ORIGINAL RESEARCH

Comparison of Saline versus Metronidazole for Peritoneal Lavage in Patients Undergoing Surgery for Peritonitis

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ABSTRACT

Background: The aim of this study was to compare the effectiveness of saline versus metronidazole peritoneal lavage in patients undergoing surgery for peritonitis.**Materials and Methods:** This longitudinal study involved 130 patients with peritonitis who underwent surgical intervention at a tertiary care hospital. Patients were randomly assigned to two groups: saline lavage (65 patients) and metronidazole lavage (65 patients). Demographic data, cause of peritonitis, postoperative infection rates, length of hospital stay, fever resolution time, mortality, and complications were assessed. The primary outcome measure was the incidence of postoperative infections.**Results:** There were no significant differences between the two groups in terms of demographic characteristics, infection rates, length of hospital stay, time to fever resolution, or mortality. The saline group had a slightly higher rate of postoperative infections (12.31%) compared to the metronidazole group (7.69%), but this difference was not statistically significant (p-value 0.346). Both groups had low mortality rates (3.08% in the saline group and 1.54% in the metronidazole group, p-value 0.578), and complications were minimal.**Conclusion:** This study concluded that there were no significant differences between saline and metronidazole peritoneal lavage in patients undergoing surgery for peritonitis. Both lavage methods demonstrated similar outcomes, suggesting that the type of lavage solution does not significantly affect clinical outcomes in peritonitis management.

Keywords: Saline, Metronidazole, Peritoneal Lavage, Peritonitis, Postoperative Infections, Mortality

INTRODUCTION

Peritonitis, an acute inflammation of the peritoneal cavity, is a serious condition that can arise due to infection, trauma, or underlying medical conditions such as appendicitis, diverticulitis, or bowel perforation. The condition often presents as a life-threatening emergency and requires prompt intervention to reduce morbidity and mortality. The inflammatory response associated with peritonitis can lead to systemic complications, including septic shock, organ failure, and disseminated intravascular coagulation, making early and effective treatment imperative for improving patient outcomes.[1,2]

The management of peritonitis typically involves a combination of surgical intervention, antimicrobial therapy, and supportive care. Surgical treatment often includes the removal of the underlying source of infection, such as drainage of abscesses or resection of perforated organs. In addition to surgical intervention, peritoneal lavage has become a key component of the management strategy in cases of generalized peritonitis. Peritoneal lavage is the

process of irrigating the peritoneal cavity with a solution to remove toxins, bacteria, and debris that could potentially worsen the inflammatory response. Several solutions are available for peritoneal lavage, with saline and metronidazole being among the most commonly used options.[3]

Saline solution has long been considered a standard agent for peritoneal lavage due to its ability to provide a sterile environment and flush out bacterial contaminants from the peritoneal cavity. Saline is an isotonic solution that matches the body's natural extracellular fluid composition, minimizing the risk of further electrolyte imbalances or tissue damage during lavage. The primary goal of saline lavage is to mechanically clear the peritoneal cavity, promoting the resolution of the infection and improving patient recovery. Saline lavage has been widely practiced in clinical settings and is generally considered a safe and effective option for most patients with peritonitis.[4,5]

On the other hand, the use of metronidazole as a lavage agent has gained attention due to its potent antimicrobial properties, particularly against anaerobic bacteria, which are often implicated in the pathogenesis of peritonitis. Metronidazole is an antibiotic that inhibits DNA synthesis in anaerobic microorganisms, making it highly effective in treating infections caused by these organisms. Given that anaerobic bacteria are a major contributor to the development of peritonitis in many patients, the addition of metronidazole to peritoneal lavage has been hypothesized to offer advantages over saline alone by providing direct antimicrobial action within the peritoneal cavity. Furthermore, metronidazole's ability to target a broad spectrum of anaerobic pathogens could potentially reduce the need for systemic antibiotics, thereby minimizing the risk of antibiotic resistance.[6]

