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Original Article

Rate of Infection in Arthroplasty in Comparison to Surgical Time

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ABSTRACT

Surgical site infections (SSIs) and periprosthetic joint infections (PJIs) are among the major complications seen after an arthroplasty procedure; they lead to morbidity, surgical revisions, and medical cost escalation. The operating time has been shown as one of the risk factors for these infections, and hence can be modified by proper intervention. **Objective:** To determine the rate of surgical site infection in arthroplasty and evaluate its association with operative duration among patients undergoing primary total knee arthroplasty. **Methods:** From January to June of 2025, this prospective observational cohort study was carried out at the Department of Orthopaedics & Spine Centre, GTTH, Lahore. Included were 94 patients having elective primary total knee arthroplasty. Clinical, perioperative, and demographic information was documented. Using CDC criteria, patients were monitored for ninety days to determine whether surgical site infections had occurred. SPSS version 27.0 was used for statistical analysis. **Results:** In total, surgical site infections occurred in 8 out of 94 patients (9%). 12% of patients who had surgery for more than 120 minutes had SSI (p=0.07), whereas those who had surgery for less than 120 minutes had no infections. Logistic regression analysis revealed a not statistically significant correlation between an elevated risk of SSI and an operative duration of ≥120 minutes (OR=3.80, p=0.03). **Conclusions:** After a primary total knee replacement, a longer operating time is linked to a higher risk of surgical site infection. There was a greater chance of postoperative infection in patients whose operations took longer than 120 minutes.

INTRODUCTION

Following total joint arthroplasty, periprosthetic joint infection (PJI) and surgical site infection (SSI) continue to be among the most devastating complications, resulting in significant patient morbidity, multiple surgeries, and higher healthcare costs [1-3]. Large registry and claims-based studies indicate that the "true" incidence is higher than what is captured by revision-only data, sometimes by 40% or more, even though overall deep infection rates following primary total hip arthroplasty (THA) are relatively low—typically around 0.5–1.5% depending on definition and follow-up [4, 5] Even though other arthroplasty outcomes have improved, recent national and international registry analyses from Scandinavia and Canada show that the cumulative risk of revision for infection has increased over time but appears to be levelling out in more recent years, especially within the first 90 days postoperatively [6, 7]. Multiple patient-related and surgical factors have been implicated as contributors to PJI risk, including male sex, obesity, diabetes, higher ASA class, and discharge to facilities other than home [8, 9]. Among intraoperative variables, operative duration has emerged as a key, potentially modifiable factor. Longer surgery times are

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consistently linked to an increased incidence of superficial and deep SSIs or PJI, according to large database and registry studies. In primary THA, each 10-minute increase in operating time has been associated with a 6–7% increase in odds or hazard of infection, with thresholds exceeding 90–120 minutes giving significantly increased risk [10, 11]. Similar findings have been reported in propensity-matched cohorts and national registers, where operative time ≥120–121 minutes independently increased PJI risk regardless of surgical approach. In middle-income settings, prolonged surgery has also been known as a modifiable institutional risk factor in audits of deep infection after THA [12].

Despite extensive work on incidence and patient risk factors, less is known about how infection risk scales quantitatively with surgical time across different arthroplasty types (hip vs knee, primary vs revision) and across healthcare environments. Furthermore, reported temporal trends in infection (increasing revision for infection vs stable or decreasing SSI rates) highlight the influence of differing definitions and surveillance methods. Hence, the association between operative time and the rate of infection in arthroplasty must be well understood in order to establish appropriate efficiency standards in the operating room, training in operative techniques, and patient optimization strategies in reducing preventable infections. This study aimed to investigate the relationship between the duration of surgery and the rate of infection in arthroplasty in order to understand the time-dependent risk of infection better.

