

Efficacy of Single vs. Double Antibiotic Prophylaxis in Preventing Surgical Site Infections Following Mesh Hernioplasty: A Comparative Analysis

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Abstract:

Background: Surgical site infections (SSIs) are among the most common postoperative complications, particularly in surgeries involving prosthetic materials such as mesh. Although single antibiotic prophylaxis is widely practiced, the benefit of using a combination of antibiotics to further reduce the risk of SSI remains under investigation. This study aims to compare the efficacy of single versus double antibiotic prophylaxis in reducing SSIs among patients undergoing mesh hernioplasty.

Methods: A prospective, comparative observational study was conducted on 120 patients undergoing elective mesh hernioplasty at Department of General Surgery, Dr. Panjabrao Deshmukh Memorial Medical College, Amravati, Maharashtra, India. Patients were randomly divided into two groups. Group A (n=60) received a single dose of intravenous ceftriaxone (1g) 30 minutes before surgery. Group B (n=60) received a combination of intravenous ceftriaxone (1g) and metronidazole (500mg) 30 minutes prior to surgery. Standardized surgical techniques and postoperative wound care protocols were followed in all cases. Patients were monitored postoperatively for 30 days, and SSIs were diagnosed based on CDC criteria. Infection rates were compared between the two groups using appropriate statistical tests.

Results: The incidence of SSIs in Group A (single antibiotic) was found to be 13.3%, while in Group B (double antibiotics) it was significantly lower at 3.3% ($p < 0.05$). Most infections were superficial and resolved with conservative management. No major mesh-related infections or reoperations were noted in either group.

Conclusion: The use of double antibiotic prophylaxis with ceftriaxone and metronidazole significantly reduced the incidence of SSIs compared to single antibiotic prophylaxis. In clean-contaminated surgeries involving mesh, dual prophylaxis may be more effective in minimizing postoperative infection risk.

Keywords: Surgical site infection, mesh hernioplasty, antibiotic prophylaxis, ceftriaxone, metronidazole, single vs. double prophylaxis.

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Introduction

Surgical site infections (SSIs) represent a significant cause of postoperative morbidity, extended hospital stay, and increased healthcare costs, especially in procedures involving the implantation of foreign material such as mesh hernioplasty. Inguinal and ventral hernias are among the most commonly encountered conditions in general surgery, and the use of synthetic mesh has become the standard of care due to its lower recurrence rate. However, the insertion of mesh inherently increases the risk of infection, making effective prophylactic strategies imperative.

Antibiotic prophylaxis plays a pivotal role in the prevention of SSIs. The goal of prophylactic

antibiotic administration is to reduce the microbial load at the surgical site to a level that the host's immune defense can manage, thereby preventing infection. While the use of prophylactic antibiotics in clean-contaminated and contaminated surgeries is well established, their use in clean surgeries such as elective mesh hernioplasty is still debated.

Many surgeons opt for a single-agent prophylaxis, most commonly a third-generation cephalosporin such as ceftriaxone, due to its broad-spectrum coverage and ease of administration. However, evidence suggests that the addition of a second antibiotic, such as metronidazole, may provide enhanced coverage against anaerobic organisms,

which are also implicated in postoperative wound infections. Dual antibiotic prophylaxis has shown potential benefits in contaminated and high-risk surgeries, but its role in elective mesh hernia repair needs further evaluation.

The existing literature on the comparative efficacy of single versus dual antibiotic prophylaxis in clean surgical procedures presents mixed results. Some studies report no added advantage of using two antibiotics, while others suggest a significant reduction in infection rates with a combination regimen, especially in areas with a high burden of resistant or mixed flora.

Given this ambiguity and the clinical significance of minimizing SSIs in mesh surgeries, this study aims to compare the effectiveness of single antibiotic prophylaxis (ceftriaxone alone) versus double antibiotic prophylaxis (ceftriaxone plus metronidazole) in reducing the incidence of surgical site infections in patients undergoing elective mesh hernioplasty. The findings of this study will contribute to the optimization of prophylactic antibiotic strategies and help establish more definitive guidelines for clean surgical interventions involving prosthetic implants.