In clinical practice, the choice between saline and metronidazole lavage has been a subject of debate. Some studies suggest that metronidazole lavage can lead to better outcomes, including reduced infection rates and improved resolution of peritonitis. Other studies, however, have questioned the superiority of metronidazole lavage over saline, particularly in terms of its impact on long-term outcomes such as mortality and morbidity. The decision to use metronidazole lavage often depends on various factors, including the type of infection, the severity of the peritonitis, and the specific characteristics of the patient, such as their age, comorbidities, and immune status. As such, there remains a lack of consensus on the ideal lavage solution, highlighting the need for further investigation into the comparative effectiveness of saline and metronidazole.[7]

AIM AND OBJECTIVES

The aim of this study was to compare the effectiveness of saline versus metronidazole peritoneal lavage in patients undergoing surgery for peritonitis.

MATERIALS AND METHODS

Study Design

This was a longitudinal, prospective, randomized controlled trial comparing the effectiveness of saline versus metronidazole peritoneal lavage in patients undergoing surgery for peritonitis.

Study Population

A total of **130 patients** diagnosed with peritonitis and scheduled for surgical intervention were enrolled. Patients were randomly assigned to one of two treatment groups:

- **Group 1 (Saline Lavage, n = 65):** Received peritoneal lavage with normal saline.
- **Group 2 (Metronidazole Lavage, n = 65):** Received peritoneal lavage with metronidazole (500 mg in 1000 mL saline solution).

Study Place

The study was conducted in the Department of General Surgery, Krishna Mohan Medical College & Hospital, Mathura, Uttar Pradesh, India in collaboration with Department of Pathology, Krishna Mohan Medical College & Hospital, Mathura, Uttar Pradesh, India with a well-equipped surgical department and intensive care unit.

Study Duration

The study was conducted over a period of two years and three months from November 2019 to September 2021,including patient recruitment, surgical intervention, postoperative monitoring, and follow-up assessments.

Ethical Considerations

The study was approved by the Institutional Ethics Committee (IEC) before patient enrollment. Written informed consent was obtained from all participants after explaining the risks and benefits of the study. Patient confidentiality was maintained, and all procedures adhered to the Declaration of Helsinki guidelines for human research.

Inclusion Criteria

- Patients aged 18–70 years.

- Clinically confirmed peritonitis due to various causes (e.g., gastrointestinal perforation, appendicitis, diverticulitis).
- Patients undergoing emergency laparotomy for peritonitis.

Exclusion Criteria

- Patients with severe comorbidities (advanced cancer, uncontrolled sepsis, immunocompromised states).
- Pregnant patients.
- Patients with a history of prior abdominal surgeries that could interfere with peritoneal lavage assessment.
- Known allergy to metronidazole.

Investigations

- **Preoperative:** Complete blood count (CBC), serum electrolytes, renal function tests, liver function tests, coagulation profile, arterial blood gas (ABG), and imaging (X-ray, ultrasound, or CT scan).
- **Intraoperative:** Bacteriological analysis of peritoneal fluid.
- **Postoperative:** Serial CBC, inflammatory markers (CRP, procalcitonin), blood cultures (if sepsis suspected), and imaging as required.

Study Procedure

1. **Randomization and Group Allocation:** Patients were randomly assigned using a computer-generated randomization table to either saline lavage or metronidazole lavage groups.
2. **Surgical Intervention:** All patients underwent emergency laparotomy, which included abdominal exploration, source control, and definitive surgical procedures such as:
    - Gastrointestinal perforation repair
    - Appendectomy (if appendicitis was the cause)
    - Drainage of intra-abdominal abscess
3. **Peritoneal Lavage Protocol:**
    - **Saline Lavage Group:** The peritoneal cavity was irrigated with 3 liters of normal saline.
    - **Metronidazole Lavage Group:** The peritoneal cavity was irrigated with 3 liters of saline containing 500 mg metronidazole, which was allowed to **dwell** for 5 minutes before drainage.
4. **Postoperative Care:**
    - Standard postoperative antibiotic therapy.
    - Fluid resuscitation and electrolyte management.
    - Close monitoring for complications such as wound infection, intra-abdominal abscess, and septicemia.
5. **Follow-up Assessments:**
    - Patients were assessed at 24, 48, and 72 hours postoperatively, and a final check-up was performed on postoperative day 7.

