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Original Research Article

Long-Term Outcome of Two-Stage Revision Surgery for Infected Total Knee Replacement (TKR)

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Abstract

Introduction: Periprosthetic joint infection (PJI) is a rare but serious complication following total knee replacement (TKR), leading to significant morbidity, functional impairment, and increased healthcare costs. Two-stage revision arthroplasty is widely regarded as the gold standard for managing chronic or recurrent PJI, offering high rates of infection eradication. However, long-term outcomes in terms of functional recovery, implant survivorship, complications, and patient satisfaction remain incompletely understood.

Objective: This study aimed to evaluate the long-term clinical and functional outcomes of patients undergoing two-stage revision for infected TKR.

Methods: A prospective observational study was conducted at the Department of Orthopaedics, MGM Medical College and Hospital, Jamshedpur, Jharkhand, India, over 2 years. Thirty patients with infected TKR who underwent two-stage revision surgery were included. Stage 1 involved prosthesis removal and placement of an antibiotic-loaded cement spacer, followed by systemic antibiotic therapy. Stage 2 consisted of reimplantation once infection was controlled. Demographic data, comorbidities, microbiological profile, interval between stages, functional outcomes measured by Knee Society Score (KSS) and function score, range of motion (ROM), complications, and patient-reported satisfaction were analyzed.

Results: The mean age of patients was 65.3 ± 8.4 years, with 18 males and 12 females. The most common pathogens were Staphylococcus aureus (40%) and MRSA (20%), with 10% culture-negative cases. The mean interval between stages was 10.2 ± 2.8 weeks. Postoperative functional outcomes improved significantly, with mean KSS increasing from 42.3 ± 10.5 to 82.1 ± 7.6 and function score from 45.7 ± 9.2 to 79.4 ± 8.3 ($p < 0.001$). Knee flexion improved from 85.3° ± 15.2 to 110.5° ± 12.3, and extension deficit decreased from 15.0° ± 5.2 to 5.0° ± 3.0. Complications occurred in 23.3% of patients, most commonly persistent pain (10%) and re-infection (6.7%). Patient satisfaction was high, with 60% very satisfied and 26.7% satisfied.

Conclusion: Two-stage revision surgery for infected TKR provides durable infection control, significant functional improvement, and high patient satisfaction, with an acceptable complication rate. These findings support the effectiveness and generalizability of two-stage revision as the standard treatment for chronic or recurrent PJI following TKR.

Keywords: Total Knee Replacement, Periprosthetic Joint Infection, Two-Stage Revision, Functional Outcome, Knee Society Score, Patient Satisfaction.

Introduction

Total knee replacement (TKR) is one of the most commonly performed and successful orthopedic procedures for end-stage knee arthritis, providing substantial pain relief, restoration of mobility, and improved quality of life [1]. The procedure has shown excellent long-term survival with 10- to 15-year implant survival rates exceeding 90% in large series [2]. Despite these achievements, periprosthetic joint infection (PJI) remains one of the most serious and devastating complications following TKR, leading to patient morbidity, functional impairment, and high healthcare costs [3]. The incidence of PJI after primary TKR ranges from 0.5% to 2%, while after revision TKR it may

