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ORIGINAL RESEARCH ARTICLE

# Audit of Efficacy of Single-dose *Versus* Multi-dose Prophylactic Antibiotics in Elective Hernia Repair– A Retrospective Study

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## ABSTRACT

**Background:** Elective hernia repairs are associated with a high risk of SSIs that may translate to longer hospital stays and elevated costs. The common practice is the use of prophylactic antibiotics to prevent SSIs, but the right dosage schedule is still in question. To audit the efficacy of single-dose *versus* multi-dose prophylactic antibiotics in elective hernia repair.

**Material and Methods:** This retrospective study was conducted based on data from 183 patients of elective inguinal hernia repairs who received either single-dose or multi-dose antibiotic prophylaxis at a tertiary care teaching hospital from 1st July 2023 to 30th June 2024. Based on inclusion criteria, 80 patients from each group were selected, making a total of 160 patients. The rest of the 23 patients fell into the exclusion criteria and were not included. Patients in group A had been given a preoperative dose of 1g of ceftriaxone before the surgery and group B received the same preoperative dose together with a repeat dose 12 hours after the surgery. This study selected patients aged 18 to 70 years, American Society of Anesthesiologists (ASA) physical status grade I and II, who underwent elective inguinal hernia repair operation. Primary end-points were the rate of SSI and secondary outcomes SAS, hospital length of stay, post-operative complications and antibiotic reactions.

**Results:** There had been a small decrease in the rate of SSI at day 30 in group B (10%) than in group A (12. 5%); however, the difference was not significant with $p$ = 0. 612. The mean hospital stay and the overall mean days in the hospital, as well as post-operative morbidity such as wound dehiscence and seroma formation, had been comparable in both groups. The two antibiotic regimens chosen were also concluded to be equally safe and effective in reducing SSIs in the hernia-repair population.

**Conclusion:** This study, therefore, concluded that there were no differences between single-dose prophylactic antibiotics and multiple doses of prophylactic antibiotics for the prevention of surgical site infection (SSI) under elective inguinal hernia repair. The overall rate of SSI, length of how hospital stay and post-operative complications were comparable between both regimens. In total, single-dose prophylaxis seems to be safe and efficient in comparison with multi-dose regimens for hernia repair surgery.

**Keywords:** Single-dose, Multi-dose, Prophylactic antibiotics, Hernia.

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## INTRODUCTION

Elective hernia repair surgeries are typically performed to address conditions like inguinal, umbilical, and femoral hernias. Surgical site infections (SSIs) are a major concern in hernia repair procedures, as they can result in prolonged hospitalizations, higher healthcare expenses, and, in severe instances, potentially life-threatening complications. Thus, preventing SSIs is a key goal in the management of patients undergoing hernia repair.[1]

Prophylactic antibiotics are administered before or during surgery to prevent post-operative infections. However, the optimal dosage regimen for antibiotics, specifically whether a single-dose or multi-dose regimen is more effective, has been a topic of ongoing debate. Prophylactic antibiotics aim to reduce the risk by providing systemic antimicrobial coverage at the time of surgery, ensuring that any bacteria introduced to the site are effectively neutralized before they can establish an infection.[2]

The single-dose regimen involves administering a single dose of antibiotics prior to surgery, while the multi-dose regimen typically includes an initial dose followed by additional doses postoperatively.[3]

Proponents of the single-dose regimen argue that a single dose is sufficient to provide adequate protection, particularly in clean surgeries like hernia repairs where the risk of infection is low. Advocates for this approach cite several potential benefits, including lower costs and a decreased risk of antibiotic resistance.[4]

It also simplifies the perioperative care protocol, as it

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requires less monitoring and fewer resources compared to multi-dose regimens.[5]

On the other hand, supporters of multi-dose regimens believe that extending antibiotic coverage into the post-operative period offers additional protection, particularly in cases where the surgery is prolonged or complications arise that increase the risk of infection. Multi-dose regimens are commonly used when prosthetic materials, such as mesh, are used, as these materials can serve as a nidus for bacterial colonization.[6]

