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"IMPACT OF ANTIBIOTIC PROPHYLAXIS PROTOCOL ON AN INCIDENT OF SURGICAL SITE INFECTION IN PATIENTS OF CLOSED FRACTURE TREATED WITH OPEN REDUCTION AND INTERNAL FIXATION"

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ABSTRACT

Orthopedic surgical site infections (SSIs) are common and can lead to increased morbidity, extended hospital stays, and higher costs. Despite advancements in surgical techniques, SSIs persist, underscoring the need for improved infection prevention. For closed fractures, including Open Reduction and Internal Fixation (ORIF), best practices recommend limiting antibiotic prophylaxis to 24 hours post-surgery to reduce the risk of SSIs and antibiotic resistance. This study aimed to explore the impact of antibiotics on surgical site infections in closed fracture patients undergoing open reduction and internal fixation. This cross-sectional study at Gulab Devi Teaching Hospital focused on patients with closed fractures treated with open reduction and internal fixation. Data were collected through convenient sampling and a revised questionnaire. Qualitative variables were analyzed using percentages and frequencies, while means and standard deviations were used for quantitative variables. Data analysis was performed using SPSS software. This study identified both significant and non-significant effects of various independent variables. Diabetes mellitus was significantly associated with wound infections (p=0.039), and body mass index was a strong predictor of complications (p=0.001). The culture report suggested a significant link between bacterial type and infection risk (p=0.000). However, no significant associations were found for implant type (0.514), fracture site (p=0.580), or preoperative antibiotics (p=0.482). Ceftriaxone and cefazoline antibiotics reduced post-surgery infection rates by 1.9%, with chronic illness, diabetes, hypertension, and BMI influencing infection odds.

Keywords: *Surgical site infections, Open Reduction and Internal Fixation, Prophylactic, antibiotic*

INTRODUCTION

Orthopedic surgeries, particularly those involving open reduction and internal fixation (ORIF) of closed fractures, surgical site infections (SSIs) are among the most frequent side effects. Morbidity, prolonged hospital stays, higher healthcare expenses, and worse patient outcomes are all greatly impacted by SSIs.

Orthopedic surgeons around the world continue to face difficulties due to the prevalence of SSIs, even with improvements in surgical methods and infection control strategies. A crucial tactic in perioperative care is antibiotic prophylactic regimens, designed to lower the risk of infection (1).

Orthopedic surgery is frequently used to repair fractures, especially closed fractures that need intervention like Open Reduction and Internal Fixation (ORIF). Fractures are classified according to their nature, location, and level of intricacy. In an open fracture, the bone protrudes through the skin, increasing the risk of infection. In a closed fracture, the bone breaks but does not puncture the skin (2).

According to studies, young persons who have experienced trauma had the highest incidence of fractures, while elderly adults who have osteoporosis-related fragility fractures have the highest frequency. Age, gender, degree of physical activity, and concomitant conditions like osteoporosis, diabetes, or long-term steroid usage are risk factors (3, 4).

In ORIF, bone pieces are aligned (reduced) and the fracture is stabilized with hardware such as rods, screws, or plates. Restoring anatomical alignment, guaranteeing early mobilization, and lowering the possibility of problems like malunion or non-union are all made possible by this method (4).

Strict perioperative procedures, including the use of antibiotic prophylaxis, are essential to reducing these risks. One of the main causes of SSIs is bacterial contamination, which is decreased by antibiotics given before the incision and at the proper intervals (5).

One of the most frequent and serious side effects of surgery is surgical site infection (SSI), which raises patient morbidity, lengthens hospital stays, and adds to medical expenses. These infections, which involve the surgical incision or deep tissues altered during surgery, appear 30 days after surgery or within a year if an implant is employed (6, 7).

In these situations, SSIs may result in unfavourable consequences such as osteomyelitis, implant failure, delayed healing, and even sepsis (8).

Patient-related factors including diabetes, obesity, smoking, and malnutrition, as well as procedure-related factors like poor aseptic methods, lengthy surgical times, and inappropriate antibiotic prophylaxis, are important risk factors for SSIs (9, 10).

A key component of SSI prevention, particularly in implant surgeries, is antibiotic prophylaxis. During the crucial intraoperative phase, adequate tissue concentrations are ensured by administering antibiotics no later than 60 minutes before surgery (11).

However, improper use whether through prolonged delivery, improper dosage, or delayed timing, can reduce effectiveness and fuel antibiotic resistance (12).

