Original Article

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A Prospective Study on Perforated Peptic Ulcers: Peritoneal Fluid and Its Clinical Relevance to Overall Outcome

Prakash Kumar Sahoo, M.S., Suman Saurav Rout, M.S.

Department of General Surgery, IMS and SUM Hospital, Siksha 'O' Anusandhan, Deemed to be University, Bhubaneswar, Odisha-751003, India.

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Abstract:

Objective: To determine whether the spectrum of microorganisms isolated from the peritoneal fluid in a case of perforated peptic ulcer influences the various post-operative complications and the overall outcome of the patient. Perforated Peptic Ulcers (PPUs) carry the risk of severe complications, and extensive peritoneal contamination is common in India, with a potentially different microbial spectrum compared to Western India. Peritoneal fluid culture may be valuable in predicting patient outcomes.

Material and Methods: The study was conducted in the Post Graduate Department of General Surgery, Institute of Medical Sciences & SUM Hospital, Bhubaneswar, Odisha, India, over 3 years and included 525 patients with generalized peritonitis due to PPUs. Peritoneal fluid collected during surgery was analyzed for microorganisms. Postoperative complications and overall outcomes were correlated with the severity of peritonitis and the isolated microorganisms.

Results: In this series, the incidence of PPUs in males outnumbered females 11.5:1, and delayed presentation (>48 hours) occurred in 42.0% of patients. Peritoneal fluid cultures were positive in 59.0% of samples, with *Escherichia coli* (49.0%) being the most common isolate, followed by *Klebsiella pneumoniae (K. pneumoniae)*, *Citrobacter freundii (C. fruendii)*, *Enterococcus faecalis (E. faecalis)*, and *Candida albicans (C. albicans)*. Culture positivity significantly increased the risk of postoperative complications (odds ratio 6.75 times, p-value<0.05) and the need for critical life support (odds ratio 10.2 times, p-value<0.05).

Conclusion: Peritoneal fluid culture in PPU patients is a crucial investigation, revealing the spectrum of microorganisms and highlighting their impact on disease progression and postoperative outcomes.

Keywords: microbial spectrum and postoperative completion, perforated peptic ulcer (ppu), peritoneal fluid culture

Contact: Suman Saurav Rout, M.S.
Department of General Surgery, IMS and SUM Hospital, Siksha 'O' Anusandhan, Deemed to be University, Bhubaneswar, Odisha 751003, India.
E-mail: docssr1110@gmail.com

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Introduction

Perforated Peptic Ulcers (PPUs) represent a severe complication of peptic ulcer disease (PUD), carrying a potential risk of grave complications[1]. In recent years, hospital admissions and elective surgeries for acid peptic disease have declined with the development of medical therapy[2]. However, the incidence of PPU remains notably high. Various factors, such as age, gender, and co-morbid conditions, *contribute to the risk of morbidity and mortality in PPU cases. Additionally, preoperative shock, a delay in treatment exceeding 24 hours, and the size of the perforation are key predictors of postoperative complications*[3-4].

While lower digestive tract perforations typically involve mixed contamination with both aerobic and anaerobic bacteria, gastroduodenal perforations predominantly yield aerobic isolates in most instances. However, prior research has documented the presence of anaerobic bacteria in PPU cases[5]. Despite this, a significant gap in comprehensive data on microbial profiles in such scenarios remains in India and globally[6]. In India, extensive peritoneal contamination due to PPUs is commonly observed, with microbial profiles differing from those in Western populations[7]. Although the overall incidence of PUD has decreased in recent decades due to its pathogenesis and the widespread use of proton pump inhibitors (PPIs), complication rates have not seen a proportional reduction. Consequently, analyzing peritoneal fluid cultures could provide invaluable insights into anticipating and managing postoperative complications.

Thus, the present study aimed to identify the spectrum of pathogens in contaminated peritoneal fluid following peptic ulcer perforations to discern any distinct microbial patterns. It also aimed to explore whether any specific microbial pattern could influence the complication rate and thus improve the overall outcome.