Methods

This prospective comparative observational study was conducted in the Department of General Surgery at Dr. Panjabrao Deshmukh Memorial Medical College, Amravati, over a period of 12 months. A total of 120 patients aged 18–65 years, who were scheduled for elective mesh hernioplasty for inguinal or ventral hernia, were enrolled in the study. Written informed consent was obtained from all participants. Patients with active infections,

immunocompromised states, allergy to study drugs, uncontrolled diabetes, or those undergoing emergency surgery were excluded. Eligible patients were randomly assigned to one of two groups using a simple randomization technique. Group A (n=60) received a single prophylactic antibiotic dose of intravenous ceftriaxone (1 gram) administered 30 minutes prior to skin incision. Group B (n=60) received a combination of intravenous ceftriaxone (1 gram) and metronidazole (500 mg) administered at the same time point. All surgical procedures were performed under aseptic precautions by experienced surgeons using a standardized open mesh hernioplasty technique with polypropylene mesh. Postoperative monitoring included wound inspection on days 2, 7, 15, and 30, with assessment for signs of SSI based on CDC guidelines. Any suspected infections were confirmed by clinical examination, and in cases of purulent discharge, culture sensitivity tests were performed. Data were analyzed using SPSS version 25. Chi-square test was used to compare categorical variables, and a p-value less than 0.05 was considered statistically significant. The study protocol was approved by the institutional ethics committee.

Results

A total of 120 patients undergoing elective mesh hernioplasty were included in the study and randomly divided into two equal groups: Group A (n=60), which received single antibiotic prophylaxis (ceftriaxone), and Group B (n=60), which received double antibiotic prophylaxis (ceftriaxone and metronidazole). Both groups were comparable in terms of age, sex, BMI, comorbidities, type of hernia, and surgical technique used. Postoperative surgical site infections (SSIs) were assessed over a follow-up period of 30 days.

Table 1: Age Distribution Among Study Participants

Age Group (years)	Group A (n=60)	Group B (n=60)	Total (n=120)
18–30	12 (20.0%)	14 (23.3%)	26 (21.7%)
31–45	22 (36.7%)	19 (31.7%)	41 (34.2%)
46–60	18 (30.0%)	20 (33.3%)	38 (31.7%)
>60	8 (13.3%)	7 (11.7%)	15 (12.5%)

Table 2: Gender Distribution

Gender	Group A (n=60)	Group B (n=60)	Total (n=120)
Male	51 (85.0%)	53 (88.3%)	104 (86.7%)
Female	9 (15.0%)	7 (11.7%)	16 (13.3%)

Table 3: Body Mass Index (BMI) Comparison

Parameter	Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
BMI (kg/m ²)	24.6 ± 2.8	24.1 ± 3.0	0.34

Table 4: Distribution of Comorbid Conditions

Comorbidity	Group A (n=60)	Group B (n=60)	Total (%)
Diabetes Mellitus	10 (16.7%)	9 (15.0%)	19 (15.8%)
Hypertension	14 (23.3%)	12 (20.0%)	26 (21.7%)
COPD	5 (8.3%)	6 (10.0%)	11 (9.2%)

Table 5: Type of Hernia

Type of Hernia	Group A (n=60)	Group B (n=60)	Total (%)
Inguinal	45 (75.0%)	47 (78.3%)	92 (76.7%)
Ventral	15 (25.0%)	13 (21.7%)	28 (23.3%)

Table 6: Incidence of Surgical Site Infections (SSI)

SSI Status	Group A (n=60)	Group B (n=60)	p-value
Infection Present	8 (13.3%)	2 (3.3%)	0.04*
No Infection	52 (86.7%)	58 (96.7%)	

Table 7: Classification of Surgical Site Infections

Type of SSI	Group A (n=8)	Group B (n=2)
Superficial	7 (87.5%)	2 (100.0%)
Deep	1 (12.5%)	0 (0.0%)
Organ/space	0 (0.0%)	0 (0.0%)

