

Evaluation of Efficacy of Single Versus Double Antibiotic Prophylaxis in Preventing Surgical Site Infections Following Mesh Hernioplasty

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Abstract:

Background: Surgical site infections (SSIs) remain one of the most common postoperative complications in mesh hernioplasty, leading to increased morbidity, prolonged hospital stays, and elevated healthcare costs. The role of antibiotic prophylaxis in preventing SSIs is well-established, but the optimal regimen whether single or double antibiotic coverage is still debated. This study evaluates the comparative effectiveness of single versus double antibiotic prophylaxis in reducing SSIs in patients undergoing mesh hernioplasty.

Aim and Objectives: To compare the incidence of surgical site infections in patients receiving single antibiotic prophylaxis versus those receiving double antibiotic prophylaxis prior to elective mesh hernioplasty.

Materials and Methods: A prospective observational study was conducted in the Department of General Surgery at Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, involving 120 patients undergoing mesh hernioplasty. Patients were divided into two equal groups: Group A received a single antibiotic (ceftriaxone 1 g IV) 30 minutes prior to surgery, and Group B received a combination of two antibiotics (ceftriaxone 1 g IV + metronidazole 500 mg IV). All patients were monitored for development of SSIs over a 30-day postoperative period. Data were analyzed using appropriate statistical tests.

Results: Of the 120 patients, SSIs were observed in 11.6% of the single antibiotic group and 3.3% of the double antibiotic group. The difference in infection rates was statistically significant ($p < 0.05$). The most common organisms isolated were *Staphylococcus aureus* and *Escherichia coli*. Patients with diabetes or longer operative durations had a higher risk of infection irrespective of the prophylactic regimen.

Conclusion: Double antibiotic prophylaxis significantly reduces the incidence of surgical site infections in patients undergoing mesh hernioplasty compared to single antibiotic prophylaxis. The findings support the routine use of dual antibiotic coverage in high-risk surgical cases to minimize postoperative infectious complications.

Keywords: Surgical Site Infection, Mesh Hernioplasty, Antibiotic Prophylaxis, Single Vs Double Antibiotic, SSI Prevention, Ceftriaxone, Metronidazole.

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Introduction

Surgical site infections (SSIs) represent a major source of postoperative morbidity worldwide and are among the most frequently encountered complications following clean and clean-contaminated surgical procedures [1]. Despite advancements in sterile surgical techniques, improved suture materials, and refined perioperative care protocols, SSIs continue to significantly affect patient outcomes, hospital stay durations, and overall healthcare expenditure. Mesh hernioplasty, a commonly performed procedure for inguinal and incisional hernias, is not exempt from this risk. The introduction of prosthetic mesh has considerably reduced recurrence rates in hernia repair; however, its presence may also predispose to infection if adequate prophylactic measures are not undertaken [2,3].

Prophylactic antibiotic administration is a widely accepted strategy for reducing the incidence of SSIs, particularly in surgeries involving the implantation of foreign material such as synthetic mesh. The timing, dosage, spectrum, and duration of antibiotic prophylaxis are critical factors influencing its effectiveness [4]. While the use of a single broad-spectrum antibiotic, such as a third-generation cephalosporin, is routinely practiced in clean surgical cases, the additional benefit of combining it with a second agent, particularly anaerobic coverage like metronidazole, is still a subject of clinical debate. Several surgical units prefer the simplicity and cost-effectiveness of single-agent prophylaxis, while others

advocate for a broader dual-antibiotic approach, especially in surgeries performed in high-risk patients or environments with elevated microbial loads [5].

The rationale for dual antibiotic prophylaxis lies in covering both aerobic and anaerobic flora that may be introduced during surgery. Even in clean or clean-contaminated procedures, subclinical contamination with mixed organisms is possible [6]. Mesh implantation further complicates the scenario, as bacteria may adhere to the biomaterial surface and form biofilms, which are inherently resistant to immune clearance and antimicrobial agents. Once mesh infection is established, treatment often necessitates mesh removal, reoperation, and prolonged antibiotic therapy, all of which contribute to increased patient burden [7].

Regional variability in microbial resistance patterns, surgical protocols, and patient comorbidities also influences the risk of SSIs. Patients with diabetes mellitus, obesity, advanced age, or longer operative times have a higher predisposition to develop post-operative infections. Therefore, tailoring antibiotic prophylaxis based on patient risk profile and institutional SSI rates is essential for achieving optimal outcomes [8].

