psychological Factor

All the patients were asked four satisfaction assessment questions on different major aspects (Surgical procedure, functional restoration, pain relief, and fulfilment of expectations).[5] the response was recorded using a Likert scale: "very satisfied", "satisfied", neutral", "dissatisfied", "very dissatisfied". The Questions were: 1) Overall how satisfied are you with the results of your knee replacement? 2) How satisfied are you with the surgical procedure of your knee replacement surgery? 3) How satisfied are you with the results of your knee replacement surgery for improving your functional abilities (such as standing, walking, and bathing)? 4) How satisfied are you with the results of your knee replacement surgery for relieving your pain? 5) How satisfied are you with the expectation of fulfilment of your knee replacement surgery?

The result depicted all the patients were "very dissatisfied" with the satisfaction assessment questionnaire

Discussion

Periprosthetic joint infection is one of the most dreaded complications following TKA. As the number of knee arthroplasties is on the rise, so are the PJI cases. Amputation serves as a last resort for the management of PJI. In this study, PJI emerged as the sole causative aetiology for multiple failed procedures, ultimately resulting in the amputation of the limb. The rate of PJI in primary TKA varies from 2-5% [6-8] whereas it escalates sharply in the case of revision TKA to 8%-10%.[9,10] Due to irreparable complications due to infection in TKA, amputations in such cases become a salvage procedure. Still, the rate of such complications resulting in amputations is less so there is no definitive data or protocol on when to pursue amputation post-TKA.[11,12] With the advancement in surgical techniques and antibiotics, the rate of amputation is supposed to be reduced as compared to the previously published literature. The rate of transfemoral amputation as reported by Bengston and Knutson was 0.18% and 6% in all cases and patients with infected TKA respectively.[13] Similar to this, the study by Sierra et al. also reported the rate of amputation at 0.14%.[2] Whereas the study by Van Rensch et al. reported the prevalence of amputation in infected TKAs as low as 0.41%.[12] The study carried out by Paula Mozella et al. reported infections as the main cause of amputation in 81% of the cases.[14] The study by T. Amouyel et al. reported 8% amputation in 72 chronically infected knee patients, who underwent prosthesis removal and considered fusion and spacer as salvage procedures.[15] Min-sun Son et al. reported the data from the national registry depicting a 4.1% amputation rate in failed total knee arthroplasties.[16] Mousavian et al. in a review showed an amputation rate of 5.1% and 0.025% in infected TKA and primary TKA respectively.[17] Another complication of PJI was associated with a periprosthetic fracture with bone loss. Mozella et al. reported a 6.5% amputation rate in such cases.[14] next in line are the vascular complications following TKA leading to amputations. The arterial injuries can be acute and lead to devastating results. The amputation rate is as high as 27% in such acute cases.[17] the other consequences include ischemia, thrombosis, non-healing ulcers, gangrenous changes and pseudoaneurysm, ultimately leading to amputation. In our cases series, one patient had peripheral vascular disease, diabetic foot, gangrenous changes in the foot along with infected TKA ultimately resulting in transfemoral amputation. There can be associated compartment syndrome with vascular insults. The review by Mousavian et al. reported an amputation rate of 28% in direct vascular injury and 13% in compartment syndrome. [17] Although compartment syndrome is a rarity after TKA, but has devastating results.[18]

This study identified the most common causative microorganisms as Staphylococcus aureus and Pseudomonas aeruginosa. Although there was a mixture of culture reports from the same site at different times in the same patients. The culture sample collection technique might be the reason for such reports. The skin commensals sensing an opportunity due to a breach in physical barrier can cause mixed infections.[19] the patients were given a wide range of antibiotics but these were not helpful as generally there was a biofilm formation over the implant.[20] the biofilm not only provides a congenial environment for microorganism growth but also prevents antibiotic penetration. Procedures like debridement, incision and drainage provided a symptomatic temporary treatment rather than a solution to the real PJI problem.[21]

According to the published literature, there are no distinct guidelines for the indications of amputation following complications of TKA. Although limb salvage is always tried until or unless there is no hope for limb salvage. The amputation provides a one-time solution to multiple complex problems faced in managing failed TKAs. The complex problems can range from multiple surgeries, soft tissue problems, bone loss, osteomyelitis, poor functionality of the knee joint, neurovascular injuries and high-risk procedures in old debilitated patients. Sierra et al.[9] reported peripheral vascular diseases as the most common reason for amputation whereas Mousavian et al. reported infections as the main cause.[17] This case series is also in unison with the Mousavian et al. findings.[17] There is still no agreement as to what extent salvage procedures like arthrodesis or resection arthroplasty can be performed in multiple times failed TKA. [22,23] There has been a declining trend towards these procedures in recent years. Concerns are there regarding the success of these procedures in patients with poor bone stock and soft tissue cover. Most such revision arthroplasties are conducted in old patients with low demand.[24] the purpose of such surgeries is to eradicate infection and allow mobilisation. Both these requirements are met with amputation with emphasis on eradication of infection. The cost-benefit analysis will further help to support the decision of amputation in such multiple times failed TKAs. The economic and psychosocial burden pertaining to such multiple salvage surgeries should also be considered. The cost compared to the revision arthroplasty or arthrodesis, amputation followed by rehabilitation using the prosthetic limbs or wheel-chair costed 6-8 times more economical to the patients. Due to less incidence, more and more better

surgical techniques and complication management facilities, the rate of amputations following the TKA complications were less. No criteria or guidelines could be framed in this study. However, the author was of the opinion that two revision surgeries, presence of gram-negative organisms, poor psychological factors, more than 3 different surgical incisions, persistence of infection more than 6 months despite multiple debridement and financial constraints, such patients should be offered amputation as the first line of treatment.

There were limitations of the study as it was a retrospective study with fewer patient numbers owing to the rarity of the surgery post-TKR. Further long-term multicentric studies are required to denote the beneficial effects of such surgery.

Conclusion

Transfemoral amputation is a feasible option for multiple-failed arthroplasty patients. Infection and its consequences were the main causative factor for such amputations. The amputation should be offered to such patients considering the number of failed procedures, cost-benefit analysis, and psychosocial and economic factors.

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