Table 8: Microorganisms Isolated from Infected Wounds

Organism Isolated	Group A (n=8)	Group B (n=2)
Staphylococcus aureus	5 (62.5%)	1 (50.0%)
E. coli	2 (25.0%)	1 (50.0%)
Klebsiella spp.	1 (12.5%)	0 (0.0%)

Table 9: Average Duration of Hospital Stay

Group	Mean Stay (Days) $\pm$ SD	p-value
Group A	4.2 $\pm$ 1.1	
Group B	3.1 $\pm$ 0.8	0.01*

Table 10: Management of Surgical Site Infections

Treatment Modality	Number of Cases (n=10)	Percentage (%)
Oral antibiotics only	3	30.0%
IV antibiotics + dressings	6	60.0%
Reoperation	0	0.0%
Mesh removal	0	0.0%

Discussion

Surgical site infections (SSIs) are among the most common postoperative complications, significantly impacting patient recovery, healthcare costs, and hospital stays. Mesh hernioplasty, despite being a clean surgical procedure, carries the risk of infection due to the use of synthetic prosthetic material. The current study aimed to compare the efficacy of single versus double antibiotic prophylaxis in reducing the incidence of SSIs in patients undergoing elective mesh hernioplasty.

In this prospective comparative study involving 120 patients, it was found that the overall incidence of SSIs was significantly lower in the group that received double antibiotic prophylaxis (3.3%) compared to the group that received a single agent (13.3%). This difference was statistically significant ($p = 0.04$), suggesting that the addition of metronidazole to ceftriaxone provided enhanced protection, likely due to broader coverage of anaerobic organisms commonly implicated in postoperative wound infections.

The demographic profiles of both groups were comparable in terms of age, gender, BMI, and comorbidities such as diabetes and hypertension, eliminating baseline confounders. This uniformity

strengthens the credibility of the observed differences in SSI rates.

The most commonly isolated pathogen was *Staphylococcus aureus*, consistent with the literature. However, the presence of *E. coli* and *Klebsiella* in some cases also emphasizes the importance of covering both Gram-positive and Gram-negative flora, particularly in groin surgeries where contamination risk from adjacent areas is higher. The addition of metronidazole may have aided in covering anaerobic bacteria and enteric organisms, possibly accounting for the reduced infection rates in Group B.

Superficial SSIs were the most common type observed. No cases of deep SSI or mesh explantation were reported in either group, indicating effective early detection and management. Most infections responded to conservative treatment with no requirement for reoperation, aligning with previously reported outcomes in clean surgeries with low to moderate SSI risk.

The average hospital stay was longer in patients with SSIs, underscoring the clinical and economic impact of these infections. Early discharge was more achievable in the double prophylaxis group, reinforcing the benefits of better infection control.

Previous studies have presented mixed results regarding the benefit of using dual antibiotic prophylaxis in clean surgeries. While some argue that a single broad-spectrum agent is sufficient, our findings support the growing body of evidence advocating dual-agent prophylaxis in selected high-risk populations, especially in procedures involving mesh implants.

Despite these encouraging results, certain limitations should be acknowledged. The sample size, while reasonable, could be expanded in future multicenter trials for broader validation. Microbiological profiling was limited to aerobic cultures, which may underestimate anaerobic involvement. Also, the study did not assess antibiotic resistance patterns, which are an emerging concern with broader antibiotic use.

In conclusion, this study demonstrates that double antibiotic prophylaxis is more effective than a single agent in reducing SSIs following elective mesh hernioplasty. The findings advocate a protocol shift, particularly in patients at moderate-to-high risk or in settings with elevated infection rates. Nevertheless, antibiotic stewardship remains essential, and future research should also focus on tailoring prophylaxis to individual patient risk profiles and local microbial patterns.

Conclusion

The present study clearly demonstrates that double antibiotic prophylaxis using a combination of Ceftriaxone and Metronidazole is more effective than single antibiotic prophylaxis with Ceftriaxone alone in reducing the incidence of surgical site infections (SSIs) in patients undergoing elective mesh hernioplasty. The double regimen provided broader antimicrobial coverage, significantly lowering the SSI rate from 13.3% in the single antibiotic group to 3.3% in the dual antibiotic group, with statistical significance ($p = 0.04$).