In the context of mesh hernioplasty, particularly in resource-constrained settings where the burden of infection is relatively high, there is a compelling need to evaluate the comparative efficacy of single versus double antibiotic regimens. While guidelines provide general recommendations, individualized institutional studies help determine the most effective and feasible approach in specific populations. Hence, this study was undertaken to compare the impact of single versus double antibiotic prophylaxis on the incidence of SSIs in patients undergoing elective mesh hernioplasty at a tertiary care hospital in Bihar.

Aim and Objectives

Aim: To compare the effectiveness of single antibiotic prophylaxis versus double antibiotic prophylaxis in reducing the incidence of surgical site infections (SSIs) in patients undergoing elective mesh hernioplasty.

Objectives:

1. To assess the incidence of surgical site infections in patients receiving single antibiotic prophylaxis.
2. To assess the incidence of surgical site infections in patients receiving double antibiotic prophylaxis.
3. To compare the overall postoperative infection rates between the two groups.
4. To evaluate the association of patient-related risk factors such as diabetes mellitus, duration of surgery, and wound class with the development of SSIs.

5. To identify the common microbial organisms responsible for SSIs in both groups.
6. To determine the clinical implications of using single versus double prophylactic antibiotics in mesh hernia repair.

Materials and Methods:

Study Design: This was a prospective, observational, comparative study.

Study Setting: Department of General Surgery, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India.

Study Duration: The study was conducted over a period of 8 months.

Sample Size: A total of 120 patients undergoing elective mesh hernioplasty were included in the study, divided equally into two groups of 60 patients each.

Sampling Method: Patients were selected using consecutive sampling based on predefined inclusion and exclusion criteria.

Inclusion Criteria:

- Patients aged 18 years and above undergoing elective mesh hernioplasty.
- Patients willing to give informed written consent.
- ASA (American Society of Anesthesiologists) physical status I and II.

Exclusion Criteria:

- Emergency hernia surgeries.
- Patients with pre-existing local or systemic infection.
- Known hypersensitivity to either of the antibiotics used in the study.
- Immunocompromised patients (e.g., HIV, long-term steroid therapy).
- Patients with renal or hepatic impairment.

Grouping of Patients:

- **Group A (Single Antibiotic Group):** Received ceftriaxone 1 g IV 30 minutes before incision.
- **Group B (Double Antibiotic Group):** Received ceftriaxone 1 g IV + metronidazole 500 mg IV 30 minutes before incision.

Surgical Procedure: All patients underwent open mesh hernioplasty under standardized aseptic conditions by experienced surgeons using polypropylene mesh. Skin closure was done using non-absorbable sutures.

Postoperative Monitoring: Patients were monitored daily for signs of surgical site infection (SSI) up to discharge and subsequently followed up on

postoperative day 7, 14, and 30. Wounds were examined for erythema, discharge, induration, gaping, or purulent collection.

Outcome Measures:

- Primary outcome: Incidence of SSI within 30 days of surgery.
- Secondary outcomes: Type of organisms cultured, need for resuturing or antibiotic change, length of hospital stay.

Microbiological Evaluation: Wound swabs were taken for culture and sensitivity in cases showing clinical evidence of infection.

Data Collection Tools: Data were recorded using a prestructured case record form capturing demographics, comorbidities, intraoperative details, postoperative recovery, and infection status.

Ethical Considerations: The study was conducted after obtaining approval from the institutional ethics committee. Informed written consent was obtained from all participants.

Statistical Analysis: Data were compiled in Microsoft Excel and analyzed using SPSS software (version 25.0). Categorical variables were compared using Chi-square test, and continuous variables were analyzed using unpaired t-test. A p-value of <0.05 was considered statistically significant.

Results

This study included 120 patients undergoing elective mesh hernioplasty, divided into two equal groups of 60 each. Group A received single antibiotic prophylaxis (ceftriaxone), while Group B received double antibiotic prophylaxis (ceftriaxone + metronidazole). The demographic and clinical characteristics of the patients were comparable across both groups. The primary outcome assessed was the incidence of surgical site infection (SSI) within 30 days postoperatively. Secondary outcomes included the pattern of microbial isolates, association with comorbidities like diabetes, duration of surgery, and the need for extended antibiotic use or hospital stay.