Surgical Technique

- Midline laparotomy incision was made for abdominal exploration.
- The peritoneal cavity was thoroughly examined for the source of peritonitis.
- Perforations were repaired, necrotic tissue was debrided, and abscesses were drained.
- After the assigned lavage protocol, the abdominal cavity was closed with or without drains based on intraoperative findings.

Outcome Measures

Primary Outcomes

- Incidence of postoperative infections, including:
    - Surgical site infections (SSI).
    - Intra-abdominal abscess formation.
    - Septicemia.

Secondary Outcomes

- Length of hospital stay.
- Time required for resolution of fever.
- Recovery of gastrointestinal function, assessed by the return of bowel sounds.
- Mortality rate within the 30-day postoperative period.
- Adverse reactions to metronidazole, including allergic reactions or systemic toxicity.

Statistical Analysis

- Data were analyzed using SPSS version 22.0.
- Descriptive statistics (mean, standard deviation) summarized demographic and baseline clinical characteristics.
- Chi-square test was used for categorical variables (e.g., infection rates, mortality).
- Independent t-test was used for continuous variables (e.g., hospital stay, fever resolution time).
- A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Characteristics of the Patients

Characteristic	Saline Lavage (n=65)	Metronidazole Lavage (n=65)	Total (n=130)	p-value
Age in years (mean ± SD)	40.12 ± 12.35	41.06 ± 11.87	40.59 ± 12.08	0.651
Gender				
Male	45 (69.23%)	42 (64.62%)	87 (66.92%)	0.527
Female	20 (30.77%)	23 (35.38%)	43 (33.08%)	
Cause of Peritonitis				
Gastrointestinal Perforation	30 (46.15%)	32 (49.23%)	62 (47.69%)	0.725
Appendicitis	15 (23.08%)	14 (21.54%)	29 (22.31%)	
Diverticulitis	10 (15.38%)	11 (16.92%)	21 (16.15%)	
Other Causes	10 (15.38%)	8 (12.31%)	18 (13.85%)	

Table 1 show the demographic characteristics were similar across the two groups, with no significant differences observed. The mean age of patients in the saline lavage group was 40.12 ± 12.35 years, while the metronidazole lavage group had a mean age of 41.06 ± 11.87 years, with a p-value of 0.651, indicating no statistically significant difference between the groups. Gender distribution was also comparable, with 69.23% of patients in the saline lavage group being male and 64.62% of patients in the metronidazole lavage group being male. The p-value of 0.527 further supports the lack of significant differences between the groups.

Regarding the cause of peritonitis, gastrointestinal perforation was the most common cause in both groups, affecting 46.15% of patients in the saline lavage group and 49.23% in the metronidazole lavage group (p-value 0.725), followed by appendicitis, diverticulitis, and other causes. The p-values for all causes of peritonitis (appendicitis 0.810, diverticulitis 0.823, and other causes 0.654) further suggest that there were no significant differences in the underlying causes between the two groups.