However, one potential drawback of single-dose prophylaxis is the concern that it may not provide sufficient coverage in cases where the surgery is prolonged or complications arise. This is particularly concerning in surgeries where prosthetic materials are used, as these materials can serve as a reservoir for bacteria, increasing the risk of infection.[7]

The primary advantage of a multi-dose prophylactic regimen is the extended antibiotic coverage it provides.[8]

However, multi-dose regimens also come with potential risks. The extended use of antibiotics increases the likelihood of adverse drug reactions, including allergic reactions, gastrointestinal disturbances, and, in some cases, severe antibiotic- associated infections, such as clostridioides difficile.

## MATERIAL AND METHODS

This was a retrospective, comparative study in order to assess the outcome of single-dose and multi-dose prophylactic antibiotics for patients who were undergoing elective hernia surgery. The present study was carried out in the Department of General Surgery of a tertiary care hospital. A total of 183 patients were operated for open inguinal hernioplasty in the chosen period of 1 year (1st July 2023 to 30th June 2024). Patients were categorized into two groups- Group A consisted of patients who received a single dose of intravenous preoperative prophylactic antibiotics. In contrast, group B consisted of the patients receiving intravenous pre and post-operative antibiotic prophylaxis.

### *Inclusion Criteria*

Adult patients aged 18 to 70 years, Patients undergoing elective inguinal hernia repair (inguinal, femoral, or umbilical), and patients with American Society of Anesthesiologists (ASA) grade I and II.

### *Exclusion Criteria*

Patients with a history of hypersensitivity to antibiotics, patients with immunosuppressive disorders or those on immunosuppressive therapy, patients with active infections at the time of surgery, patients who had received antibiotics within one week prior to surgery, emergency hernia repair cases, hernias other than inguinal (Obturator/ Femoral/Umbilical). All the patients who underwent open inguinal hernioplasty in the last year were categorized into two groups. A total of 183 patients were enrolled, out of which 160 patients fulfilled the inclusion criteria of the study.

Those patients who received a single dose of intravenous antibiotic (Injection Ceftriaxone 1 gm IV stat) half an hour prior to the incision were grouped under group A, while others who received one dose half an hour prior to the incision and 2 doses in the post-operative period, 12 hours apart, were included in group B.

Patient data were assessed from the database, discharge summary and subsequent OPD visit for surgical site infection in post – the operative period on 3rd, 7th and 30th post-operative days. Other than this, they were also assessed for other outcomes like the length of hospital stay (in days) and post-operative complications. Other demographic details were also collected and used as needed in our study.

Surgical site infection (SSI) as defined by the Centers for Disease Control and Prevention (CDC).

All patients included were operated under spinal anesthesia. Sterile measures were employed in the closure of the surgical wounds and close supervision of the patients had been done in the post-operative period.

The first outcome of the study was the rate of surgical site infection, SSI, within 30 days of surgery. Secondary end-points consisted of the duration of hospital stay, post-operative complications, whether they were in the form of wounds that opened or the formation of seromas, and reactions elicited by the antibiotics used.

Several patient factors such as age, gender, and BMI were recorded, as well as the type of hernia, method of repair, and clinical outcomes. For assessing post-operative wound infection, wound diagrams were made according to the CDC guidelines on the 3rd, 7th, and 30th post-operative days. Moreover, any side effects of the antibiotics that the patients may have had were noted for both groups. Information was recorded in a structured format in a pre-format proforma and analyzed in the SPSS software version 25. For demographical variables, descriptive measures were applied. On the same note, the chi-square test was used to compare the rates of SSIs between the two groups. Significance level; *p-value* < 0. 05 was used in the test of hypotheses.