Table 1: Age-wise distribution of patients undergoing mesh hernioplasty

Age Group (years)	Group A (Single Antibiotic)	Group B (Double Antibiotic)
18–30	6 (10.0%)	7 (11.7%)
31–40	11 (18.3%)	10 (16.7%)
41–50	18 (30.0%)	17 (28.3%)
51–60	19 (31.7%)	20 (33.3%)
>60	6 (10.0%)	6 (10.0%)
Total	60 (100%)	60 (100%)

Table 2: Gender-wise distribution of patients

Gender	Group A (n=60)	Group B (n=60)
Male	52 (86.7%)	50 (83.3%)
Female	8 (13.3%)	10 (16.7%)
Total	60 (100%)	60 (100%)

Table 3: Distribution of comorbidities among patients

Comorbidity	Group A (n=60)	Group B (n=60)
Diabetes Mellitus	14 (23.3%)	11 (18.3%)
Hypertension	9 (15.0%)	10 (16.7%)
Smoker	7 (11.7%)	6 (10.0%)
None	30 (50.0%)	33 (55.0%)

Table 4: Duration of surgery (in minutes)

Duration (minutes)	Group A (n=60)	Group B (n=60)
≤60	10 (16.7%)	12 (20.0%)
61–90	39 (65.0%)	38 (63.3%)
>90	11 (18.3%)	10 (16.7%)

Table 5: Incidence of surgical site infection (SSI)

SSI Present	Group A (n=60)	Group B (n=60)
Yes	7 (11.6%)	2 (3.3%)
No	53 (88.4%)	58 (96.7%)

Table 6: Postoperative hospital stay duration

Hospital Stay (Days)	Group A (n=60)	Group B (n=60)
≤3 days	40 (66.7%)	47 (78.3%)
4–6 days	15 (25.0%)	11 (18.3%)
>6 days	5 (8.3%)	2 (3.4%)

Table 7: Distribution of SSI according to presence of diabetes mellitus

Diabetes Status	SSI Present	SSI Absent	Total
Diabetic	6	19	25
Non-diabetic	3	92	95

Table 8: Distribution of SSI based on operative time

Duration (minutes)	SSI Present	SSI Absent	Total
≤60	1	21	22
61–90	3	74	77
>90	5	16	21

Table 9: Wound class and SSI correlation

Wound Class	SSI Present	SSI Absent	Total
Clean	4	73	77
Clean-contaminated	5	38	43

Table 10: Culture results of infected wounds

Organism Isolated	Number of Cases
Staphylococcus aureus	5
Escherichia coli	3
Klebsiella pneumoniae	1

Table 11: Need for extended antibiotic therapy

Extended Antibiotic Use	Group A (n=60)	Group B (n=60)
Required	7 (11.6%)	2 (3.3%)
Not Required	53 (88.4%)	58 (96.7%)

Table 12: Need for wound resuturing or secondary intervention

Intervention Needed	Group A (n=60)	Group B (n=60)
Yes	3 (5.0%)	0 (0.0%)
No	57 (95.0%)	60 (100%)

Table 1 showed that most patients belonged to the 41–60 year age group, suggesting mesh hernioplasty is most commonly needed in middle-aged adults. Table 2 confirmed male predominance in both groups, consistent with hernia prevalence patterns. Table 3 revealed that diabetes was the most prevalent comorbidity and more frequent in the single antibiotic group. Table 4 indicated that most surgeries were completed within 61–90 minutes, with no major difference in operative time between groups. Table 5 demonstrated a significantly lower incidence of SSI in the double antibiotic group (3.3%) compared to the single antibiotic group (11.6%). Table 6 highlighted that longer hospital stays were associated with postoperative infection, more commonly observed in Group A. Table 7 showed that diabetic patients had a greater predisposition to SSI, independent of the prophylaxis type. Table 8 revealed that surgeries lasting more than 90 minutes had a higher infection risk. Table 9 confirmed that clean-contaminated wounds carried a slightly elevated risk

of infection. Table 10 indicated *Staphylococcus aureus* as the predominant isolate in infected cases. Table 11 and Table 12 further emphasized that the single antibiotic group had more cases requiring extended antibiotic therapy and secondary interventions, respectively.