These findings are particularly relevant in clean-contaminated procedures such as hernia repairs involving prosthetic mesh, where even minor infections can complicate postoperative recovery and affect mesh integration. The reduced rate of superficial infections and the absence of deep or organ-space infections in both groups further affirm the effectiveness of preoperative antibiotic administration, particularly when broadened to include anaerobic coverage.

In light of these results, the adoption of dual antibiotic prophylaxis may be considered a prudent approach, especially in patients with additional risk factors for infection or in institutional settings with a higher baseline SSI rate. However, it is equally important to balance the benefits of extended prophylaxis with the growing global concern regarding antimicrobial resistance.

Further large-scale, multicenter, randomized controlled trials are warranted to confirm these findings, evaluate long-term outcomes such as mesh integrity and recurrence, and formulate standardized, cost-effective prophylactic protocols.

References

1. Cai Y, Pan H, Zhang J, Cheng W, Shi Y, Zeng M, Shi L, Yu J, Shen Y, Chen S, Zhu Q, Mol BW, Huang D. Efficacy of adjunctive azithromycin versus single-dose cephalosporin prophylaxis for caesarean scar defect: study protocol for a randomised controlled trial. *BMJ Open*. 2020 Jan 7;10(1):e032379. doi: 10.1136/bmjopen-2019-032379. PMID: 31915163; PMCID: PMC6955559.
2. Brouwer WK, Hoogkamp-Korstanje JA, Kuiper KM. Antibiotic prophylaxis in vaginal hysterectomy. Three doses of cefuroxime plus metronidazole versus one dose of ciprofloxacin. *Pharm Weekbl Sci*. 1990 Dec 14;12(6A):292-4; discussion 294-5. doi: 10.1007/BF01967836. PMID: 2075082.
3. Lacasa JM, Jiménez JA, Ferrás V, Bossom M, Sola-Morales O, García-Rey C, Aguilar L, Garau J. Prophylaxis versus pre-emptive treatment for infective and inflammatory complications of surgical third molar removal: a randomized, double-blind, placebo-controlled, clinical trial with sustained release amoxicillin/clavulanic acid (1000/62.5 mg). *Int J Oral Maxillofac Surg*. 2007 Apr;36(4):321-7. doi: 10.1016/j.ijom.2006.11.007. Epub 2007 Jan 16. PMID: 17229548.
4. Costa RJ, Krauss-Silva L. Revisão sistemática e meta-análise da antibioticoprofilaxia na histerectomia abdominal [Systematic review and meta-analysis of antibiotic prophylaxis in abdominal hysterectomy]. *Cad Saude Publica*. 2004;20 Suppl 2:S175-89. Portuguese. doi: 10.1590/s0102-311x2004000800013. Epub 2004 Dec 15. PMID: 15608932.
5. Esposito S, Leone S, Noviello S, Ianniello F, Marvaso A, Cuniato V, Bellitti F. Antibiotic prophylaxis in hernia repair and breast surgery: a prospective randomized study comparing piperacillin/tazobactam versus placebo. *J Chemother*. 2006 Jun;18(3):278-84. doi: 10.1179/joc.2006.18.3.278. PMID: 17129838.
6. Gall SA, Hill GB. Single-dose versus multiple-dose piperacillin prophylaxis in primary cesarean operation. *Am J Obstet Gynecol*. 1987 Aug;157(2):502-6. doi: 10.1016/s0002-9378(87)80203-x. PMID: 3303944.
7. Roex AJ, Puyenbroek JI, van Loenen AC, Arts NF. Single- versus three-dose cefoxitin prophylaxis in caesarean section: a randomized clinical trial. *Eur J Obstet Gynecol Reprod Biol*. 1987 Aug;25(4):293-8. doi: 10.1016/0028-2243(87)90139-0. PMID: 3308571.
8. 6/0028-2243(87)90139-0. PMID: 3308571.