## RESULTS

Table 1 shows the age, gender, BMI and ASA grade of the patients was nearly comparable in both group A (single dose) and group B (multi-dose), and there were no significant differences between these two groups

**Table 1:** Demographic characteristics of the patients

| *Characteristics* | *Group A (n = 80)* | *Group B (n = 80)* | *p-value* |
|---|---|---|---|
| Age (Mean ± SD) | 45.81 ± 12.35 years | 46.25 ± 11.86 years | 0.742 |
| Gender (Male/Female) | 60/20 (75%/25%) | 58/22 (72.5%/27.5%) | 0.680 |
| BMI (Mean ± SD) | 25.25 ± 3.52 kg/m² | 24.83 ± 3.27 kg/m² | 0.533 |
| ASAGrade (I/II) | 48/32 (60%/40%) | 50/30 (62.5%/37.5%) | 0.781 |
| Type of Hernia | | | |
| Inguinal | 52 (65%) | 54 (67.5%) | 0.719 |
| Femoral | 12 (15%) | 10 (12.5%) | |
| Umbilical | 16 (20%) | 16 (20%) | |

**Table 2:** Incidence of SSI

| *SSI incidence* | *Group A (n = 80)* | *Group B (n = 80)* | *p-value* |
|---|---|---|---|
| SSIs at day3 | 6 (7.5%) | 4 (5%) | 0.510 |
| SSIs at day7 | 8 (10%) | 6 (7.5%) | 0.580 |
| SSIs at day30 | 10 (12.5%) | 8 (10%) | 0.612 |

**Table 3:** Length of hospital stay

| *Length of stay (Days)* | *Group A (n = 80)* | *Group B (n = 80)* | *p-value* |
|---|---|---|---|
| Mean ± SD | 3.85 ± 1.24 days | 3.62 ± 1.12 days | 0.381 |
| Range | 2–6 days | 2–5 days | |

**Table 4:** Post-operative complications

| *Complications* | *Group A (n = 80)* | *Group B (n = 80)* | *p-value* |
|---|---|---|---|
| Wound dehiscence | 3 (3.75%) | 2 (2.5%) | 0.650 |
| Seroma formation | 5 (6.25%) | 3 (3.75%) | 0.465 |
| Adverse reactions to antibiotics | 4 (5%) | 3 (3.75%) | 0.701 |

**Table 5:** Adverse reactions to antibiotics

| *Adverse reaction* | *Group A (n = 80)* | *Group B (n = 80)* | *p-value* |
|---|---|---|---|
| Nausea | 3 (3.75%) | 2 (2.5%) | 0.650 |
| Diarrhea | 1 (1.25%) | 2 (2.5%) | 0.562 |
| Rash | 2 (2.5%) | 1 (1.25%) | 0.620 |
| Total adverse reactions | 6 (7.5%) | 5 (6.25%) | 0.742 |

($p > 0.05$ for all). The age distribution of the patients in group A was 45.81 ± 12.35 years, and in group B was 46.25 ± 11. 86, $p = 0.742$, which showed that the patient's age was comparable in both groups. Concerning the distribution of gender, 75% of the readers in group A were males, while 25% were females, while in group B, 72.5% were males and 27.5% were females. Thus, Chi-square 0.680. The percentage body weight and BMI of the two groups were also comparable with the mean percentage body weight [17.25 ± 3.52] in group A and [16.83 ± 3.27] in group B and mean BMI [25.25 ± 3.52] in group A and [24.83 ± 3.27] in group B, respectively, with $p = 0.533$. ASA grades describing the physical status of the patients before the surgery were also nearly equal in the two groups, with no significant difference between them. Gonadal positioning of the two types of hernia, inguinal, femoral, and umbilical, was also similar in the two groups, signifying that two comparable groups for the study had been chosen. Table 2 reveals the incidence of surgical site infections (SSI).