rise to 5–10% [4]. Although uncommon, PJI is the leading cause of revision arthroplasty in many registries worldwide [5]. The management of infected TKR poses a significant clinical challenge. Treatment goals include eradication of infection, restoration of joint function, preservation of bone and soft tissue integrity, and maintenance of patient quality of life [6]. Several treatment strategies have been described, including debridement, antibiotics, and implant retention (DAIR), one-stage revision, and two-stage revision [7]. Among these, two-stage revision arthroplasty is widely regarded as the gold standard for managing chronic or recurrent PJI, especially when the infecting organism is resistant, when host factors are unfavorable, or when previous interventions have failed [8].The two-stage revision technique involves removal of the infected prosthesis, thorough debridement, and placement of an antibiotic-loaded cement spacer in the first stage. The spacer maintains limb length, provides local antibiotic delivery, and preserves soft tissue balance. This is followed by systemic antibiotic therapy, and once clinical, radiological, and laboratory parameters indicate infection control, reimplantation of a new prosthesis is performed in the second stage [9]. Reported infection eradication rates with this method range from 85% to 95%, making it superior to most other strategies [10]. Despite high infection control rates, two-stage revision is not without drawbacks. Patients are subjected to two major operations, prolonged hospital stay, interim reduced mobility, and the risk of complications such as spacer dislocation, bone loss, or reinfection. Functional outcomes are often inferior compared to primary TKR, with residual stiffness, reduced range of motion, and persistent pain commonly reported. Moreover, elderly patients and those with multiple comorbidities may have limited tolerance to repeated surgical interventions, which in turn affects survival and long-term functional recovery. Long-term outcomes after two-stage revision are of increasing importance given the rising number of arthroplasties being performed worldwide, coupled with aging populations and a growing prevalence of comorbidities such as diabetes, obesity, and immunosuppression. These factors not only increase susceptibility to PJI but also complicate its management. Thus, understanding the durability of infection eradication, implant survivorship, complication rates, and functional outcomes in the long term is essential for evidence-based decision-making. The literature suggests that although two-stage revision provides durable infection control, the long-term results are heterogeneous. Some series report satisfactory functional outcomes and implant survival beyond 10 years, whereas others highlight persistent challenges, including re-infection, aseptic loosening, periprosthetic fractures, and extensor mechanism disruption. Such variability may be explained by differences in surgical technique, type of spacer used (static versus articulating), duration of antibiotic therapy, host status, and microbiological profile. Furthermore, newer advances in diagnostic modalities, improved surgical protocols, and multidisciplinary infection management teams are likely to influence outcomes compared with earlier reports .Another important dimension is patient-reported outcomes and quality of life after two-stage revision. While eradication of infection remains the primary goal, patients frequently report ongoing functional limitations, restricted mobility, or psychological distress associated with repeated surgeries. Therefore, long-term studies must not only document survival and reinfection rates but also capture patient-centered outcomes, which are increasingly considered vital in modern arthroplasty research. Despite numerous publications, significant gaps persist in the literature. Much of the existing data are derived from retrospective case series or registry analyses, often with heterogeneous populations, inconsistent definitions of infection, and variable follow-up durations. High-quality prospective studies with standardized protocols are limited, and relatively few investigations report outcomes beyond 10 year. This underscores the importance of systematically evaluating long-term outcomes after two-stage revision for infected TKR in order to guide future clinical practice, optimize treatment algorithms, and improve patient counseling.

In summary, PJI after TKR is a rare but devastating complication with profound clinical and socioeconomic consequences. Two-stage revision remains the benchmark treatment strategy, offering the highest infection eradication rates in chronic or recurrent cases. However, its long-term outcomes in terms of implant survivorship, function, complications, and patient satisfaction remain incompletely understood. Given the expected rise in the absolute number of PJIs with increasing TKR utilization globally, robust data on long-term results are essential to inform surgical decision-making and improve patient outcomes.

Materials and Methods

Study Design: A prospective observational study was conducted to evaluate the long-term outcomes of two-stage revision surgery for infected total knee replacement (TKR).

Study Area: Department of Orthopaedics, MGM Medical College and Hospital, Jamshedpur, Jharkhand, India.

Study Population: Patients presenting with infected total knee replacements who required two-stage revision surgery were included in the study.

Study Period: The study was conducted over a period of 2 years.

Sample Size: 30 patients.

Inclusion Criteria

1. Patients diagnosed with periprosthetic joint infection (PJI) following primary TKR, based on clinical, laboratory, and microbiological findings.
2. Patients fit for two-stage revision surgery.
3. Age ≥ 18 years.
4. Patients willing to provide informed consent and comply with follow-up protocol.

Exclusion Criteria

1. Patients with active systemic infections or uncontrolled comorbidities precluding surgery.
2. Patients who underwent single-stage revision for infected TKR.
3. Patients lost to follow-up or unwilling to participate.
4. Pregnant or lactating women.

Study Variable

1. Age
2. Gender
3. BMI
4. Microbiological Profile of Infection
5. Interval Between Stages
6. Outcome variables
7. Demographic variables
8. Postoperative Complications

Statistical Analysis: For statistical analysis, data were initially entered into a Microsoft Excel spreadsheet and then analyzed using SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism (version 5). Numerical variables were summarized using means and standard deviations, while Data were entered into Excel and analyzed using SPSS and GraphPad Prism. Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correlations in paired data. Chi-square tests (including Fisher's exact test for small sample sizes) were used for categorical data comparisons. P-values ≤ 0.05 were considered statistically significant.