METHODS

The study followed was an prospective observational cohort study that was carried out at the Department of Orthopaedics and Spine Centre, Ghurki Trust Teaching Hospital, Lahore, between January 2025 and June 2025. Before the study started, the Institutional Review Board granted ethical approval (Ref No. 2025/01/R-03, dated 15th January 2025), and informed written consent was received from all the participants. The sample size was calculated a priori using the mean operative time of 151 ± 43 minutes and a clinically meaningful difference of 11 minutes (151 vs 140 minutes). With a two-sided Type I error of 0.05 and 80% power, the required sample size was approximately 120 patients using a one-sample formula; if a two-group comparison was intended, approximately 240 patients per group would be required. Because only 94 patients were enrolled, the study is underpowered for the primary duration SSI comparison at $\alpha = 0.05$; $p < 0.10$. Therefore, the association between operative duration and SSI should be considered exploratory and hypothesis-generating. The study involved 94 successive patients who were undergoing primary total knee arthroplasty on an elective basis. Participants in the research had to meet the criteria of being at least 18 years old and having a history of an elective primary TKA due to conditions like advanced osteoarthritis, among others. Men and women were eligible if they had been medically prepared for surgery and were subjected to the regular practices in place during surgery, like the administration of antibiotics. Only patients who had signed informed consent documents were eligible for the research.Individuals who had revision total knee arthroplasty or sequential bilateral surgeries, were suffering from active infection either locally or systemically during the surgical procedure, or who had previously undergone surgery for their knees, were not included in the study. Patients with immunosuppression or immune deficiencies, active rheumatologic disorders, poorly controlled diabetes, or other comorbid conditions considered by the treating orthopedic team to substantially increase perioperative infection risk were excluded. Individuals whose data were not available for a minimum of 90 days were excluded from the analysis. The consecutive sampling technique was used to collect the data. The demographic variables were measured in terms of age, gender, residence, and smoking status. Such comorbidities in clinical variables included diabetes mellitus and hypertension. The variables recorded in surgery were type and side of surgery, duration of surgery, administration of antibiotic prophylaxis, surgical approach, agent used in skin preparation, wound closure method, and postoperative day of discharge. The recorded intraoperative variables included surgical approach, skin preparation agent, wound closure method, operative duration, antibiotic prophylaxis, and postoperative day of discharge. The duration of operation was defined as the time from when the skin incision was made until wound closure, and it was measured in minutes. In instances where duration was first determined in hours, it was changed into minutes to be uniformly analyzed. Follow-up was done on the development of surgical site infection by conducting postoperative surveillance.

The outcome measure was mainly the acquisition of a surgical site infection within 90 days after surgery. SPSS version 27.0 was used to perform statistical analysis. Categorical variables were presented as frequencies and percentages, and continuous variables were presented as means and standard deviations. The mean duration of the operation of patients with SSI and without SSI was compared using the independent sample t-test to determine the causes of the results. SSI was assessed during postoperative surveillance according to CDC criteria; outcome assessment was not blinded to operative characteristics. The use of Fisher's exact test was done to investigate the relationship between long duration of

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operations (longer than 120 minutes) and SSI occurrence. The logistic regression was conducted to determine the independent effect of operative duration on infection after having considered possible confounding variables, such as comorbidities and smoking status. The p-value was taken as statistically significant below 0.10.

RESULTS

The study participants comprised a total of 94 patients. The majority of the participants were females, as 61.7% of the participants were females, whereas males constituted only 38.3%. The majority of the participants were non-smokers, as only a small percentage of participants, i.e., 9.6%, were found to be smokers. The majority of the participants, i.e., 64.9%, belonged to urban areas, whereas only a small percentage of participants, i.e., 35.1%, belonged to rural areas. The mean age of the participants was found to be 62.4 ± 8.7 years, indicating that most of the participants who were undergoing surgery were elderly individuals (Table 1).

Table 1: Demographic Characteristics (n=94)

Variables	Frequency (%)
Gender	
Male	36 (38.3%)
Female	58 (61.7%)
Smoking Status	
Smoker	9 (9.6%)
Non-smoker	85 (90.4%)
Residence	
Urban	61 (64.9%)
Rural	33 (35.1%)
Age (Years)	62.4 ± 8.7

Slightly over half of the surgeries involved the right knee (52.1%), while the left knee accounted for 43.6% of the cases. Bilateral cases were relatively less common (4.3%). Approximately 29.8% of the patients presented at least one comorbidity, of which hypertension (22.3%) and diabetes mellitus (18.1%) were the most common. All the patients in the study received antibiotic prophylaxis before the procedure. The mean duration of the procedure was 171.2 ± 29.5 minutes, and the mean postoperative stay in the hospital was 3.6 ± 1.2 days. With respect to the method of closing the wounds, sutures (80.9%) were the most common, while staples (19.1%) were used in the remaining cases (Table 2).