Material and Methods

This descriptive study was conducted as a prospective observational study at the Post Graduate Department of General Surgery of IMS & SUM Hospital, Bhubaneswar, Odisha, India, over a period of 3 years, and it included 525 patients with generalized peritonitis due to PPUs. All patients were resuscitated and underwent emergency laparotomy.

Inclusion criteria

The inclusion criteria comprise patients who presented with peritonitis caused by perforated peptic ulcers (PPUs). Additionally, all participants provided informed consent for the study.

Exclusion criteria

The exclusion criteria include patients who did not provide informed consent, those diagnosed with primary peritonitis, and individuals presenting with intra-abdominal contamination or peritonitis due to hollow viscus perforation from non-peptic origins. These conditions may interfere with the study outcomes or pose additional risks, warranting their exclusion from participation.

Data collection:

Microbial analysis

The peritoneal fluid collected during surgery was analyzed to identify potential microorganisms, particularly those that may be responsible for contamination during perforated peptic ulcers (PPUs). The isolated fluid was initially processed for Gram staining and aerobic /anaerobic culture. Samples were then promptly cultured in selective and differential media to differentiate the pathogens: neomycin blood agar (NBA), brain heart infusion (BHI) agar, MacConkey agar, and Sabouraud agar for bacterial and fungal cultures. After isolation, samples were further

processed for confirmatory identification using colony morphology, Gram staining, and biochemical tests. The occurrence of post-operative complications and the overall clinical outcomes of the patients were correlated with the severity of peritonitis and the specific microorganisms isolated from the peritoneal fluid.

Statistical analysis:

The analysis of the data was conducted using Statistical Package for the Social Sciences (SPSS) version 22. Descriptive statistics are presented as mean and standard deviation (S.D.). A probability p-value of ≤0.05 was considered statistically significant. Demographic information is reported in terms of frequency and percentage.

Results

Age incidence

In this study, a total of 525 subjects were included, and 396 showed an increase in the incidence of perforated peptic ulcer after the age of 40, accounting for 75.4% of cases. In this study, duodenal ulcer perforation was most commonly observed in the 40–60-year age group. However, it is important to note that perforation can occur at any age.

Sex incidence

Analysis of sex incidence revealed a male predominance, with 483 males and 42 females, for a ratio of 11.5:1. This marked male predominance is consistent with findings from various studies conducted over the past decade.

Associated etiological factors

In this study, several lifestyle and pharmacological factors were observed to contribute to the development and complications of peptic ulcer disease (PUD). Among the patients, 49.1% were smokers, while 44.0% reported regular use of non-steroidal anti-inflammatory drugs (NSAIDs). Additionally, 41.5% consumed alcohol and 38.2% chewed tobacco. A smaller proportion, 14.6%, used bhang or ganja, and 6.8% chewed betel. These factors were significantly associated with the onset and aggravation of PUD and its sequelae. The overall etiological factors, complications, and development of PUD findings are represented in Table 1.

Clinical presentation and assessment

The patients most commonly presented with sharp epigastric pain (96.0%), vomiting (semi-digested and bilious) (94.2%), and abdominal distension (74.0%). Additionally, diffuse abdominal tenderness was observed in 98.8% of patients, while signs of peritonitis, such as rigidity and muscle guarding, were present in 91.4% of patients. A smaller proportion (20.0%) exhibited shock, manifested as hypotension, tachycardia, and reduced urine output.

Table 1 Factors associated with peptic ulcer disease (PUD)

Complication factors	No of cases (out of 525)	Percentage of patients (%)	Association with PUD
Smokers	258	49.1	Highly associated
Regular NSAID use	231	44	Highly associated
Alcohol consumption	218	41.5	Highly associated
Tobacco Chewing	201	38.2	Moderated associated
Bhang or Ganja use	77	14.6	Less associated
Betel chewing	36	6.8	Less associated

NSAID=Nonsteroidal Anti-Inflammatory Drug

Radiological findings

Abdominal X-rays in the erect position revealed pneumoperitoneum in 96.7% of patients. Classic findings included free gas under the right diaphragm and a ground-glass appearance, both indicative of diffuse peritonitis. In the minority of cases, where pneumoperitoneum was not visualized, diagnosis relied on strong clinical suspicion and the exclusion of differential diagnoses.