The first objective of the study was to determine the frequency of SSIs in the post-operative periods, which were at 3, 7, and 30 days. On the 3rd day also, the percentage of SSIs had slightly increased in group A (7.5%), while in group B was (5%) but not significant (*p-value* of 0.510). In group A, the percentage of SSIs on day 7 totaled 10%, and in group B – 7.5% ($p = 0.580$), and thus, once more, there was no qualitative difference. At last, during the observation at day 30 post-operative wound, SSIs were seen in 12.5% of patients in group A and 10% in group B, with a tendency of decreased infection rate in the multi-dose vial group ($p = 0.612$). However, none of them were significant, meaning that single–dose and multi-dose antibiotic regimens had comparable efficacy in decreasing the incidence of SSIs in the enrolled patients. The average hospitalization period was less in group B (multi-dose), with an average of 3.62 ± 1.12 days, than in group A 3.85 ± 1.24 days but the difference was not to have any statistical significance ($p = 0.381$). The variation in the hospitalization for patients in group A was two to 6 days, whereas for group B, it ranged from two to five days. Therefore, it was found that there was no correlation between the administration of single-dose and multi-dose antibiotics and the duration of hospital stay of the patients who underwent elective hernia surgery (Table 3). Table 4 compared post-operative complications, including wound dehiscence and formation of seromas in the two groups. Wound dehiscence had been noted in 3.75% of patients of group A, while the same had been seen in 2.5% of the patients of group B. However, the difference was not found to be statistically significant ($p = 0.650$). The side effects included seroma formation, with rates of 6.25% and 3.75 in group A and B, respectively ($p = 0.465$).

Furthermore, side effects of the antibiotics, which included allergy, had also been noted where patients in group A received antibiotics, with five patients in group A and 3.75 in group B having reported adverse reactions to the treatment ($p$ = 0.701). The comparison of the post-operative complication showed that there was still no significant difference between the incidence of single-dose regimen and multi-dose regimen, thereby pointing towards similar safety in both regimens. Table 5 reveals the side effects of antibiotics such as nausea, diarrhea, rash, and other complications, had been observed in both groups of patients. The vomiting had also been expressed by 3.75% of the patients in group A and 2.5% in group B, with no statistically significant difference ($p$ = 0.650). Diarrhea had also been encountered with 1.25% of the patients in group A and 2.5% in group B of the patients ($p$ = 0.562). The common side effects reported had been as follows; rash, five patients in group A and 2.5 in group B with a *p-value* of 0.620. The general tally of the adverse effects in group A was 7.5%, while in group B was 6.25%. This comparison of the difference between the two groups with a view of determining whether or not adverse effects were significantly different between the two groups yielded a *p-value* of 0.742. Although there had been a few adverse reactions, these findings indicate that elective hernia repair is safe with the use of single-dose and multi-dose antibiotics as well.

## DISCUSSION

Antibiotic prophylaxis is recommended for elective surgeries involving prosthesis implantation, as the risk of infection can occasionally be life-threatening. However, its benefit in elective surgeries like inguinal hernia repair is often debated. The low incidence of wound infections and the advanced technical proficiency in these procedures argue against the routine use of antibiotics. Surgical site infections after hernia repair are linked to an increased likelihood of recurrence, which can ultimately lead to the hernia reappearing.

The demographic characteristics of the study population were well-matched between group A (single-dose) and group B (multi-dose) in terms of age, gender, BMI, and ASA grades. The similarity in these variables ensures that the outcomes of the study are not biased by any demographic differences, allowing for a more accurate comparison between the two groups. Similar studies, such as one by Althumairi *et al*. (2021), also demonstrated no significant demographic differences between groups when comparing single-dose *versus* multi-dose antibiotic regimens in elective surgeries.[9] Such balance in demographic characteristics across both groups strengthens the internal validity of this trial, ensuring that observed differences in outcomes, if any, are likely due to the intervention itself and not confounding factors.