Table 2: Clinical and Perioperative Characteristics (n=94)

Variables	Frequency (%)	Mean ± SD
Side of Surgery		
Right	49 (52.1%)	–
Left	41 (43.6%)	–
Bilateral	4 (4.3%)	–
Comorbidity Present	28 (29.8%)	–
Diabetes Mellitus	17 (18.1%)	–
Hypertension	21 (22.3%)	–
Antibiotic Prophylaxis Given	94 (100%)	–
Mean Operative Duration (min)	–	171.2 ± 29.5
Post-op Day of Discharge	–	3.6 ± 1.2 days
Wound Closure		
Staples	18 (19.1%)	–
Sutures	76 (80.9%)	–

Among patients with operative times of less than 120 minutes, no cases of SSI were recorded. Conversely, among the patients who had an operative time of 120 minutes or beyond, the rate of SSI was higher, resulting in 8 (12%) out of the total number of patients having SSI. The results showed that 8 out of the total of 94 patients (9%) had SSI. The mean operative time for the group with longer procedures was significantly higher than for the group with shorter procedures. The results showed that there was a non-significant trend toward higher SSI rates with operative duration ≥120 minutes (p=0.067) (Table 3).

Table 3: Association Between Operative Duration and Surgical Site Infection (SSI)

Operative Duration	SSI, n (%)	No SSI, n (%)	Total, (n)	Mean Duration (min ± SD)	p-value
<120 min	0 (0%)	26 (100%)	26	110 ± 15	0.07*
≥120 min	8 (12%)	60 (88%)	68	185 ± 95	
Total	8 (9%)	86 (91%)	94	168.9 ± 78.4	

Statistically significant at $p < 0.05$

Among the total number of 94 patients, the majority of the population did not have surgical site infections after the operation. In other words, 91% of the total population, i.e., 86 patients, did not have surgical site infections, whereas the remaining 9%, i.e., 8 patients, had surgical site infections (Figure 1).

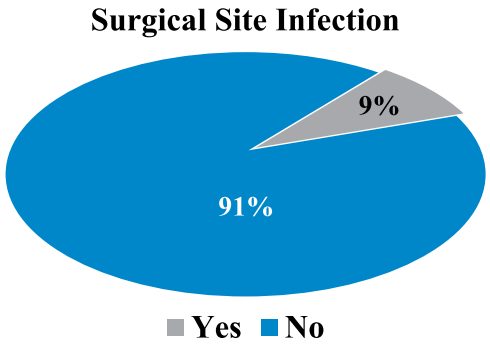


Figure 1: Infection Rate

In the exploratory logistic regression analysis, operative duration ≥120 minutes, diabetes mellitus, and hypertension showed associations with SSI; however, the small number of SSI events limits the stability and precision of these estimates. Conversely, age, gender, smoking status, side of operation, and closure technique were not established as

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factors that influence the occurrence of SSI. These findings should be interpreted cautiously because of the limited number of SSI events and the resulting instability of the multivariable model (Table 4).

Table 4: Logistic Regression for Factors Associated with Surgical Site Infection (SSI)

Variables	OR (95% CI)	p-value
Demographics		
Age (Years)	0.98 (0.95–1.02)	0.31
Gender – Male	1.20 (0.35–4.50)	0.78
Comorbidities		
Any comorbidity – Yes	1.60 (0.40–6.20)	0.51
Hypertension – Yes	1.85 (1.02–3.36)	0.04
Diabetes – Yes	1.24 (1.01–1.53)	0.04*
Lifestyle / Smoking		
Smoking – Smoker	1.40 (0.30–5.70)	0.62
Operative Characteristics		
Operative duration ≥120 min	3.80 (1.10–12.90)	0.03*
Side of surgery – Left	1.10 (0.30–4.20)	0.87
Side of surgery – Bilateral	1.50 (0.20–12.30)	0.70
Wound closure – Staples	1.30 (0.40–4.10)	0.63

