

Comparison of Surgical Outcomes in Perforation Peritonitis Managed by Primary Repair, Diversion, and Staged Laparotomy

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Abstract:

Background: Perforation peritonitis continues to be one of the most frequent and life-threatening surgical emergencies encountered worldwide, particularly in low- and middle-income countries. Despite advances in resuscitation, antimicrobial therapy, anesthesia, and intensive care, postoperative morbidity and mortality remain unacceptably high. The heterogeneity of disease etiology, delayed presentation, degree of peritoneal contamination, and patient physiological reserve contributes to variability in outcomes. Surgical management strategies for perforation peritonitis broadly include primary repair, diversion procedures, and staged laparotomy (damage-control surgery). However, there is no universally accepted consensus regarding the optimal operative approach, and decision-making is often individualized based on intraoperative findings and surgeon discretion. Comparative data evaluating these strategies within a single institutional cohort remain limited.

Objectives: The primary objective of this study was to compare postoperative surgical outcomes among patients with perforation peritonitis managed by primary repair, diversion procedures, and staged laparotomy. Secondary objectives included assessment of postoperative complications, length of hospital stay, need for re-intervention, and mortality, as well as identification of clinical and operative factors predictive of adverse outcomes.

Methods: A retrospective cross-sectional analysis was conducted at a tertiary care teaching hospital over a six-year period. Adult patients who underwent emergency laparotomy for perforation peritonitis were included. Patients were categorized into three groups based on the definitive surgical strategy employed: primary repair, diversion, or staged laparotomy. Demographic characteristics, comorbid conditions, duration of symptoms, clinical severity at presentation, intraoperative findings (site of perforation, extent of contamination), and postoperative course were recorded. Outcomes were analyzed using appropriate statistical methods, and multivariate logistic regression was performed to identify independent predictors of postoperative morbidity and mortality.

Results: A total of 312 patients were analyzed. Primary repair was the most commonly performed procedure in patients presenting early with localized or moderate contamination, whereas diversion and staged laparotomy were predominantly employed in patients with delayed presentation, extensive peritoneal soiling, or physiological instability. The overall postoperative complication rate was significantly lower in the primary repair group compared to diversion and staged laparotomy groups. Patients undergoing staged laparotomy experienced the highest incidence of postoperative complications, including surgical site infection, intra-abdominal sepsis, prolonged ventilatory support, and multi-organ dysfunction. The median length of hospital stay progressively increased from primary repair to diversion and staged laparotomy. Mortality rates were lowest in the primary repair group and highest among patients managed with staged laparotomy. Multivariate analysis identified advanced age, septic shock at

presentation, feculent peritoneal contamination, and staged laparotomy as independent predictors of mortality.

Conclusion: This study demonstrates that primary repair, when performed in carefully selected patients with favorable clinical and intraoperative profiles, is associated with superior surgical outcomes, including reduced postoperative morbidity, shorter hospital stay, and lower mortality. Diversion procedures and staged laparotomy remain essential and often lifesaving strategies in patients with advanced disease and severe physiological compromise; however, these approaches are associated with significantly higher postoperative burden. Early diagnosis, prompt surgical intervention, meticulous intraoperative assessment, and individualized operative strategy selection are critical determinants of outcome in perforation peritonitis.

Keywords: Perforation peritonitis; primary repair; diversion; staged laparotomy; emergency laparotomy; surgical outcomes; retrospective study.

INTRODUCTION

Perforation peritonitis remains one of the most challenging and frequently encountered surgical emergencies worldwide, constituting a major cause of morbidity and mortality despite significant advances in perioperative care. It is defined as inflammation of the peritoneal cavity resulting from perforation of a hollow viscus, leading to contamination by gastrointestinal contents, bacteria, and toxins. The resulting pathological cascade progresses rapidly from localized peritoneal inflammation to generalized peritonitis, systemic inflammatory response syndrome (SIRS), sepsis, septic shock, and ultimately multi-organ dysfunction if not promptly and adequately managed.

