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Original Research Article

Impact of Operative Duration on Postoperative Surgical Site Infection

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Abstract:

Background: Surgical site infection (SSI) is a major postoperative complication that significantly impacts patient recovery, increases hospital stay, and raises healthcare costs. Among various risk factors for SSI, the duration of surgery has been suggested as a critical determinant. Prolonged operative time may increase tissue exposure to pathogens, compromise tissue perfusion, and enhance bacterial contamination, thereby elevating the risk of infection. Despite recognition of this association, precise quantification of the correlation between operative duration and SSI remains limited, particularly in the context of elective general surgeries in tertiary care settings.

Objective: To investigate the relationship between the duration of surgery and the incidence of surgical site infection, and to identify operative time thresholds associated with increased risk in patients undergoing elective general surgical procedures.

Methods: This prospective observational study was conducted at the Department of General Surgery, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India, from December 2023 to November 2024. A total of 125 patients undergoing elective surgeries were included. Operative duration was recorded in minutes, and patients were monitored for SSI up to 30 days postoperatively. SSI diagnosis was based on Centers for Disease Control and Prevention (CDC) criteria. Patients were stratified into three groups according to surgical duration: <60 minutes, 61–90 minutes, and >90 minutes. Additional variables analyzed included patient age, gender, comorbidities, type of surgery, and perioperative antibiotic use. Statistical analysis was performed to assess the correlation between operative time and SSI incidence.

Results: Among the 125 patients, SSI occurred in 18 patients (14.4%). The incidence of infection increased with operative duration: 4/42 (9.5%) in surgeries <60 minutes, 6/45 (13.3%) in 61–90 minutes, and 8/38 (21.1%) in surgeries >90 minutes. Statistical analysis revealed a significant positive correlation between prolonged operative time and SSI ($p < 0.05$). Comorbidities such as diabetes mellitus and prolonged hospitalization were also associated with higher infection rates.

Conclusion: Prolonged duration of surgery is significantly associated with an increased risk of surgical site infection. Optimizing surgical efficiency, adhering strictly to aseptic protocols, and providing targeted perioperative care to high-risk patients are crucial strategies to minimize SSIs and improve postoperative outcomes.

Keywords: Surgical Site Infection, Operative Duration, Risk Factors For SSI, Postoperative Complications, General Surgery, Elective Surgery, Perioperative Infection, Wound Infection, Infection Prevention, Duration-Dependent SSI Risk.

Introduction

Surgical site infection (SSI) remains one of the most frequent and serious complications following surgery, representing a significant burden to patients and healthcare systems alike. Globally, SSIs account for a substantial proportion of healthcare-associated infections, leading to delayed wound healing, prolonged hospitalization, increased treatment costs, higher rates of morbidity, and, in severe cases, mortality [1]. Despite advancements in surgical techniques, sterilization procedures, perioperative antibiotic prophylaxis, and infection control protocols, SSIs continue to pose challenges, particularly in busy tertiary care centers [2].

Multiple patient- and surgery-related factors contribute to SSI risk. Patient-specific factors include age, nutritional status, comorbidities such as diabetes mellitus or immunosuppression, and obesity [3]. Surgery-related factors include wound

classification (clean, clean-contaminated, contaminated, or dirty), type and complexity of the procedure, use of implants, intraoperative blood loss, and duration of surgery [4]. Among these, the duration of surgery has been identified as a modifiable risk factor with a strong influence on postoperative infection rates. Prolonged operative time may result in increased exposure of tissues to environmental pathogens, higher bacterial contamination, greater tissue trauma, and decreased local perfusion, all of which predispose to infection [5].

Several studies have suggested a positive correlation between longer surgical duration and SSI occurrence, yet findings vary across surgical specialties and patient populations. Identifying operative time thresholds associated with elevated SSI risk is essential for guiding surgical planning, resource allocation, and targeted infection prevention measures [6]. Moreover, understanding the interaction between operative duration and patient comorbidities or surgical complexity can help prioritize high-risk cases for enhanced perioperative care [7].

The present study was designed to evaluate the correlation between the duration of surgery and the incidence of SSIs in patients undergoing elective general surgical procedures at a tertiary care hospital. By stratifying patients according to operative time and analyzing the occurrence of SSIs, this study aims to provide evidence-based insights into optimizing surgical practices, enhancing infection control, and improving postoperative outcomes.

Materials and Methods

Study Design and Setting: This prospective observational study was conducted in the Department of General Surgery, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India, over a 12-months period from December 2023 to November 2024. The study aimed to evaluate the correlation between the duration of surgery and the incidence of surgical site infection (SSI) in patients undergoing elective general surgical procedures.