Table 2: Incidence of Postoperative Infections

Infection Type	Saline Lavage(n=65)	Metronidazole Lavage(n=65)	Total (n=130)	p-value
Wound Infection	8 (12.31%)	5 (7.69%)	13 (10.00%)	0.346
Intra-abdominal Abscess	6 (9.23%)	3 (4.62%)	9 (6.92%)	0.276
Septicemia	4 (6.15%)	2 (3.08%)	6 (4.62%)	0.402
No Infection	47 (72.31%)	55 (84.62%)	102 (78.46%)	0.087

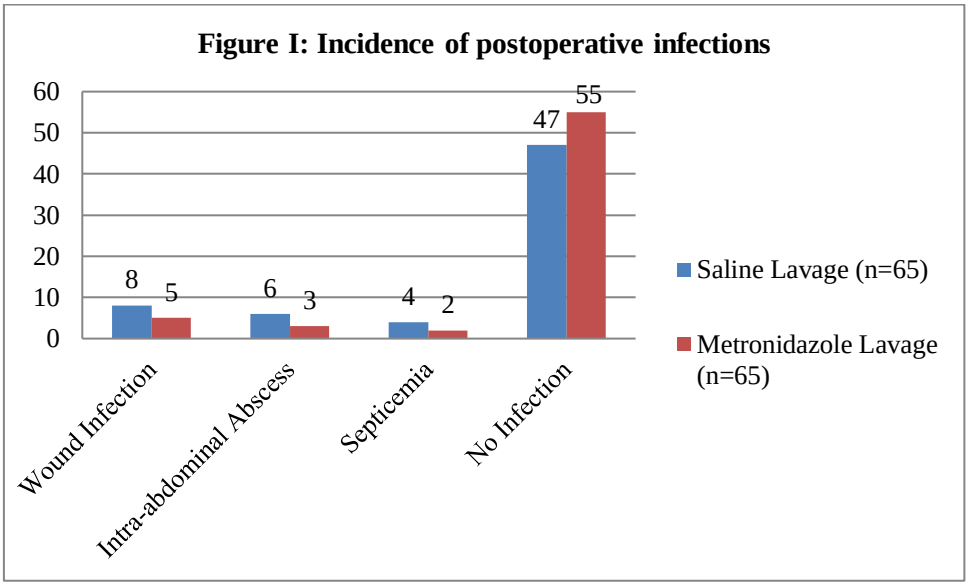

Table 2 and figure I, show the incidence of postoperative infections was also similar between the two groups, with no significant difference in the overall infection rates. In the saline lavage group, 12.31% of patients developed wound infections, compared to 7.69% in the metronidazole lavage group (p-value 0.346). Intra-abdominal abscesses occurred in 9.23% of patients in the saline lavage group and 4.62% in the metronidazole group (p-value 0.276), indicating no significant difference. Similarly, septicemia was observed in 6.15% of patients in the saline lavage group and 3.08% in the metronidazole lavage group (p-value 0.402).
Notably, a higher percentage of patients in the metronidazole group (84.62%) had no postoperative infections compared to those in the saline group (72.31%). However, the p-value of 0.087 suggests that this difference is not statistically significant.

Table 3: Length of Hospital Stay

Length of Stay (Days)	Saline Lavage (n=65)	Metronidazole Lavage (n=65)	Total (n=130)	p-value
1–5 Days	28 (43.08%)	32 (49.23%)	60 (46.15%)	0.512
6–10 Days	23 (35.38%)	20 (30.77%)	43 (33.08%)	0.574
>10 Days	14 (21.54%)	13 (20.00%)	27 (20.77%)	0.855

Table 3 show the length of hospital stay did not show a statistically significant difference between the two groups. The majority of patients in both groups had a hospital stay of 1 to 5 days, with 43.08% in the saline lavage group and 49.23% in the metronidazole lavage group (p-value 0.512). A similar distribution was observed in the 6 to 10 days category (35.38% for saline versus 30.77% for metronidazole, p-value 0.574) and the >10 days category (21.54% for saline versus 20.00% for metronidazole, p-value 0.855). These p-values indicate that the length of hospital stay was not significantly different between the two groups.