The burden of perforation peritonitis is disproportionately higher in low- and middle-income countries, where delayed presentation, limited access to healthcare, malnutrition, and higher prevalence of infectious etiologies such as enteric fever and tuberculosis significantly influence disease severity and outcomes. In contrast, peptic ulcer disease and diverticular perforations predominate in Western populations. This epidemiological variation not only affects clinical presentation but also determines operative decision-making and postoperative outcomes.

From a pathophysiological standpoint, the severity of perforation peritonitis is influenced by several interrelated factors, including the site and size of perforation, duration between perforation and surgical intervention, degree of peritoneal contamination, virulence of microbial flora, and the host's physiological reserve. Prolonged contamination leads to bacterial translocation, endotoxemia, cytokine release, and progressive organ dysfunction. Therefore, timely surgical intervention aimed at source control remains the cornerstone of management.

Surgical treatment of perforation peritonitis has evolved over decades; however, the fundamental principles remain consistent—control of the source of contamination, thorough peritoneal lavage, and restoration or diversion of gastrointestinal continuity. Despite these principles, the optimal operative strategy remains controversial. Surgeons are often faced with the dilemma of choosing between primary repair, diversion procedures, or staged laparotomy, particularly in patients presenting with advanced disease and physiological instability.

Primary repair, involving direct closure of the perforation with or without reinforcement (such as an omental patch), is generally preferred in patients presenting early with minimal to moderate contamination and stable physiological parameters. This approach preserves intestinal continuity, avoids stoma-related morbidity, and is associated with shorter hospital stay and improved postoperative quality of life. However, concerns regarding anastomotic integrity in the presence of sepsis, edema, and poor tissue quality limit its universal applicability.

Diversion procedures, including loop ileostomy or colostomy, are frequently employed in patients with gross contamination, friable bowel, or multiple perforations where primary repair is considered unsafe. While diversion reduces the risk of anastomotic leakage and allows distal bowel rest, it is associated with significant drawbacks such as fluid and electrolyte imbalance, skin complications, psychosocial impact, need for a second surgery for stoma closure, and prolonged hospitalization. These factors contribute to increased overall morbidity and healthcare burden.

Staged laparotomy, also referred to as damage-control surgery, is reserved for patients with severe physiological derangement, septic shock, or overwhelming peritoneal contamination. The initial surgery focuses on rapid source control and contamination limitation, often leaving definitive repair for a subsequent procedure once the patient is physiologically optimized. Although this approach can be lifesaving in critically ill patients, it is associated with high rates of postoperative complications, prolonged intensive care unit stay, increased resource utilization, and substantial mortality. Importantly, outcomes following staged laparotomy are often influenced more by the severity of illness at presentation than by the procedure itself.

Despite the frequent use of these surgical strategies, there is a lack of standardized guidelines dictating the optimal operative approach for perforation peritonitis. Most existing literature focuses on individual procedures or specific etiologies, with limited comparative analyses evaluating all three strategies within a single institutional cohort. Furthermore, variations in patient selection, disease severity, and perioperative care make direct comparisons challenging.

Given these uncertainties, a comprehensive evaluation of surgical outcomes based on operative strategy is essential to guide evidence-based decision-making. Understanding how primary repair, diversion, and staged laparotomy compare in terms of postoperative morbidity, length of hospital stay, need for re-intervention, and mortality can help refine surgical judgment and optimize patient outcomes.

The present study was therefore designed to retrospectively compare surgical outcomes among patients with perforation peritonitis managed by primary repair, diversion procedures, and staged laparotomy at a tertiary care center. By analyzing clinical presentation, intraoperative findings, and postoperative course, this study aims to identify factors influencing outcomes and provide meaningful insights into procedure selection in the management of perforation peritonitis.

MATERIALS AND METHODS

Study Design: This study was conducted as a retrospective cross-sectional observational analysis at a tertiary care teaching hospital with a high-volume emergency general surgery unit. The study design was chosen to evaluate real-world surgical decision-making and outcomes in patients presenting with perforation peritonitis over an extended period. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Study Period: The study included patients operated between January 2018 and December 2023, allowing adequate sample size, temporal variability, and inclusion of changes in perioperative care protocols over time.