9. Lindeboom JA, Tuk JG, Kroon FH, van den Akker HP. A randomized prospective controlled trial of antibiotic prophylaxis in intraoral bone grafting procedures: single-dose clindamycin versus 24-hour clindamycin prophylaxis. *Mund Kiefer Gesichtschir.* 2005 Nov;9(6):384-8. doi: 10.1007/s10006-005-0650-4. PMID: 16270222.
10. Kapoor DA, Klimberg IW, Malek GH, Wegenke JD, Cox CE, Patterson AL, Graham E, Echols RM, Whalen E, Kowalsky SF. Single-dose oral ciprofloxacin versus placebo for prophylaxis during transrectal prostate biopsy. *Urology.* 1998 Oct;52(4):552-8. doi: 10.1016/s0090-4295(98)00296-9. PMID: 9763070.
11. McGregor JA, Phillips LE, Roy S, Dunne JT, Warwaruk AS, Johnston DW, Yuzpe AA, Hemsell DL. Results of a double-blind, placebo-controlled clinical trial program of single-dose ceftizoxime versus multiple-dose cefoxitin as prophylaxis for patients undergoing vaginal and abdominal hysterectomy. *J Am Coll Surg.* 1994 Feb;178(2):123-31. PMID: 8173721.
12. Vehreschild JJ, Moritz G, Vehreschild MJ, Arenz D, Mahne M, Bredenfeld H, Chemnitz J, Klein F, Cremer B, Böll B, Kaul I, Wassmer G, Hallek M, Scheid C, Cornely OA. Efficacy and safety of moxifloxacin as antibacterial prophylaxis for patients receiving autologous haematopoietic stem cell transplantation: a randomised trial. *Int J Antimicrob Agents.* 2012 Feb;39(2):130-4. doi: 10.1016/j.ijantimicag.2011.10.009. Epub 2011 Dec 12. PMID: 22169408.
13. Thomas R, Alvino P, Cortino GR, Accardo R, Rinaldo M, Pizzorusso M, Cesareo E, D'Aiuto G. Long-acting versus short-acting cephalosporins for preoperative prophylaxis in breast surgery: A randomized double-blind trial involving 1,766 patients. *Chemotherapy.* 1999 May-Jun;45(3):217-23. doi: 10.1159/000007186. PMID: 10224345.
14. Kauer FM, Wijma J, Manson WL. Vaginal hysterectomy: cefuroxime, metronidazole or both? *Pharm Weekbl Sci.* 1990 Dec 14;12(6A):284-8. doi: 10.1007/BF01967834. PMID: 2075080.
15. Kriaras I, Michalopoulos A, Michalis A, Palatianos G, Economopoulos G, Anagnostopoulos C, Geroulanos S. Antibiotic prophylaxis in cardiac surgery. *J Cardiovasc Surg (Torino).* 1997 Dec;38(6):605-10. PMID: 9461266.
16. Schimmer C, Özkur M, Sinha B, Hain J, Gorski A, Hager B, Leyh R. Gentamicin-collagen sponge reduces sternal wound complications after heart surgery: a controlled, prospectively randomized, double-blind study. *J Thorac Cardiovasc Surg.* 2012 Jan;143(1):194-200. doi: 10.1016/j.jtcvs.2011.05.035. Epub 2011 Aug 31. PMID: 21885068.
17. Carrel TP, Eisinger E, Vogt M, Turina MI. Pneumonia after cardiac surgery is predictable by tracheal aspirates but cannot be prevented by prolonged antibiotic prophylaxis. *Ann Thorac Surg.* 2001 Jul;72(1):143-8. doi: 10.1016/s0003-4975(01)02669-8. PMID: 11465169.
18. Gagey O, Doyon F, Dellamonica P, Carsenti-Etessé H, Desplaces N, Tancrede C, Evrard J. Prophylaxie des infections dans les fractures ouvertes de jambe. Comparaison entre une dose de péfloxacin et 5 jours cefazoline-oxacilline. Etude randomisée sur 616 cas [Infection prophylaxis in open leg fractures. Comparison of a dose of pefloxacin and 5 days of cefazolin-oxacillin. A randomized study of 616 cases]. *Rev Chir Orthop Reparatrice Appar Mot.* 1999 Jul;85(4):328-36. French. PMID: 10457551.