Operative management

All patients in the study underwent emergency laparotomy under general anesthesia. The peritoneal fluid characteristics documented intraoperatively were as follows: sero-sanguineous in 132 patients (25.1%), bilious in 111 patients (21.1%), and purulent in 282 patients (53.7%). The volume of peritoneal fluid ranged from 500 to 1000 ml. The majority of perforations were located in the duodenum (504 patients; 96.0%), while the remaining 21 patients (4.0%) had gastric ulcers. The median ulcer size was 5.4 mm, with a range of 3 to 20 mm. Notably, 35 perforations (6.6%) were found to be sealed at the time of surgery.

Post-operative complications

Post-operative complications were recorded and are detailed in Table 2. Surgical site infections (SSIs) occurred in 205 patients (39.0%), with 121 patients (23.0%) experiencing wound dehiscence following SSI. Pulmonary infections were observed in 61 patients (11.6%), while burst abdomen, typically occurring on post-operative days 4–5, was noted in 15 patients. Additionally, 67 patients (12.8%) required immediate transfer to critical care after surgery. Sluggish recovery accompanied by septicemic shock affected 49 patients (9.3%), and post-operative mortality was reported in 26 patients (4.9%).

Table 2 Post-operative complications

Postoperative complication	No.	%
Surgical site infection	205	39.0
Wound dehiscence	121	23.0
Pulmonary infections	61	11.6
Burst abdomen	15	2.8
Incisional hernia	55	10.4
Septic shock	49	9.3
Mortality	26	4.9

Peritoneal fluid cultures

Peritoneal fluid cultures were obtained during surgery to assess the extent of intra-abdominal contamination in the 525 patients. The results showed that 322 cases (61.3%) had positive bacterial growth, while 203 cases (38.6%) exhibited no growth after 48 hours of incubation. Among patients who presented after 48 hours of symptom onset (n=219), 192 (87.6%) were culture positive. In contrast, only 52.6% of patients who presented within 24–48 hours had positive cultures, establishing a correlation between delayed presentation and increased culture positivity (Figure 1).

The most frequently isolated organism was *Escherichia coli* (*E. coli*), which was found in 251 cases (49.1%) (Table 3). In many instances, it was present as a single isolate, though it was also detected in combination with *K. pneumoniae*, *E. faecalis*, and *C. albicans*. Other organisms identified included *K. pneumoniae* in 36 cases (6.8%), *E. faecalis* in 9 cases (1.7%), *C. freundii* in 8 cases (1.7%), and *C. albicans* (budding yeast cells) in 18 cases (3.4%). Notably, one sample contained 3 organisms simultaneously: *E. coli*, *E. faecalis*, and *C. albicans*.

Post-operative complications vs. microbiological spectrum

Post-operative complications were significantly influenced by culture positivity, with culture-positive patients being 6.75 times more likely to develop complications