Guidelines advise using first-generation cephalosporins, including cefazolin, for closed fractures undergoing ORIF because of its effectiveness against gram-positive bacteria, such as Staphylococcus aureus (13). Inconsistent protocol adherence has been documented despite these suggestions, highlighting the necessity of uniform processes (14).

According to studies, to reach the best tissue concentrations at the moment of incision, antibiotics should be administered no later than one hour before the surgical procedure (15). Drugs with longer infusion durations, like fluoroquinolones or vancomycin, should be administered 120 minutes before incision (16). The importance of exact scheduling is highlighted by the fact that delayed administration, even by a few hours, is linked to higher SSI rates (17). To maintain therapeutic concentrations in tissues during the surgical operation, the antibiotic dosage must be adequate. Dosing needs are influenced by patient characteristics such as blood loss, obesity, and renal function. To guarantee proper distribution in fatty tissues, obese patients, for example, might need greater dosages(18).

Antibiotic usage that lasts longer than 24 hours after surgery raises the risk of antibiotic resistance and provides no further benefit in preventing SSI (18). With some high-risk surgeries being an exception, current guidelines recommend a single preoperative dose or continuance for no more than 24 hours in the majority of procedures (19).

In many hospital settings, prophylactic protocol compliance is still below ideal levels, even with defined criteria. Obstacles include a lack of standard operating procedures, a lack of understanding among healthcare professionals, and logistical difficulties in environments with low resources (20).

This study investigates whether antibiotic prophylaxis guidelines lower infection rates in patients undergoing ORIF surgery for closed fractures. These surgeries pose infection risks, and while pre-surgery antibiotics are recommended, their optimal use is debated. The research evaluates a targeted antibiotic approach to improve patient care, aiming for shorter hospital stays and lower healthcare costs from postoperative infections.

Objective

The objective of this study is to determine the effect of antibiotics on surgical site infection in a patient of a closed fracture that is treated with open reduction and internal fixation.

Methods and Materials

A cross-sectional study was conducted at Gulab Devi Teaching Hospital in Lahore for four months after the study synopsis obtained official approval. We studied patients who experienced a closed bone fracture and underwent open reduction and internal fixation surgery. The Slovins formula showed that 52 participants would provide enough representation for this study. We selected all participants for this study using convenient sampling methods.

This study evaluated male and female victims of accident-related trauma who had undergone closed fracture treatment. The research excluded people who had amputations or open fractures alongside those treated with Plaster of Paris casts or needle biopsies. The approved synopsis allowed us to select patients who met our specific criteria for participation. The research team explained the study project to participants who then signed consent forms. We took privacy steps to maintain their ethical protection.

For data gathering, we used a modified questionnaire that captures basic participant information and research variables. The data collector received the finished questionnaires and the answers became final. I processed the information in SPSS IBM-26 by showing data in percentage values along with frequency counts and mean plus standard deviation statistics. We used Chi-square analysis to study how these two variables connect. We received ethical approval from Superior University Lahore's board of study and advanced research committee before the study started. To protect patient privacy we used anonymous questionnaires and secured all completed documents.

Results

Sociodemographic and Clinical-related factors of the participants:

This study involved 52 patients with a balanced age distribution: 16 (30.8%) aged 15-30 years, 21 (40%) between 30-45 years, and 9 (28%) over 45. The gender distribution showed a higher prevalence of males, with 37 (71.2%) males and 15 (28.8%) females, which may relate to workplace risks. Additionally, 37 (71.2%) participants were married, potentially aiding recovery. Health-wise, 10 participants (19.2%) had diabetes, 16 (30.8%) had hypertension, and 6 (11.5%) were severely malnourished. Among the group, 27 (51.9%) had a healthy weight, while 16 (30.8%) were overweight and 3 (5.8%) were obese, which increases the risk of surgical complications. These sociodemographic and health characteristics are crucial for understanding factors influencing post-surgery antibiotic prophylaxis outcomes. As shown in Table No. 4.1.