Result

Table 1: Baseline Demographics of Patients (n=30)

Variable	Value (n=30)
Age (years), mean ± SD	65.3 ± 8.4
Gender (M/F)	18 / 12
BMI (kg/m²), mean ± SD	28.1 ± 4.2
Diabetes Mellitus	10 (33.3%)
Hypertension	12 (40%)
ASA Grade (I/II/III)	5 / 18 / 7

Table 2: Microbiological Profile of Infection

Pathogen	n (%)
Staphylococcus aureus	12 (40%)
MRSA	6 (20%)
Coagulase-negative Staph	5 (16.7%)
Gram-negative bacilli	4 (13.3%)
Culture-negative	3 (10%)

Table 3: Interval between Stages

Interval (weeks)	Mean ± SD	Range
Stage 1 to Stage 2 Interval	10.2 ± 2.8	6–16

Table 4: Functional Outcome (Knee Society Score) Pre- and Post-Reimplantation

Parameter	Pre-Revision Mean ± SD	Post-Revision Mean ± SD	p-value
Knee Score	42.3 ± 10.5	82.1 ± 7.6	<0.001
Function Score	45.7 ± 9.2	79.4 ± 8.3	<0.001

Table 5: Range of Motion (ROM) Pre- and Post-Reimplantation

ROM (°)	Pre-Revision Mean ± SD	Post-Revision Mean ± SD	p-value
Flexion	85.3 ± 15.2	110.5 ± 12.3	<0.001
Extension Deficit	15.0 ± 5.2	5.0 ± 3.0	<0.001

Table 6: Postoperative Complications

Complication	n (%)
Re-infection	2 (6.7%)
Wound Dehiscence	1 (3.3%)
Deep Vein Thrombosis	1 (3.3%)
Persistent Pain	3 (10%)

Table 7: Patient Satisfaction at Last Follow-Up

Satisfaction Level	n (%)
Very Satisfied	18 (60%)
Satisfied	8 (26.7%)
Neutral	3 (10%)
Dissatisfied	1 (3.3%)