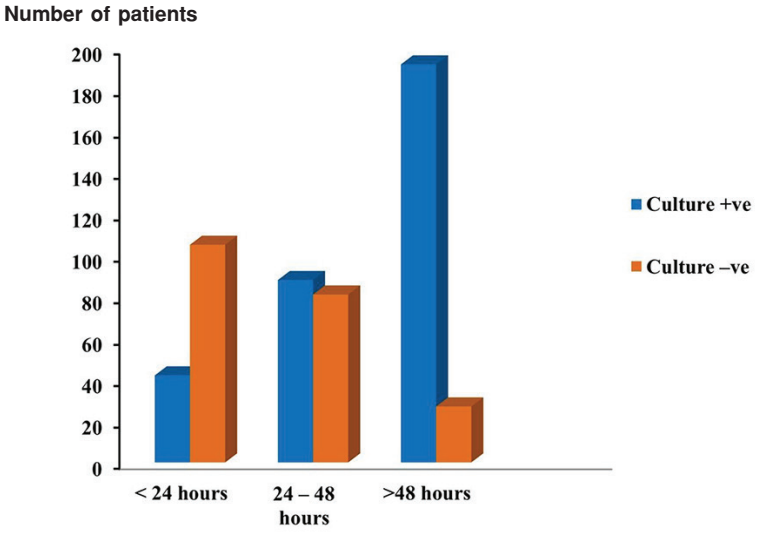

Figure 1 Peritoneal fluid culture in relation to the duration of symptoms

Table 3 Organisms grown from peritoneal fluid

Organism	No.	%
Escherichia coli	251	47.8
Klebsiella pneumoniae	36	6.8
Enterococcus	9	1.7
Citrobacter	8	1.5
Candida albicans (budding yeast cells)	18	3.4

compared to culture-negative patients. Additionally, culture positivity increased the likelihood of requiring critical life support post-operatively by 10.2 times (Figure 2). Among *E. coli*-positive cases (n=86), 56.9% developed surgical site infections, 17.4% developed pulmonary infections, and 12.7% experienced septicemic shock. The post-operative mortality rate in this group was 8.1%, higher than the overall mortality rate of 6.8%. Furthermore, *E. coli* increased the risk of post-operative complications by 3.1 times (p-value<0.0001). Wound cultures confirmed *E. coli* in 39 patients, which was associated with a 17.0% higher incidence of surgical site infections. In *Klebsiella* positive cases (n=12), 33.3% developed life-threatening complications, and a notably high mortality rate of 25.0% was observed in this group. The low frequency of other organisms limited the possibility of conducting statistically significant analyses.

Discussion

Historically, the sex distribution of perforated peptic ulcers has undergone a significant shift. Prior to 1900, perforated ulcers were as common in women as in men[8]. By 1920, this changed dramatically, with only 1 out of every 10 perforations occurring in women. Modifiable risk factors, such as smoking, alcohol intake, NSAID use, and substance abuse, are associated with peptic ulcer disease. The consumption of substances like bhang and betel, although less frequently examined in Western literature, may contribute to gastric mucosal damage and delayed ulcer healing in regional populations. Our findings reflect these trends, with nearly half of the patients identified as smokers, and a similarly high proportion who consume alcohol and NSAIDs.