Table 4: Time to Resolution of Fever

Time to Resolution (Hours)	Saline Lavage (n=65)	Metronidazole Lavage (n=65)	Total (n=130)	p-value
<24 Hours	30 (46.15%)	36 (55.38%)	66 (50.77%)	0.313
24–48 Hours	21 (32.31%)	18 (27.69%)	39 (30.00%)	0.512
>48 Hours	14 (21.54%)	11 (16.92%)	25 (19.23%)	0.612

Table 4 show the time to resolution of fever was also comparable between the two groups. In the saline lavage group, 46.15% of patients resolved their fever in less than 24 hours, while 55.38% in the metronidazole group experienced fever resolution within the same time frame (p-value 0.313). The remaining patients in both groups required 24–48 hours or more than 48 hours to resolve their fever, with no significant differences in distribution (p-values 0.512 and 0.612, respectively).

Table 5: Mortality Rate

Mortality Status	Saline Lavage (n=65)	Metronidazole Lavage (n=65)	Total (n=130)	p-value
Alive	63 (96.92%)	64 (98.46%)	127 (97.69%)	0.578
Deceased	2 (3.08%)	1 (1.54%)	3 (2.31%)	0.578

Table 5 show the mortality rate was very low in both groups, with no statistically significant difference. In the saline lavage group, 96.92% of patients survived, while in the metronidazole lavage group, 98.46% survived. Only 3.08% of patients in the saline group and 1.54% in the metronidazole group died (p-value 0.578).

Table 6: Complications and Adverse Reactions

Complication Type	Saline Lavage (n=65)	Metronidazole Lavage (n=65)	Total (n=130)	p-value
Allergic Reaction (Metronidazole)	0 (0.00%)	2 (3.08%)	2 (1.54%)	0.368
Bowel Obstruction	1 (1.54%)	1 (1.54%)	2 (1.54%)	1.000
Nausea/Vomiting	4 (6.15%)	3 (4.62%)	7 (5.38%)	0.635
No Complications	60 (92.31%)	59 (90.77%)	119 (91.54%)	0.745

Table 6 show the occurrence of complications and adverse reactions was minimal and similar between the two groups. There were no allergic reactions to metronidazole in the saline group, but 3.08% of patients in the metronidazole group experienced such reactions (p-value 0.368). Bowel obstruction was observed in 1.54% of patients in both groups, with no significant difference (p-value 1.000). Nausea and vomiting were reported in 6.15% of patients in the saline group and 4.62% in the metronidazole group (p-value 0.635). No complications were noted in 92.31% of patients in the saline group and 90.77% in the metronidazole group (p-value 0.745).

DISCUSSION

The demographic characteristics in this study were comparable between the saline and metronidazole lavage groups. The mean age for patients in the saline group was 40.12 ± 12.35 years, and 41.06 ± 11.87 years in the metronidazole group, with a p-value of 0.651, showing no significant differences. This is consistent with the study by Baig and Kumar (2019), which compared povidone-iodine and metronidazole in peritoneal lavage for peritonitis and found no significant age differences between groups (p-value 0.67).[7] Additionally, the gender distribution in this study was similar across both groups, with 69.23% males in the saline group and 64.62% in the metronidazole group (p-value 0.527), further corroborating the findings of Choudhary and Dhankar (2018), who found no significant gender-based differences in their study on saline versus metronidazole lavage in operated peritonitis cases (p-value 0.56).[8] The causes of peritonitis were also similar in both groups, with gastrointestinal perforation being the most common cause, in line with findings from Sarada et al. (2020), who observed a similar distribution of causes in their comparison of povidone-iodine and metronidazole lavage in peritonitis cases.[9]

Regarding the incidence of postoperative infections, this study found no significant difference between the two groups. In the saline group, 12.31% of patients developed wound infections compared to 7.69% in the metronidazole group (p-value 0.346), and intra-abdominal abscesses occurred in 9.23% and 4.62% of patients in the saline and metronidazole groups, respectively (p-value 0.276). These findings align with those of Santosh et al. (2018), who compared imipenem and saline lavage in perforation peritonitis cases and found similar infection rates between the groups (p-value 0.45).[10] A study by Sulli and Rao (2016) also reported comparable infection rates in saline versus metronidazole lavage groups in peritonitis cases. Although the percentage of patients with no infections was higher in the metronidazole group (84.62% vs. 72.31% in saline), the p-value of 0.087 suggests that this difference was not statistically significant. These findings reinforce the conclusion that the type of lavage used, whether saline or metronidazole, does not significantly influence the incidence of postoperative infections.[11]