Table No. 4.1 Description Regarding Sociodemographic and Clinical-related factors

Variables	Number%
Age (Years)	
15-30 Years	16 (30.8%)
30-45 years	21 (40.4%)
> 45 years	15 (28.8%)
Gender	
Male	37 (71.2%)
Female	15 (28.8%)
Marital Status	

Single	15 (28.8%)
Married	37 (71.2%)
Diabetes Mellitus	
Yes	10 (19.2%)
No	42 (80.8%)
Hypertension	
Yes	16 (30.8%)
No	36 (69.2%)
BMI	
Underweight	6 (11.5%)
Healthy Weight	27 (51.9%)
Overweight	16 (30.8%)
Obesity	3 (5.8%)

Descriptions of study variables:

The study included 20 males and 32 females, with 35 patients (67.3%) receiving ceftriaxone as the preferred preoperative antibiotic, while 17 (32.7%) received cefazolin. A total of 51 patients (98.1%) received implants, with only 1 (1.9%) developing a postoperative wound infection. Inflammatory markers were abnormal in just 1.9% of patients. Among the patients, 18 (34.6%) wore plates, 16 (30.8%) wore nails, 17 (32.7%) wore screws and 1(1.9%) were without implants. The lower limb was affected in 76.9% of cases, and culture results showed 98.1% grew gram-negative bacilli. The study concluded that ceftriaxone and cefazolin effectively reduced the frequency of SSIs, leading to mostly favorable outcomes. Displayed in Table 4.2 and illustrated in Figures 4.1 & 4.2.

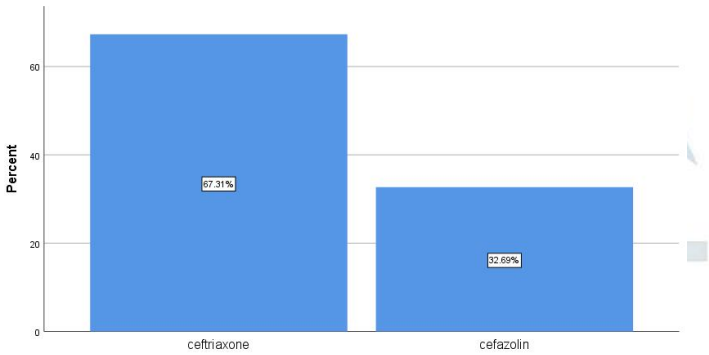

Figure No. 4.1 Description of Pre-Op Antibiotics

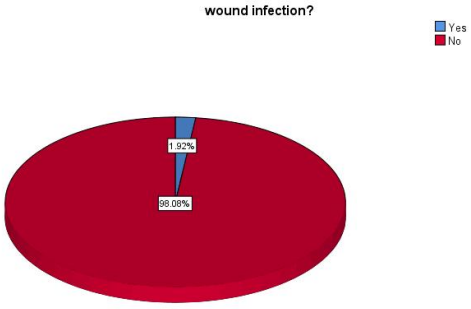

Figure No. 4.2 Description of Wound Infection

The study results indicate several independent variables affecting outcomes. A significant association was found with diabetes mellitus (p = 0.039), which impacted wound infections. BMI also showed major effects (p = 0.001), suggesting that being overweight increases complication risks. The culture report was highly significant (p = 0.000), highlighting the link between bacterial type and infection risk. Conversely, factors like type of implant (p = 0.350), fracture site (p = 0.580), and pre-operative antibiotics (p = 0.482 for ceftriaxone vs. cefazolin) showed no significant correlation with outcomes.

Table No. 4.2 Comparison of outcome with other independent variables

Categories	**Variables**	Does the patient have any wound infection?		Total	P-Values
		Yes	**No**		
Does the patient is given pre-op antibiotics (ceftriaxone or cefazolin)	ceftriaxone	1	34	35	
	cefazolin	0	17	17	
	Total	1	51	52	0.482
Gender	Male	0	37	37	
	Female	1	14	15	0.113
	Total	1	51	52	
Diabetes Mellitus:	Yes	1	9	10	
	No	0	42	42	0.039
	Total	1	51	52	
Hypertension:	Yes	0	16	16	
	No	1	35	36	0.501
	Total	1	51	52	
BMI:	Underweight.	0	6	6	
	Healthy Weight.	0	27	27	
	Overweight	0	16	16	0.001
	Obesity	1	2	3	
	Total	1	51	52	
Which type of implant?	Plate	0	18	18	
	Nail	1	15	16	
	Screw	0	17	17	0.514
	No implant	0	1	1	
	Total	1	51	52	
What are the types of Fracture	Upper limb	0	12	12	0.580

sites?	Lower Limb	1	39	40	
	Total	1	51	52	
Culture report	Positive	1	0	1	0.000
	Negative	0	51	51	
	Total	1	51	52	

Discussion

The study sample displayed an even age distribution, primarily among working-age individuals. The largest group (40%) was aged 30-45 years, followed by those aged 15-30 years (30.8%). This aligns with typical fracture patterns, as younger individuals often engage in activities that lead to injuries. Patients over 45 may face degenerative issues that increase their fracture risk. Previous studies indicate that older age is a significant risk factor for surgical infections due to impaired immune responses and slower wound healing (21).