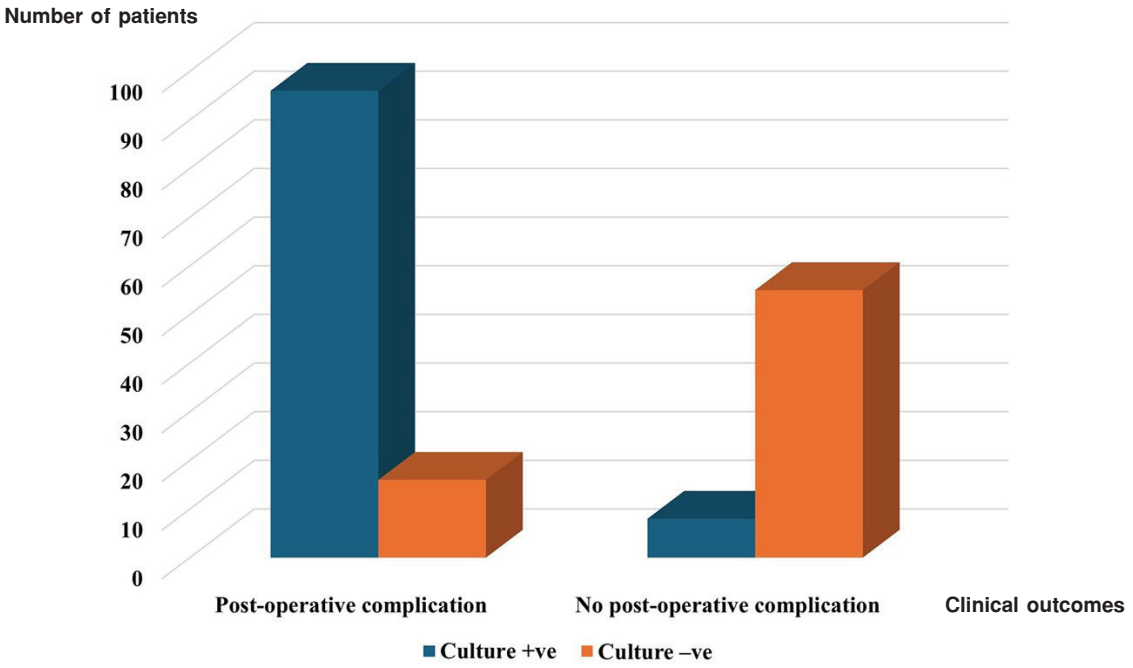

Figure 2 Peritoneal fluid culture vs post-operative complications

In terms of clinical presentation, our findings closely align with previous research. Hannan et al. (2005) reported severe epigastric pain in all patients, with 67.0% experiencing abdominal distension and 19.0% presenting in shock[9]. Chalya et al. (2011) similarly found that 97.6% of patients experienced sudden epigastric pain, 76.2% had distension, and 66.7% showed signs of peritonitis[10]. Our data reinforce these findings, with exceptionally high rates of abdominal tenderness (98.8%) and peritoneal signs (91.4%). The 20.0% incidence of shock at presentation reflects the severity and late-stage nature of many cases. Radiologically, erect abdominal X-rays proved highly valuable in diagnosis, with pneumoperitoneum detected in the vast majority of cases. The presence of free subdiaphragmatic air remains a cornerstone in the detection of perforated ulcers. However, in rare instances, where imaging was inconclusive, diagnosis was made clinically, underscoring the importance of surgical intuition and thorough physical examination in acute settings.

Overall, the pattern of complications observed aligns closely with other studies, reaffirming the importance of rapid surgical intervention, infection control, and robust critical care support in improving patient outcomes. Peritoneal fluid culture results highlight the critical role of intra-abdominal microbial contamination in determining patient outcomes following perforated peptic ulcer surgery. As previous studies by Shinagawa et al. and Greco et al. have shown that organisms such as *E. coli*, *K. pneumoniae*, *S. pneumoniae*, *B. fragilis*, and *C. albicans* are commonly involved in secondary infections post-perforation[11,12]. Our findings corroborate these observations, with *E. coli* being the most commonly isolated pathogen.

A clear trend emerged showing that late presentation (after 48 hours) significantly increased culture positivity (87.6% vs. 52.6%), indicating more severe intra-abdominal contamination. This supports the theory that delayed surgical intervention allows for bacterial proliferation and a heightened inflammatory response, thereby worsening prognosis.

Culture positivity was not only a marker of infection but also a predictor of adverse outcomes. Patients with positive cultures had markedly higher risks of complications and mortality. In particular, *E. coli* was significantly associated with surgical site infections, pulmonary infections, and septicemic shock, resulting in a higher mortality rate. Its presence in wound cultures further reinforced its pathogenic role.

While *K. pneumoniae* was less frequently isolated, its presence carried a high mortality rate (25.0%) and a strong association with life-threatening complications (33.3%), suggesting it may act as an early warning sign for poor outcomes. Although statistical conclusions are limited by sample size, these findings warrant closer clinical attention when such organisms are isolated.

The limited frequency of other organisms like *C. albicans*, *E. faecalis*, and Citrobacter prevented meaningful statistical correlations, though their detection indicates the polymicrobial nature of contamination in advanced cases. The presence of *C. albicans*, especially, may suggest a need to consider antifungal therapy in selected high-risk patients.

Conclusion

Peritoneal contamination from perforated peptic ulcer is common in India, where the spectrum of microorganisms differs from Western countries. Peritoneal fluid culture revealed that the most common organisms introduced into the sterile environment by a perforated ulcer were *E. coli* and *K. pneumoniae*. The findings underscore the risks of microorganisms having a profound influence over post-operative complications and overall outcome. Thus, the influence of contaminated peritoneal fluid on complications in these cases cannot be neglected. Future studies should clarify the exact relationship between the microorganisms and disease progression, and any resulting pre- and post-operative life-threatening conditions.

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Conflict of interest

None.

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