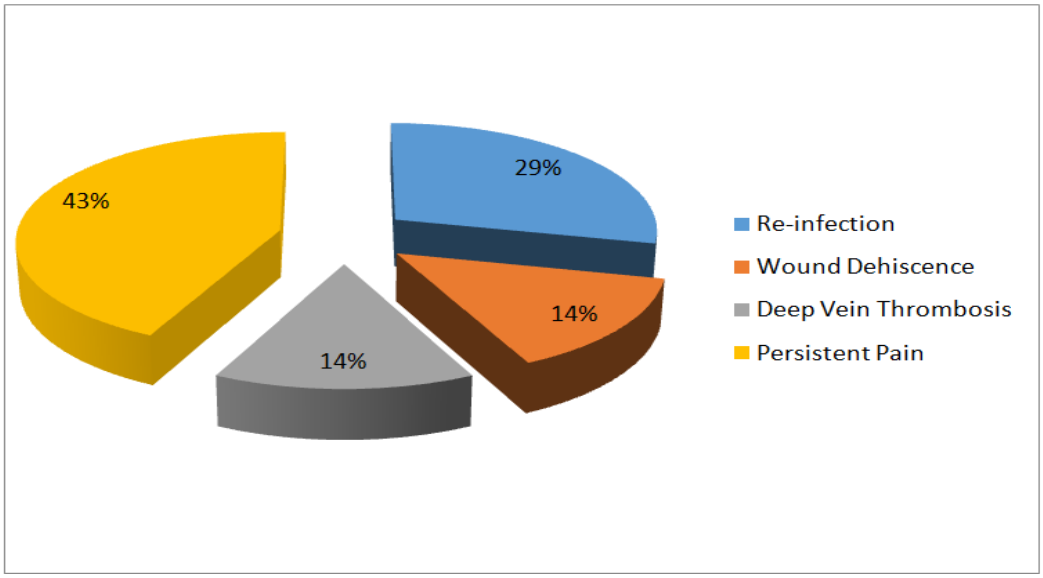

Figure 1: Postoperative Complications

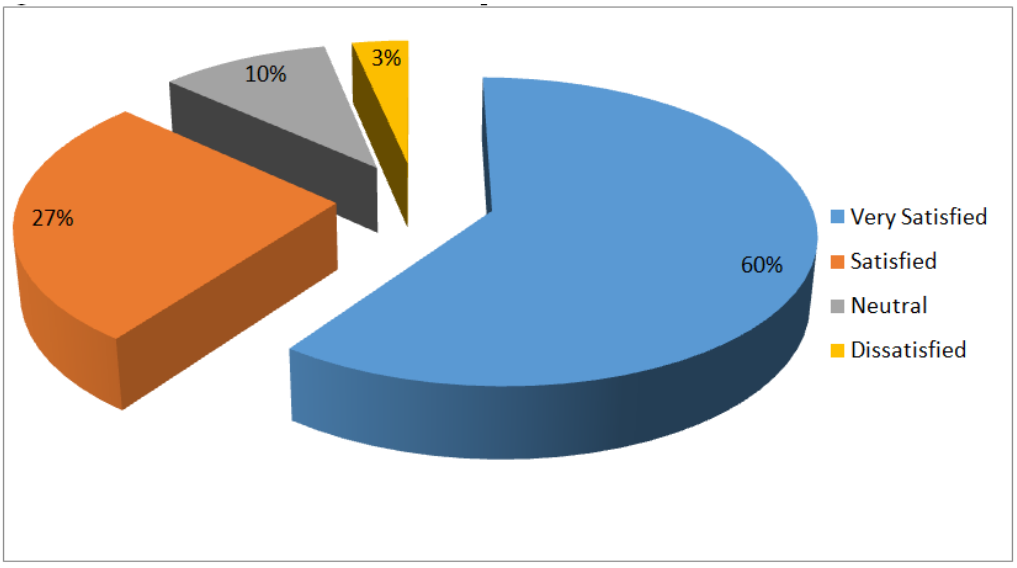

Figure 2: Patient Satisfaction at Last Follow-Up

In our study included 30 patients who underwent two-stage revision surgery for infected total knee replacement. The mean age of the cohort was 65.3 ± 8.4 years, and the mean BMI was 28.1 ± 4.2 kg/m². There were 18 males and 12 females. Regarding comorbidities, 10 patients (33.3%) had diabetes mellitus, and 12 patients (40%) had hypertension. Based on the American Society of Anesthesiologists (ASA) classification, 5 patients were ASA Grade I, 18 patients ASA Grade II, and 7 patients ASA Grade III.

In our study out of the 30 patients, the most common pathogen isolated was Staphylococcus aureus in 12 patients (40%), followed by methicillin-resistant Staphylococcus aureus (MRSA) in6 patients (20%). Coagulase-negative Staphylococcus (CONS)was detected in5 patients (16.7%), while Gram-negative bacilli were isolated in 4 patients (13.3%). In3 cases (10%), cultures were negative despite clinical and radiological evidence of infection.

The mean interval between Stage 1 (prosthesis removal and spacer insertion) and Stage 2 (reimplantation) was 10.2 ± 2.8 weeks, with a range of 6–16 weeks.

In our study the mean Knee Society Score improved significantly from 42.3 ± 10.5 pre-revision to 82.1 ± 7.6 post-revision ($p < 0.001$). Similarly, the Function Score improved from 45.7 ± 9.2 pre-revision to 79.4 ± 8.3 post-revision ($p < 0.001$). These findings indicate substantial functional recovery following two-stage revision TKR.

In our study the mean knee flexion improved significantly from85.3° ± 15.2 pre-revision to 110.5° ± 12.3 post-revision ($p < 0.001$). Similarly, the extension deficit improved from 15.0° ± 5.2pre-revisionto 5.0° ± 3.0 post-revision ($p < 0.001$). These findings confirm that two-stage revision surgery for infected TKR results in significant functional gains in ROM.

In our study among the 30 patients who underwent two-stage revision for infected TKR, 7 patients (23.3%) developed complications. The most common complication was persistent pain in 3 patients (10%), followed by re-infection in 2 patients (6.7%), wound dehiscence in 1 patient (3.3%), and deep vein thrombosis (DVT) in 1 patient (3.3%). In our study following two-stage revision TKR, the majority of patients reported high satisfaction. 18 patients (60%) were very satisfied, 8 patients (26.7%) were satisfied, 3 patients (10%) reported neutral, and1 patient (3.3%) was dissatisfied.