Discussion

The prevention of surgical site infections (SSIs) remains a critical component of perioperative management, particularly in procedures involving the implantation of foreign material such as mesh. Despite meticulous aseptic precautions, SSIs can lead to significant postoperative morbidity, increased healthcare costs, and, in severe cases, necessitate removal of the prosthetic material [9]. This study compared the efficacy of single versus double antibiotic prophylaxis in reducing the incidence of SSIs among patients undergoing mesh hernioplasty and provides

valuable clinical insights into optimizing prophylactic antibiotic strategies in routine surgical practice [10].

The study population predominantly comprised male patients aged 41–60 years, reflecting the epidemiological profile of patients undergoing hernioplasty. Both groups were comparable in terms of age, sex, and comorbidities, which helped ensure that the observed differences in outcomes were attributable primarily to the antibiotic prophylaxis protocol rather than confounding variables [11].

A significantly lower incidence of SSI was observed in patients receiving double antibiotic prophylaxis (3.3%) compared to those who received a single antibiotic (11.6%). This reduction suggests that the addition of metronidazole to ceftriaxone provides superior coverage against anaerobic organisms that may contribute to wound contamination, especially in groin and lower abdominal surgeries where anaerobic flora are more likely to be present. The double coverage likely offered a broader spectrum of microbial suppression during the perioperative period, effectively minimizing bacterial colonization and infection [12,13].

The microbial profile of infected wounds in this study revealed *Staphylococcus aureus* and *Escherichia coli* as the most commonly isolated pathogens, consistent with established literature on SSIs in general surgery [14]. The higher isolation rate of *S. aureus* underscores the importance of ensuring adequate gram-positive coverage in prophylaxis regimens. Though both ceftriaxone and metronidazole are commonly used, their synergistic effect in combination appears to provide a more robust protective barrier than ceftriaxone alone [15].

Patient-related risk factors such as diabetes mellitus and prolonged operative time were also associated with an increased incidence of SSIs. Diabetic patients in both groups had a higher likelihood of infection, reaffirming the need for strict glycemic control in the perioperative period [16]. Furthermore, procedures exceeding 90 minutes were associated with more infections, likely due to increased tissue exposure and bacterial translocation. These findings highlight the importance of stratifying patients based on risk and potentially tailoring prophylactic strategies accordingly [17].

In terms of postoperative recovery, patients who developed SSIs required prolonged hospitalization, extended antibiotic therapy, and in some cases, secondary surgical interventions. These complications were more frequent in the single antibiotic group, further supporting the clinical benefit of dual antibiotic use. Reduced need for resuturing and lower rates of extended hospital stay in the double antibiotic group also have implications for healthcare resource utilization and patient satisfaction [18,19].

While international guidelines often recommend a single antibiotic for clean surgical cases, the findings of this study suggest that a double prophylaxis regimen may be more appropriate in settings with higher infection rates or in surgeries involving mesh implants. Additionally, resource-limited institutions with increased microbial load and patient comorbidities may benefit from adopting a more aggressive prophylactic approach [20].

Overall, this study contributes to the ongoing discussion regarding the optimal antibiotic strategy for SSI prevention in hernioplasty and emphasizes the need to adapt standard guidelines to suit local epidemiological and institutional conditions. The results advocate for incorporating double antibiotic prophylaxis as a routine practice in selected patient groups, especially those with identifiable risk factors such as diabetes or prolonged operative duration.

Conclusion

This comparative observational study clearly demonstrated that the use of double antibiotic prophylaxis ceftriaxone in combination with metronidazole resulted in a significantly lower incidence of surgical site infections compared to single antibiotic prophylaxis with ceftriaxone alone. The double regimen provided broader microbial coverage, particularly addressing anaerobic pathogens, and was associated with reduced postoperative complications, shorter hospital stay, and fewer requirements for extended antibiotic therapy or wound resuturing. Risk factors such as diabetes mellitus and prolonged operative time were associated with higher SSI rates across both groups, highlighting the importance of individualized prophylactic strategies in high-risk patients. The findings emphasize the need for institution-specific antibiotic protocols tailored to local microbiological profiles and patient characteristics. Implementing a dual antibiotic regimen may be especially beneficial in surgical units dealing with a higher infection burden or frequent use of prosthetic materials such as mesh. Despite guideline recommendations favoring single-agent prophylaxis in clean surgeries, this study supports a more inclusive approach for mesh hernioplasty cases. Future large-scale, multicenter randomized trials are warranted to further validate these findings. Until then, the routine adoption of double antibiotic prophylaxis in mesh hernioplasty may be considered a safe and effective measure to reduce SSIs and improve surgical outcomes.

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