Study Population: All adult patients (≥ 18 years) who underwent emergency exploratory laparotomy for perforation peritonitis during the study period were screened for eligibility.

Inclusion Criteria

1. Age ≥ 18 years
2. Clinical, radiological, and intraoperative confirmation of hollow viscus perforation with peritonitis
3. Patients undergoing emergency surgical intervention
4. Availability of complete medical records, including operative notes and postoperative follow-up

Exclusion Criteria

1. Perforations secondary to gastrointestinal malignancy
2. Iatrogenic perforations (endoscopic or surgical)
3. Primary peritonitis without gastrointestinal perforation
4. Patients who expired prior to definitive surgical intervention
5. Incomplete or missing clinical records.

PREOPERATIVE EVALUATION AND RESUSCITATION

1. All patients were initially assessed in the emergency department following Advanced Trauma Life Support (ATLS) and sepsis management principles. Preoperative evaluation included:
2. Detailed clinical examination
3. Vital parameters (heart rate, blood pressure, respiratory rate, oxygen saturation)
4. Laboratory investigations: complete blood count, renal function tests, serum electrolytes, arterial blood gas analysis, serum lactate
5. Radiological assessment using erect chest/abdominal radiographs; contrast-enhanced computed tomography (CECT) of the abdomen was performed where hemodynamic stability permitted
6. Severity of illness was assessed using qSOFA and SOFA scores at admission. Patients were resuscitated with intravenous fluids, broad-spectrum antibiotics, vasopressors when required, and electrolyte correction prior to surgery. Endotracheal intubation and mechanical ventilation were instituted in patients with respiratory compromise or altered sensorium.

OPERATIVE DECISION-MAKING AND GROUP ALLOCATION

The choice of surgical strategy was made intraoperatively by the operating surgeon based on a combination of preoperative clinical status and intraoperative findings. Patients were categorized into three groups based on the definitive operative procedure performed:

Group A – Primary Repair

This group included patients who underwent direct closure of the perforation, with or without omental patch reinforcement. Criteria favoring primary repair included:

1. Single perforation
2. Early presentation (≤ 24 hours from symptom onset)
3. Minimal to moderate peritoneal contamination
4. Viable bowel with acceptable tissue quality
5. Hemodynamic stability or response to resuscitation

Group B – Diversion Procedures

1. Diversion was performed in patients where primary repair was considered unsafe due to:
2. Gross peritoneal contamination
3. Friable or edematous bowel
4. Multiple perforations
5. High risk of anastomotic failure
6. Diversion included loop ileostomy or colostomy, with or without primary repair or limited resection, depending on intraoperative findings.

Group C – Staged Laparotomy

1. Staged laparotomy (damage-control surgery) was employed in patients with:
2. Diffuse feculent peritonitis
3. Septic shock or severe physiological derangement
4. Inability to tolerate prolonged definitive surgery

Intraoperative Assessment

Intraoperative findings documented included:

1. Site and size of perforation
2. Etiology of perforation
3. Degree of peritoneal contamination (serous, purulent, feculent)
4. Number of perforations
5. Presence of bowel edema or ischemia
6. Peritoneal lavage was performed using warm saline in all cases, and abdominal drains were placed as deemed necessary.

Postoperative Management

Postoperatively, patients were managed in surgical wards or intensive care units depending on clinical status. Standardized postoperative care included:

1. Continued broad-spectrum antibiotic therapy
2. Fluid and electrolyte monitoring
3. Early enteral nutrition when feasible
4. Ventilatory support and vasopressors as indicated
5. Monitoring for postoperative complications
6. Stoma care education was provided to patients undergoing diversion, and stoma closure was planned after adequate recovery.

Outcome Measures

Primary Outcome: Postoperative morbidity and mortality within 30 days

Secondary Outcomes: Surgical site infection, Intra-abdominal collections, Anastomotic leak, Need for reoperation, Length of hospital stay, Duration of intensive care unit stay.

