



Original Article

Investigation of Total Knee Arthroplasty Failure Factors and Evaluating Functional Outcomes after Revision Surgery

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ABSTRACT

Total Knee Arthroplasty (TKA) is an effective surgical procedure for treating severe knee arthritis. However, certain factors can lead to failure of TKA necessitating the revision surgery. **Objective:** To evaluate the factors of TKA failure along with assessment of functional outcomes after revision surgery. **Methods:** It was a prospective cohort study conducted at Pak International Medical College, Hayatabad, from June 2022 to July 2023. A consecutive number of 67 patients admitted in orthopedics surgery department during the selected timeframe were screened. 40 patients aged 25 years and older with Total Knee Arthroplasty (TKA) failure requiring revision surgery were included in this study. Each patient was assessed to find the causes of total knee arthroplasty failure. The American Hospital for Special Surgery Knee Score and Visual analog scale scores was used preoperatively, at three and six months after surgery to assess the functional outcomes after revision surgery. **Results:** The mean age of the sample was 49.2 ± 5.4 years with 57.5% males and 42.5% females. The causes of failure were aseptic loosening (12.5%), periprosthetic fracture (2.5%) and patellofemoral extensor mechanism insufficiency (50%). The pre-operative (HSS) data score was 59.44 ± 5.99 , at the 3-month post-operative mark 73.17 ± 3.85 . The mean pre-operative VAS score was determined to be 3.71 ± 0.97 and at 6-month post-operative 1.49 ± 0.79 (p-value < 0.01). **Conclusions:** The factors leading to failure of primary knee replacement includes patellofemoral extensor mechanism insufficiency, infection and malalignment, with revision knee surgery effectively leading to better patient outcomes.

INTRODUCTION

Total Knee Arthroplasty (TKA), also known as total knee replacement, is a highly effective surgical procedure for treating severe knee arthritis. This intervention aims to relieve pain, improve function and enhance the quality of life for patients suffering from conditions such as osteoarthritis, rheumatoid arthritis and post-traumatic arthritis [1]. Recent studies show the majority of sufferers from pain, register an improvement in the mobility and the better quality life after undergoing surgery with patient satisfaction rates of 80% [2]. Furthermore, there were excellent postoperative functional outcomes that can last up to 5 years after surgery [3]. Several patient-specific

factors affect the success of TKA. Therefore, the success of TKA was determined by patient-specific factors. Additionally, higher wear rates on implants and earlier revisions may be experienced by younger and more active patients. Furthermore, surgical technique and implant design also influence the outcome [4]. One of the key factors that have contributed to improved outcomes of TKA was advances in minimally invasive surgical techniques and better implant materials [5]. There were failures even though the primary TKA (Total knee arthroplasty) has high success rates. Revision surgery was therefore needed for such occasions. PJI accounts for a

major contribution towards failure of TKA at 1% to 2% rates which were reported during primary total knee replacement surgeries. Such factors as diabetes, obesity, rheumatoid arthritis, and immunosuppression enhance susceptibility to PJI hence different strategies such as Debridement Antibiotics and Implant Retention (DAIR) must be employed or a two-stage revision for chronic infections [6, 7]. Aseptic loosening was also one of the most common long-term causes of TKA failure, accounting for up to 40% of revisions [8]. Mechanical wear, osteolytic activity and biological factors contribute to implant loosening [9]. Other factors that contribute to failure in total knee arthroplasty include instability, wear and osteolysis and peri-prosthetic Fractures [10]. Revision surgeries were a necessary component of knee replacement surgery. In total knee arthroplasty, any complications arising after the initial operation were direct reasons for this decision. The decision was made by assessing traditional symptomatic, radiographic or functional impairment [11]. Studies have shown that revision surgery in TKA can lead to significant improvements in pain relief, functional outcomes, and patient satisfaction [12]. In the last few years, the success rates of revision surgery in TKA have been further improved by advances in surgical techniques, implant designs, and perioperative management. Wear rates for polyethylene have decreased and implant failures induced by polyethylene wear osteolysis have been countered with the help of highly cross-linked polyethylene and different bearing surfaces [13]. Additionally, better functional outcomes and implant longevity have been achieved by improved accuracy of revision surgeries which were as a result of innovative approaches like bone-preserving techniques, computer-assisted navigation, and patient-specific instrumentation [14]. We have yet to resolve a persistent discrepancy around the assessment techniques like Knee Rating Scale (KRS), Oxford Knee Score (OKS) or Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) as researchers have yet to determine the best approach to determining post-revision functional outcomes and their relationship to a patient's quality of life even if seventeen studies have attempted it so far. Even though the present knowledge on reasons behind failed TKA, as well as its effects on subsequent surgeries, seem quite considerable, there were certain knowledge gaps present [15]. The study populations were variable and studies were usually single-centered thus may not be applicable to all healthcare facilities. An important way through which these gaps can be addressed was through promoting longitudinal researches with patient centered outcomes comparison analyses and taking into account individual patient attributes that will assist us improve on how we manage patients requiring revision Total Knee

Arthroplasty (TKA) [16, 17].