Sample Size and Selection: A total of 125 patients were enrolled in the study, with sample size determined based on previous institutional SSI rates and feasibility within the study period. Consecutive patients meeting inclusion criteria and providing informed consent were included.

Inclusion Criteria:

- Patients aged 18 years and above.
- Patients scheduled for elective general surgical procedures, including hernia repair, appendectomy, cholecystectomy, thyroidectomy, and other clean or clean-contaminated surgeries.
- Patients able to provide informed consent and comply with postoperative follow-up for SSI assessment.

Exclusion Criteria:

- Emergency surgical procedures.
- Patients with pre-existing infection at the surgical site.
- Patients with immunosuppressive conditions or on chronic immunosuppressive therapy.
- Patients with incomplete follow-up or who refused participation.

Data Collection: Preoperative demographic data including age, gender, body mass index (BMI), and comorbidities (diabetes mellitus, hypertension, etc.) were recorded. Surgical details such as type of procedure, wound classification, and operative duration (in minutes) were documented. Operative duration was defined as the time from skin incision to completion of skin closure.

Postoperative Monitoring and SSI Assessment: Patients were monitored for surgical site infections during hospitalization and followed up for 30 days postoperatively, either in the outpatient department or via telephonic follow-up. SSI was diagnosed according to the Centers for Disease Control and Prevention (CDC) criteria, which include:

- Superficial incisional infection involving skin and subcutaneous tissue,
- Deep incisional infection involving fascia and muscle,
- Organ/space infection involving any part of anatomy manipulated during surgery.

Stratification: Patients were categorized based on operative time into three groups:

- Group I: <60 minutes
- Group II: 61–90 minutes
- Group III: >90 minutes

Outcome Measures:

- Primary outcome: Incidence of surgical site infection in each operative duration group.
- Secondary outcomes: Association of SSI with comorbidities, type of surgery, and wound classification.

Perioperative Protocols:

- All patients received standard preoperative skin preparation and prophylactic antibiotics according to institutional protocols.
- Aseptic surgical technique was maintained throughout all procedures.
- Postoperative wound care was standardized for all patients.

Statistical Analysis: Data were analyzed using SPSS software. Continuous variables were expressed as mean ± standard deviation and compared using independent t-tests or ANOVA, as appropriate. Categorical variables were expressed as frequencies and percentages, with comparisons performed using the Chi-square test or Fisher's exact test. The correlation between operative duration and SSI incidence was analyzed using Pearson correlation coefficient. A p-value <0.05 was considered statistically significant.

A total of 125 patients undergoing elective general surgical procedures were included in the study. The mean age of patients was 44.1 ± 11.2 years, with a slight male predominance (57.6%). Surgeries included hernia repair, cholecystectomy, appendectomy, thyroidectomy, and other elective procedures. Surgical site infections were observed in 18 patients (14.4%), and SSI incidence increased with longer operative duration. Comorbidities such as diabetes mellitus and hypertension were also associated with higher SSI rates.

Results

Table 1: Age distribution of patients

Age group (years)	Number of patients	Percentage (%)
18–30	25	20.0
31–40	37	29.6
41–50	34	27.2
51–60	20	16.0
>60	9	7.2

Table 1 shows the age distribution of patients across all surgical procedures.

Table 2: Gender distribution of patients

Gender	Number of patients	Percentage (%)
Male	72	57.6
Female	53	42.4

Table 2 shows a slight male predominance in the study population.

Table 3: Distribution by type of surgery

Type of surgery	Number of patients	Percentage (%)
Hernia repair	30	24.0
Cholecystectomy	28	22.4
Appendectomy	25	20.0
Thyroidectomy	22	17.6
Other procedures	20	16.0

Table 3 presents the surgical procedures performed.

Table 4: Operative duration groups

Duration of surgery	Number of patients	Percentage (%)
<60 minutes	42	33.6
61–90 minutes	45	36.0
>90 minutes	38	30.4

Table 4 shows stratification based on duration of surgery.

Table 5: Incidence of surgical site infection (SSI) by operative duration

Operative duration	Number of SSI cases	Total patients in group	SSI rate (%)
<60 minutes	4	42	9.5
61–90 minutes	6	45	13.3
>90 minutes	8	38	21.1

Table 5 shows that SSI incidence increases with longer surgery duration.

Table 6: SSI distribution by comorbidity

Comorbidity	Number of patients	Number of SSI cases	SSI rate (%)
Diabetes mellitus	28	7	25.0
Hypertension	32	5	15.6
None	65	6	9.2

Table 6 shows that diabetes mellitus was associated with higher SSI rates.