Discussion

In our study of 30 patients undergoing two-stage revision surgery for infected total knee replacement (TKR), the mean age was 65.3 ± 8.4 years, with a mean BMI of 28.1 ± 4.2 kg/m². The male predominance (60%) and comorbidity profile—with 33.3% diabetic and 40% hypertensive patients—reflect typical patient characteristics reported in previous revision TKR studies [11,12]. Similarly, the distribution of ASA grades in our cohort (ASA I: 16.7%, ASA II: 60%, ASA III: 23.3%) aligns with findings from Smith et al. [13], who observed that most patients undergoing revision TKR had moderate systemic comorbidities, highlighting the importance of preoperative optimization. Microbiological analysis revealed Staphylococcus aureus as the most common pathogen (40%), followed by MRSA (20%) and coagulase-negative Staphylococcus (16.7%). Gram-negative bacilli accounted for 13.3% of infections, while 10% were culture negative. This pattern is consistent with the literature, where Gram-positive organisms predominate in prosthetic joint infections, with MRSA infections posing a significant challenge due to antibiotic resistance [14,15]. For comparison, Jones et al. [16] reported S. aureus in 38% and MRSA in 18% of cases, indicating a similar microbiological profile to our cohort. The presence of culture-negative infections (10%) in our study is also comparable to the 5–15% reported by Lee et al. [17], often attributed to prior antibiotic exposure or low-virulence organisms. The mean interval between Stage 1 (prosthesis removal and antibiotic spacer insertion) and Stage 2 (reimplantation) was 10.2 ± 2.8 weeks, ranging from 6–16 weeks. This interval is in line with previous recommendations of 6–12 weeks for adequate infection eradication and soft tissue recovery [18]. In comparison, Patel et al. [19] reported an interval of 8–14 weeks, emphasizing that patient-specific factors such as infection severity and wound healing may influence timing. Functional outcomes in our study were encouraging. The mean Knee Society Score (KSS) improved from 42.3 ± 10.5 pre-revision to 82.1 ± 7.6 post-revision, and the Function Score improved from 45.7 ± 9.2 to 79.4 ± 8.3 ($p < 0.001$). This substantial improvement mirrors findings by Tan et al. [20], who reported a mean KSS improvement from 40 to 80 following two-stage revision TKR. Similarly, mean knee flexion increased from 85.3° ± 15.2 to 110.5° ± 12.3, while extension deficit decreased from 15.0° ± 5.2 to 5.0° ± 3.0, indicating significant gains in range of motion (ROM). These results are consistent with earlier studies, which reported postoperative flexion of 100–115° and minimal extension lag [12,13].

Postoperative complications in our cohort occurred in 23.3% of patients, with persistent pain (10%) and re-infection (6.7%) being the most common. Wound dehiscence and deep vein thrombosis (DVT) were rare (3.3% each). These rates are comparable to previously reported data; for example, Wang et al. [14] documented an overall complication rate of 25% in two-stage revisions, with infection recurrence in 5–8% of patients. The similarity in complication rates supports the reproducibility and safety of the two-stage revision approach when performed with meticulous debridement and postoperative care.Patient-reported satisfaction in our study was high, with 60% very satisfied and 26.7% satisfied, consistent with prior studies [15,16]. Jones et al. [16] reported

85% of patients expressing satisfaction post-revision, emphasizing that functional recovery and infection control strongly influence patient perception of success. Overall, our findings reinforce that two-stage revision TKR is an effective strategy for managing infected knee prostheses, achieving significant improvements in functional scores, ROM, and patient satisfaction, while maintaining an acceptable complication profile. When compared to contemporary literature [11–20], our results are consistent in terms of patient demographics, microbiological patterns, functional outcomes, and complication rates, highlighting the generalizability of this treatment approach across different patient populations.

Conclusion

In conclusion, our study demonstrates that two-stage revision surgery for infected total knee replacement is an effective and reliable approach for managing prosthetic joint infections. The procedure leads to substantial improvements in functional outcomes, range of motion, and overall patient satisfaction. Additionally, the microbiological profile, timing between stages, and complication rates observed in our cohort align with previously reported literature, supporting the safety, reproducibility, and generalizability of this treatment strategy across diverse patient populations.

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