A demographic analysis revealed that 71.2% of participants in this research were male. This aligns with other studies indicating that men are more prone to fracture injuries, particularly from workplace accidents. Literature suggests that men are more likely to experience fractures in their lifetime, which may explain the all-male patient group in this study (22).

This work analyzed coexisting diseases, such as diabetes and hypertension, and their impact on infection risk. Findings revealed a statistically significant difference in wound infections among patients with diabetes mellitus ($p = 0.039$), supporting previous research that identifies diabetes as a predictor of surgical site infections (SSIs). Diabetes weakens the immune system and hampers recovery, leading to increased postoperative infection rates. (23). Patients with diabetes undergoing orthopedic surgeries are at a higher risk of SSIs than those without diabetes. (24).

The study found a strong link between Body Mass Index (BMI) and postoperative complications, with overweight patients facing a higher risk of SSIs ($p = 0.001$). This aligns with other research highlighting obesity as a significant factor in surgical risks, including infections. Obesity can reduce immunity, impair blood flow, and hinder wound healing due to low tissue oxygen levels. Additionally, comorbidities like diabetes and hypertension further elevate these risks, reinforcing the importance of maintaining good health to avoid surgeries and illnesses. (25).

The study focused on two antibiotics regarding SSI rates: ceftriaxone (67.3% usage) and cefazolin (32.7%). The overall infection incidence was low at 1.9%, indicating both antibiotics effectively minimize SSIs. Previous literature confirms their use in specific orthopedic surgeries, particularly those involving implant placement like ORIF, to reduce SSI rates (26). The results showed no significant difference between ceftriaxone and cefazolin ($p = 0.482$), aligned with previous studies indicating both drugs are equally effective in controlling infections in clean orthopedic surgeries.

The study examined the impact of implant type (plate, screw, or nail) on surgical site infections (SSIs) and found no statistically significant difference, with a p-value of 0.514. This contradicts previous recommendations suggesting that implant type affects infection rates, such as La Porta et al's claim that larger surfaces like plates have a higher risk for bacterial colonization. This study suggests that as long as appropriate antibiotic prophylaxis and surgical techniques are used, the type of implant may not significantly influence SSI rates (26).

The study examined fracture sites, revealing that most fractures (76.9%) were open fractures in the lower limbs, while only 23.1% were in the upper limbs. No significant difference was found in fracture distribution or the occurrence of SSIs ($p = 0.580$), consistent with other research indicating that fracture site is less influential on infection outcomes than factors like systemic comorbidities and antibiotic prophylaxis.(27).

In this study, 98.1% of cases had negative microbiological reports, while only 1.9% showed positive bacterial findings. The prevalence of gram-negative bacteria in postoperative infections, particularly in orthopedic surgeries, is significant, as these organisms are commonly found in clinical settings and on skin surfaces. This aligns with other studies indicating a rise in gram-negative infections in surgical site infections (SSIs) following orthopedic procedures. (28).

Conclusion

The study found a low infection rate of 1.9% with preoperative antibiotics ceftriaxone and cefazolin. Diabetes, hypertension, and BMI increased infection risk. Implant type and fracture location did not significantly affect SSI rates. Both antibiotics were equally effective in reducing infections, emphasizing the need for proper prophylaxis and management of risk factors in orthopedic surgeries. Further multi-center studies are needed to confirm these findings and enhance antibiotic strategies.

Recommendations

The study recommends several tactics to improve patient care and prevent surgical site infections (SSIs) in orthopedic surgery. These include larger sample sizes, multi-center studies, randomized controlled trials, exploring alternative antibiotics, personalized prophylaxis, enhanced care protocols, ongoing education and training, cost-effectiveness analyses, and collaboration among specialists. The ultimate goals are to reduce SSIs, improve patient outcomes, and elevate the standard of care in orthopedic surgery.

Limitations Of This Study

Research on orthopedic surgery patients with closed fractures has several limitations due to its small 52-patient study with observational design and inability to factor out other possible factors. The study specifically studied ceftriaxone and cefazolin except for different antibiotics and antibiotic combinations. The study's results do not show either long-term effects or possible reporting bias between patients. The study remains useful for understanding how antibiotic prophylaxis helps protect patients from surgical site infections despite some study restrictions.

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