Postoperative complications were graded using the Clavien–Dindo classification, with Grade II or higher considered significant.

RESULTS

Study Cohort and Patient Distribution

During the six-year study period, a total of 347 patients underwent emergency laparotomy for suspected perforation peritonitis. After applying exclusion criteria (malignancy-related perforations, iatrogenic injuries, incomplete records), 312 patients were included in the final analysis.

Based on the definitive operative strategy employed, patients were categorized into:

1. Primary Repair Group: 128 patients (41.0%)
2. Diversion Group: 102 patients (32.7%)
3. Staged Laparotomy Group: 82 patients (26.3%)

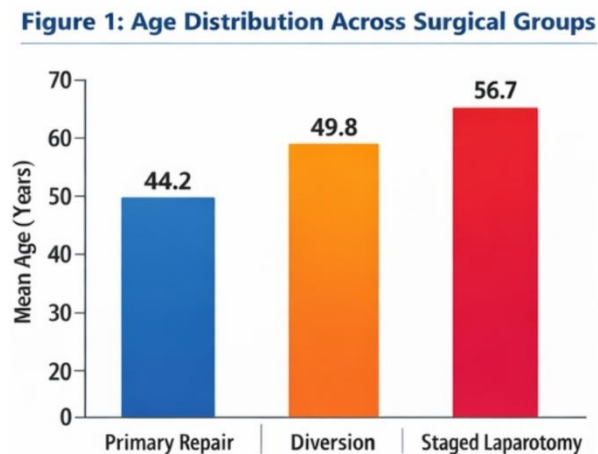
This distribution reflects institutional practice, wherein primary repair was favored in early and physiologically stable presentations, while diversion and staged laparotomy were reserved for advanced disease.

DEMOGRAPHIC AND BASELINE CLINICAL CHARACTERISTICS

The overall mean age of the study population was 46.7 ± 17.2 years (range: 18–86 years). Male predominance was observed (67%), consistent with previously reported epidemiological trends in perforation peritonitis.

Patients undergoing staged laparotomy were significantly older and had a higher burden of comorbidities compared to those managed with primary repair. Delayed presentation (>24 hours from symptom onset) was notably more frequent in the diversion and staged laparotomy groups.

Figure 1: Age distribution across surgical strategy groups



ETIOLOGY AND SITE OF PERFORATION

The most common etiologies of perforation peritonitis included:

1. Peptic ulcer disease – 33%
2. Enteric (typhoid) perforation – 21%
3. Appendicular perforation – 17%
4. Traumatic perforation – 13%
5. Others (tuberculosis, ischemic bowel, nonspecific) – 16%

Small bowel perforations were predominant in the diversion and staged laparotomy groups, whereas gastroduodenal perforations were more frequently managed with primary repair.

Figure 2: Etiological Distribution of Perforation Peritonitis

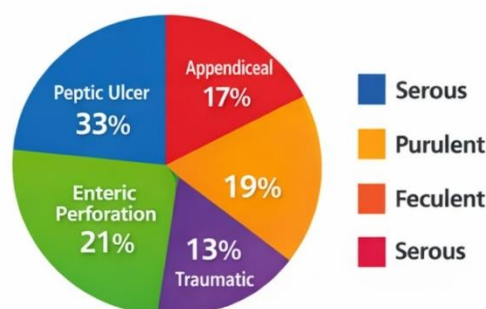


Figure 2: Etiological distribution of perforation peritonitis

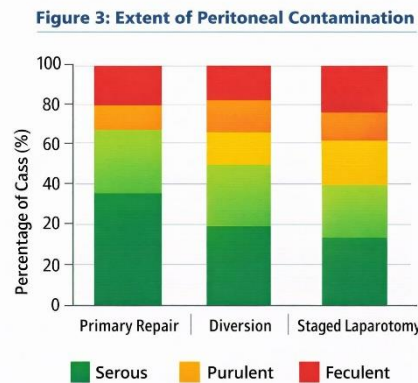
INTRAOPERATIVE FINDINGS

The degree of peritoneal contamination varied significantly among groups:

1. Primary Repair: Predominantly serous or purulent contamination
2. Diversion: Mixed purulent and feculent contamination
3. Staged Laparotomy: Extensive feculent peritonitis in the majority of cases

Multiple perforations and edematous or friable bowel were significantly more common in the diversion and staged laparotomy groups.