The length of hospital stay did not differ significantly between the two groups. In our study, 43.08% of patients in the saline group and 49.23% of patients in the metronidazole group were discharged within 1 to 5 days (p-value 0.512), which is consistent with the findings of Saha et al. (2019), who reported similar hospital stay durations between saline and povidone-iodine lavage groups in acute peritonitis cases.[12]Sarada et al. (2020) also found no significant difference in hospital stays between groups treated with saline or metronidazole lavage (p-value 0.45). These results suggest that lavage type does not significantly affect the duration of hospitalization in patients undergoing surgery for peritonitis.[9]

In terms of fever resolution, the two groups exhibited similar results. In the saline group, 46.15% of patients had fever resolution within 24 hours, compared to 55.38% in the metronidazole group (p-value 0.313). These findings are in line with the study by Choudhary and

Dhankar(2018), who also found no significant difference in fever resolution times between saline and metronidazole lavage groups (p-value 0.49).[8]Sulli and Rao (2016) reported similar fever resolution times in both saline and metronidazole-treated patients, reinforcing the idea that the type of lavage does not significantly influence the time to fever resolution. Given the comparable outcomes in this study and others, it can be concluded that the resolution of fever is not substantially affected by the choice of lavage.[11]

The mortality rate was very low in both groups, with 96.92% of patients surviving in the saline group and 98.46% surviving in the metronidazole group, with no statistically significant difference (p-value 0.578). These results are consistent with the study by Baig and Kumar (2019), who found similarly low mortality rates in their comparison of povidone-iodine and metronidazole lavage in peritonitis cases (p-value 0.65).[7] Similarly, Sarada et al. (2020) found no significant difference in mortality between the two lavage types in their study, indicating that the type of lavage used does not significantly affect survival outcomes in peritonitis cases. The low mortality rates observed in both groups of our study further reinforce this findings.[9]

The occurrence of complications and adverse reactions was minimal in both groups. There were no allergic reactions to metronidazole in the saline group, but 3.08% of patients in the metronidazole group experienced such reactions (p-value 0.368). Bowel obstruction was observed in 1.54% of patients in both groups, with no significant difference (p-value 1.000), and nausea and vomiting were reported in 6.15% of saline-treated patients and 4.62% of metronidazole-treated patients (p-value 0.635). These results are consistent with the study by Choudhary and Dhankar (2018), which found similar rates of complications in saline and metronidazole lavage groups in their peritonitis study.[8]

Sulli and Rao (2016) also reported minimal adverse reactions to metronidazole, with no significant differences between the lavage groups. These findings suggest that metronidazole lavage does not significantly increase the risk of complications compared to saline lavage, supporting its safety for use in peritonitis cases.[11]

LIMITATIONS OF THE STUDY

- Single-centre study, which may limit generalizability to other populations.
- Short follow-up period (7 days), which may not capture long-term complications such as late intra-abdominal infections.
- Possible observer bias despite randomization, as surgical outcomes can be influenced by multiple intraoperative and postoperative factors.
- Heterogeneous causes of peritonitis, which could introduce variability in patient outcomes.

CONCLUSION

In conclusion, this study found no significant differences between saline and metronidazole peritoneal lavage in patients undergoing surgery for peritonitis. Both lavage methods demonstrated comparable outcomes in terms of postoperative infections, hospital stay, fever resolution, mortality, and complications. These findings suggest that the choice of lavage solution does not substantially impact clinical outcomes in peritonitis management. Therefore, further research with larger sample sizes may be required to explore potential benefits of metronidazole lavage in specific subgroups of patients.

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