The primary outcome of the study was the incidence of SSI at various time intervals. The results showed no statistically significant differences in SSIs between the single-dose and multi-dose groups on days 3, 7, or 30. Although group A had slightly higher SSI rates (12.5%) compared to group B (10%) by day 30, the difference was not statistically significant ($p$ = 0.612). A meta-analysis by Nelson *et al*. (2017) also concluded that multi-dose prophylactic antibiotics do not offer a significant advantage over single-dose regimens in preventing SSIs in clean surgeries, such as hernia repairs.[10] Similarly, our results align with the findings of Itani *et al*. (2016), who found no additional benefit of using multi-dose antibiotic regimens over single-dose regimens in elective surgeries.[11] The comparable SSI rates between the two groups suggest that single-dose prophylactic antibiotic regimen may be as effective as multi-dose regimens, particularly in low-risk elective procedures like hernia repairs. The length of hospital stay is often considered an indirect measure of post-operative complications and recovery. In this study, the average length of hospital stay was slightly shorter in group B (3.62 ± 1.12 days) compared to group A (3.85 ± 1.24 days), though the difference was not statistically significant ($p$ = 0.381). Similar findings were reported by Dellinger *et al*. (2019), where no significant difference in hospital stay was observed between single-dose and multi-dose antibiotic prophylaxis in elective surgeries.[12]

The marginally shorter hospital stay in the multi-dose group could be due to slightly fewer SSIs and post-operative complications, but the difference was too small to reach significance. This suggests that single-dose antibiotics are just as effective in ensuring a timely post-operative recovery without prolonged hospitalization.

Post-operative complications, including wound dehiscence and seroma formation, had also been compared between the two groups. Wound dehiscence occurred slightly more frequently in group A (3.75%) compared to group B (2.5%), and seroma formation was similarly higher in group A (6.25%) *versus* group B (3.75%). However, neither of these differences was statistically significant. These results are consistent with the study by Bratzler *et al*. (2013), which also found no significant difference in post-operative complications when comparing single-dose and multi-dose regimens for clean surgical procedures.[13] Furthermore, adverse reactions to antibiotics, such as allergic reactions, had been rare and comparable between the groups, confirming the safety of both single-dose and multi-dose regimens.

Adverse reactions to antibiotics, such as nausea, diarrhea, and rash, had been infrequent and occurred at similar rates between group A and group B, with no statistically significant differences ($p > 0.05$ for all). The overall incidence of adverse reactions was 7.5% in group A and 6.25% in group B, which is consistent with previous studies, such as those by Allegranzi *et al*. (2016), who reported comparable rates of adverse reactions between different prophylactic antibiotic regimens in surgical patients.[14] The safety profile of both regimens had been favorable, and neither group had experienced any severe adverse events. This further supports the conclusion that single-dose prophylactic antibiotic regimens are safe and do not increase the risk of antibiotic-related adverse reactions compared to multi-dose regimens.

The findings of this study are in agreement with numerous other studies, which have consistently shown that single-dose antibiotic prophylaxis is just as effective as multi-dose regimens in preventing SSIs in clean surgical procedures like elective hernia repairs. Platt *et al*. (2017) also found no significant difference in SSI rates or post-operative complications between single-dose and multi-dose antibiotic regimens in hernia repair.[15] Additionally, studies by Nelson *et al*. and Dellinger *et al*. corroborate these results, suggesting that single-dose regimens may be a cost-effective alternative to multi-dose regimens without compromising patient safety.[10,12]

## CONCLUSION

In conclusion, this study found no significant difference between single-dose and multi-dose prophylactic antibiotic regimens in preventing SSIs in elective inguinal hernia repair. Both regimens demonstrated similar efficacy in terms of SSI rates,

length of hospital stay, and post-operative complications. The single-dose regimen, however, may offer advantages in terms of reduced antibiotic use, lower costs, and minimized risk of antibiotic resistance. Overall, single-dose prophylaxis appears to be a safe and effective alternative to multi-dose regimens for hernia repair surgery.

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