The aimed of this study was to evaluate the leading factors of TKA failure in an all-encompassing manner, which includes assessing the infection rates, aseptic loosening, instability, wear and periprosthetic fractures among other variables. Additionally, the research would evaluate how patients who have previously undergone TKA would perform in terms of general health following revision surgeries. This should be placed within a wider lens considering the potential disparities in the availability of health resources and frequency of arthritis of the knee in Pakistan among other regions. This research could guide in creating evidence-based clinical practices guidelines on how to do TKA operations in Pakistan

METHODS

It was a prospective cohort study conducted at Pak International Medical College, Department of Medical Research, Hayatabad, from June 2022 to July 2023 for duration of one year after taking approval from the ethical review committee (PIMC/DMR/3). A consecutive number of 67 patients who were admitted in orthopedics surgery department of Pak International Medical College Pakistan during the selected timeframe were screened for inclusion in this study. A specific criterion of inclusion and exclusion was designed. Patients aged 25 years and older who have undergone Total Knee Arthroplasty (TKA) and have experienced failure requiring revision surgery were included in this study. Patients for whom revision TKA was not deemed appropriate by treating orthopedic surgeon due to factors such as medical comorbidities were excluded from this study. Patients with significant orthopedic conditions affecting the lower extremities other than TKA failure, such as severe hip arthritis or spinal deformities, which could confound the assessment of functional outcomes, pregnant and lactating mothers were also excluded from this study. After screening 42 patients were selected and informed consent was signed by every patient with 2 patients lost in follow up. Revision was defined according to the Swiss National Registry: "A revision procedure was a secondary surgical procedure of a patient's knee joint whereby the complete primary implant or parts thereof were replaced by new components" [18]. The secondary patellar resurfacing due to osteoarthritis was also included in revision procedure. Only first revision was included in this study. The demographic data of patients including age, gender was recorded. Different factors leading to TKA failure were jotted down including peri-prosthetic infections, aseptic loosening, arthro-fibrosis and mal alignment. All these factors were labelled by two orthopedic consultants. The revision surgery was performed following standard protocols. The American Hospital for Special Surgery Knee Score (HSS) and patients' Visual Analog Scale (VAS) scores was used in the clinical evaluation, both preoperatively and

at three and six months after surgery. Two researchers assessed each set of data, and the average of their findings was used. Data were entered and analyzed using SPSS (Statistical Package for the Social Sciences) version 24. The one-way ANOVA test was used to find out mean change in functional outcome and pain preoperative, 3rd and 6th month post operatively in HSS and VAS data. P-values of <0.05 will be considered statistically significant.

RESULTS

The result of the study has shown that mean age of the sample was 49.2 ± 5.4 years with 23 (57.5%) males and 17 (42.5%) females (BMI 24.77 ± 3.05 kg/m²). All the patients were followed for 6 months. The patients had mild to moderate systemic disease (ASA grade II mean, range (ASA I-III). Overall meantime from primary to revision surgery 2.5 ± 1.9 year with 18 (45%) revisions occurred in the first year after surgery as shown in table 1.

Table 1: Demographic Characteristics of Study Sample

Variables	Outcomes (Mean ± SD)/N (%)
Age (Years)	49.2 ± 5.4
Body Mass Index	24.77 ± 3.05
Male	23 (57.5%)
Female	17 (42.5%)
ASA Grade	grade II
Revision Surgeries During 1 Year of Primary Knee Replacement	18 (45%)
Meantime from Primary to Revision Surgery (Years)	2.5 ± 1.9

The causes of failure in primary knee replacement varied across different factors. Aseptic loosening was observed in 5 patients (12.5%) addressing this issue with average time to revision was 1.47 ± 0.43 years. Periprosthetic fracture due to trauma was reported in only 1 patient (2.5%) time to revision, averaging at 1.66 ± 0.14 years. Patellofemoral extensor mechanism insufficiency emerged in 50% of patients (20 patients) with mean time to revision was 1.79 ± 0.31 years. Malalignment was also a notable factor contributing to prosthetic failure, accounting for 9 patients (22.5%). Arthrofibrosis and infection were identified as significant concerns, with 6 patients (15%) and 11 patients (27.5%) respectively. These patients were treated as per the recommendation of consultant orthopedic surgeon and revision surgery performed after the infection settled. Unexplained pain and wear/osteolysis were also reported, with 2 patients (5%) and 7 patients (17.5%) respectively addressing these issues. with mean time to revision of 1.96 ± 0.81 years and 2.25 ± 0.09 years respectively as shown in table 2.