Table 7: SSI distribution by type of surgery

Type of surgery	Number of patients	Number of SSI cases	SSI rate (%)
Hernia repair	30	3	10.0
Cholecystectomy	28	4	14.3
Appendectomy	25	3	12.0
Thyroidectomy	22	2	9.1
Other procedures	20	6	30.0

Table 7 shows infection rates according to the type of procedure.

Table 8: SSI by wound classification

Wound classification	Number of patients	Number of SSI cases	SSI rate (%)
Clean	60	5	8.3
Clean-contaminated	55	9	16.4
Contaminated	10	4	40.0

Table 8 shows SSI incidence according to wound type.

Table 9: Hospital stay in patients with and without SSI

SSI status	Mean hospital stay (days)	Standard deviation
No SSI	5.8	1.4
SSI	10.2	2.1

Table 9 shows that SSI increases hospital stay duration.

Table 10: Correlation between operative duration and SSI incidence

Operative duration (minutes)	SSI occurrence	Correlation (r)	p-value
Continuous variable	Yes/No	0.32	0.01

Table 10 shows the positive correlation between longer surgery and SSI occurrence.

Table 1 shows most patients were aged 31–50 years. Table 2 indicates a slight male predominance. Table 3 presents the distribution of surgical procedures. Table 4 stratifies patients by operative duration. Table 5 demonstrates a clear increase in SSI rates with longer surgery duration. Table 6 shows that diabetes and hypertension were associated with higher SSI incidence. Table 7 highlights that other complex procedures had the highest SSI rate. Table 8 confirms that contaminated and clean-contaminated wounds carry higher SSI risk. Table 9 shows that patients with SSI had longer hospital stays. Table 10 indicates a statistically significant positive correlation between operative duration and SSI incidence.

Discussion

Surgical site infection (SSI) remains a significant postoperative complication that can adversely affect patient outcomes, prolong hospital stay, and increase healthcare costs. The present study evaluated the correlation between operative duration and the incidence of SSIs in patients undergoing elective general surgical procedures. The results indicate a clear positive association between longer surgery duration and higher SSI rates [8].

In this study, the overall SSI incidence was 14.4%, consistent with reported rates in elective general surgeries. Stratification by operative duration revealed that patients undergoing procedures longer than 90 minutes had the highest SSI rate (21.1%), while those with surgeries less than 60 minutes had the lowest rate (9.5%) [9]. Statistical analysis confirmed a significant positive correlation between operative time and SSI occurrence ($p < 0.05$). These findings align with previous studies suggesting that prolonged exposure of tissues, increased bacterial contamination, tissue ischemia from extended retraction, and greater blood loss during longer surgeries contribute to higher infection risk [10].

Comorbid conditions, particularly diabetes mellitus, were also associated with increased SSI rates (25% among diabetic patients), highlighting the importance of optimizing glycemic control and overall patient health prior to surgery. Hypertension and other systemic conditions showed moderate association, indicating that multiple patient-related factors interact with operative duration to influence infection risk [11].

The study further analyzed SSI distribution by wound classification and type of surgery. Contaminated procedures and complex "other" surgeries had the highest infection rates, emphasizing that both the nature of the surgery and the operative environment influence SSI risk [12]. Patients who developed SSI experienced prolonged hospital stays (mean 10.2 days) compared to patients without infection (mean 5.8 days), underscoring the clinical and economic impact of SSIs [13].

These findings have important clinical implications. Surgeons should aim to minimize operative duration without compromising procedural safety, maintain strict aseptic techniques, and implement targeted infection prevention strategies, particularly for high-risk patients. Additionally, preoperative optimization of comorbid conditions, judicious

antibiotic prophylaxis, and enhanced postoperative monitoring can reduce SSI rates.

Limitations of this study include its single-center design and moderate sample size, which may limit generalizability. The study focused on elective procedures and did not include emergency surgeries, which may have different risk profiles. Future multicenter studies with larger cohorts could provide more robust data, examine cost-effectiveness, and explore long-term outcomes related to SSI and operative duration.

Conclusion

The study demonstrates a significant positive correlation between prolonged operative duration and the incidence of surgical site infections in elective general surgical procedures. Patients undergoing longer surgeries, particularly those exceeding 90 minutes, are at higher risk of developing SSIs. Preoperative optimization, efficient surgical technique, strict aseptic protocols, and targeted infection prevention strategies for high-risk patients can help reduce postoperative infections, improve recovery, and decrease hospital stay.

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