*Statistically Significant at 10% Level of Significance

DISCUSSION

The current research showed a surgical site infection (SSI) rate of 9 percent in primary total knee arthroplasty (TKA), with a higher risk of infection among patients whose operation time exceeded 120 minutes. These results align with existing literature, which identifies prolonged operative time as a significant risk factor for postoperative infection following arthroplasty procedures. Several meta-analyses and large-scale studies have highlighted operative time as a modifiable intraoperative factor contributing to infection occurrence [7, 8]. One study reported a significant association between operative duration and the occurrence of periprosthetic joint infection (PJI) in primary joint arthroplasty procedures, demonstrating that for every 20-minute increase in operative time, PJI risk increased by 25% [12]. Similarly, Anis *et al.* found that each increase in operative duration elevated the risk of PJI by 18%, while SSI risk increased by 11% in TKA [13]. Schmitt *et al.* also observed a significant rise in SSI incidence for total shoulder arthroplasty when surgical time exceeded 180 minutes, suggesting that prolonged operative time may consistently influence infection risk across different joint replacement procedures [14]. Scigliano *et al.* confirmed that arthroplasty surgeries lasting more than 90–120 minutes were associated with significantly higher odds of developing SSI and PJI, with odds ratios ranging from 1.5 to 1.6 [15]. Ravi *et al.* reported that surgical times exceeding 100 minutes increased the risk of deep infection after TKA, emphasizing operative duration as an independent predictor of infection, even when accounting for patient-related factors [16]. Further studies have shown that each 10-minute increase in surgical time was associated with a 6% higher risk of superficial SSI and a 7% higher risk of deep infection after total hip arthroplasty [11]. Shin *et al.* conducted a meta-analysis of over 400,000 TKA patients and demonstrated that patients who developed PJI had significantly longer surgical times compared to those without infection [17]. Danoff reported that both prolonged surgical and tourniquet times were independently associated with increased postoperative infection rates following TKA [18]. Additionally, Bohl *et al.* found that every additional 15 minutes of operative time increased the risk of SSI by approximately 9%, along with other complications such as wound dehiscence and sepsis [19]. Rodriguez-Merchan *et al.* concluded that prolonged operative time was associated with surgical site infection [20].The observed SSI rate of 9% was higher than rates reported in several large arthroplasty cohorts, particularly those based on deep infection or shorter surveillance periods. This difference may partly reflect variation in SSI definitions, duration of postoperative surveillance, patient characteristics, and institutional infection-prevention practices. In the present study, patients were actively monitored for 90 days using CDC criteria, which may have captured infections that could be missed with shorter follow-up. The single-center setting and relatively small sample size should also be considered when comparing this rate with estimates from larger registry-based studies
This study has several limitations. The single-center setting and relatively small sample size may limit the generalizability of the findings. Important intraoperative variables, including blood loss, complexity of surgery, and level of surgical skill, were not assessed and may have influenced SSI development. Outcome assessment was not blinded, which may have introduced detection bias. The follow-up period was limited to 90 days. An additional limitation is that the original sample size was calculated using $\alpha = 0.10$ rather than the conventional $\alpha = 0.05$, which increases the risk of Type I error and limits the strength of the conclusions. With 94 patients and only 8 SSI events, the study was underpowered for the primary comparison at $\alpha = 0.05$, and the logistic regression model may be unstable. Therefore, the observed duration–SSI association should be considered hypothesis-generating and requires confirmation in larger multicenter prospective studies with adequate numbers of SSI events.

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CONCLUSIONS

In conclusion, this study showed that prolonged operative time (>120 minutes) is a risk factor for surgical site infection following primary total knee arthroplasty. Also, the presence of co-morbid conditions like diabetes mellitus and hypertension was observed to have contributed to an increase in postoperative infections. It can therefore be recommended that surgery be conducted efficiently to reduce the incidence of infections.

Authors' Contribution

Conceptualization: AUI
Methodology: MMS, UM, MH, AS
Formal analysis: AUZ
Writing and Drafting: AUI
Review and Editing: AUI, MMS, UM, UN, MAA, AUZ, MH, AS

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflict of Interest

All the authors declare no conflict of interest.

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