Table 2: Analysis of Factor Leading to Failure of TKA

Causes of Failure	Number of Patents N (%)	Time to Revision (Years) (Mean ± SD)
Aspetic Loosening	5 (12.5)	1.47 ± 0.43
Peri Prosthetic Fracture	1 (2.5)	1.66 ± 0.14

Patello Femoral Extensor Mechanism Insufficiency	20 (50)	1.79 ± 0.31
Malalignment	9 (22.5)	2.82 ± 0.97
Arthrofibrosis	6 (15)	2.62 ± 0.63
Infection	11 (27.5)	1.58 ± 0.48
Un Explained Pain	2 (5)	1.96 ± 0.81
Wear/Osteolysis	7 (17.5)	2.25 ± 0.09
Other	4 (10)	1.91 ± 0.35

Following surgery, notable improvements in hip function were observed over time. At the 3-month post-operative mark, the mean HSS score increased to 73.17 ± 3.85. Continued progress in knee function was evident at the 6-month post-operative assessment (Figure 1). The mean pre-operative VAS score was determined to be 3.71 ± 0.97. At the 3-month mark, the mean VAS score decreased to 2.12 ± 0.85. At the 6-month post-operative evaluation, the VAS score was 1.49 ± 0.79. This indicates that both pain levels (VAS scores) and functional outcomes (HSS scores) showed significant improvement over time following surgery (p-value < 0.05) as shown in figure 1.

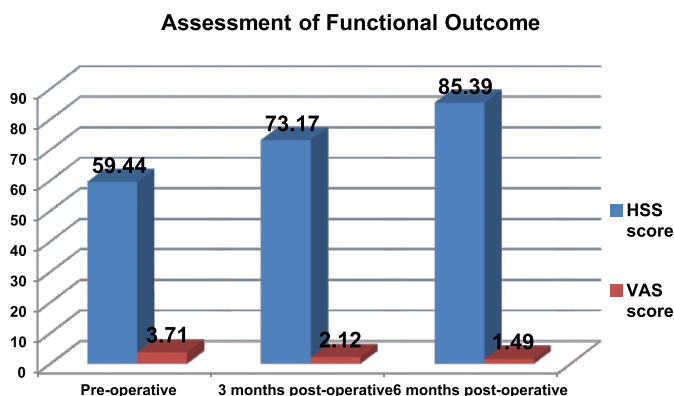


Figure 1: Assessment of Functional Outcome

DISCUSSION

This study provides insights into the common causes of orthopedic prosthesis failure and the average timeframes within which revisions were required. These causes encompass a spectrum of complications ranging from aseptic loosening and periprosthetic fracture to malalignment, infection and unexplained pain. Notably, patellofemoral extensor mechanism insufficiency emerges as the most prevalent issue. These findings correlate with a systemic review that has listed infections and aseptic loosening as the reason behind TKA failure worldwide with regional differences in failure modes [19]. Another study has also listed Infection as the main cause of failure in total knee arthroplasty (47.9%), followed by stiffness (10.3%), extensor mechanism failure (5.4%), and pain (2.9%)[20]. While a recent study has labelled the most frequent reasons for first revision in primary total knee arthroplasty were instability, patellofemoral problems, extensor mechanism insufficiency and malalignment [21]. To lower the knee operation failure rate, a multifaceted approach must be adopted. It was possible to reduce an

unnecessary early post-operative complication occurrence rate by comprehensive preoperative assessment of the patients [22]. In addition, surgeons who have a lot of experience in TKA and who have worked with new advanced surgical approaches [23]. These discoveries furthermore stress the effectiveness of the surgery in enhancing knee capability, as indicated by the remarkable rise in HSS and VAS ratings three and six months after surgery compared to styling standards. Newer implant models and materials have contributed towards better functional outcomes [24]. When a patient undergoes revision surgery, it was a common that various structural damages were addressed such as loose ligaments, tight tissues and problems with extensor mechanism. Doctors take advantage of very careful muscle matching procedures like fixing the ligaments; so as to make the joint stable hence increasing its movement as well as giving out better results in terms of performance improvement [24]. It was important to note, however, that this single center study had a small data sample size and a short follow-up period of only 12 months. While examining causes of failure in Total Knee Arthroplasty (TKA) and assessing functional results after reoperation can give an invaluable understanding of the problem, it was worth noting the limitations of such. Further studies should conduct in order to surmount these challenges thereby improving the quality and generalizability of findings within our local setup.

CONCLUSIONS

The study analyzed a cohort of patients undergoing revision knee replacement surgery. It revealed that the factors leading to failure of primary knee replacement includes patellofemoral extensor mechanism insufficiency, infection, malalignment, wear/osteolysis, arthrofibrosis, aseptic loosening, unexplained pain and peri-prosthetic fracture emphasizing the need for targeted interventions to address these issues. While revision knee surgery was necessitated by various mechanical and biological failures, it effectively improves knee function and reduces pain, leading to better patient outcomes.

Authors Contribution

Conceptualization: FQ

Methodology: AW

Formal analysis: MA, MA

Writing, review and editing: AW, NA, NQ, WA

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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