Figure 3: Extent of peritoneal contamination by surgical approach



POSTOPERATIVE MORBIDITY

Overall postoperative complications occurred in 42.6% of patients. The incidence of complications differed significantly among surgical strategies:

1. Primary Repair: 32%
2. Diversion: 47%
3. Staged Laparotomy: 61%

The most common postoperative complications included: Surgical site infection, Intra-abdominal collection Prolonged ileus, Respiratory complications, Sepsis and multi-organ dysfunction

Patients undergoing staged laparotomy had a higher incidence of severe complications (Clavien–Dindo Grade III and above), often necessitating re-intervention or prolonged intensive care support.

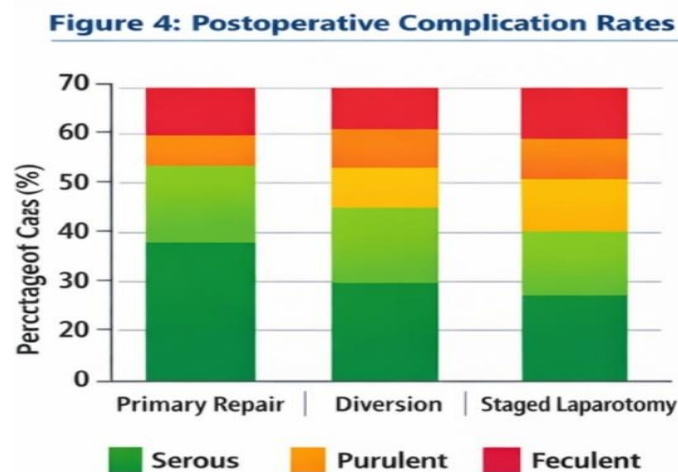


Figure 4: Postoperative complication rates by surgical strategy

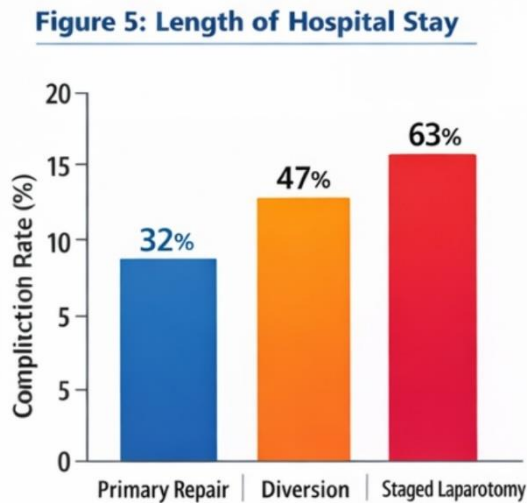
LENGTH OF HOSPITAL STAY AND INTENSIVE CARE REQUIREMENT

The median length of hospital stay increased progressively with the complexity of surgical intervention:

1. Primary Repair: 7 days (IQR 6–9)
2. Diversion: 10 days (IQR 8–14)
3. Staged Laparotomy: 13 days (IQR 11–18)

Similarly, the need for postoperative intensive care and duration of ICU stay were significantly higher in the staged laparotomy group.

Figure 5: Median hospital stay across surgical groups



RE-INTERVENTION AND STOMA-RELATED OUTCOMES

Reoperation rates were lowest in the primary repair group and highest among patients managed with staged laparotomy. Stoma-related complications, including skin excoriation, high-output stoma, and electrolyte imbalance, were observed exclusively in the diversion group and contributed to prolonged hospitalization.

MORTALITY ANALYSIS

The overall 30-day mortality rate was 11.9%. Mortality varied significantly among surgical strategies:

1. Primary Repair: 3.9%
2. Diversion: 12.7%
3. Staged Laparotomy: 22.0%

Mortality in the staged laparotomy group was primarily attributed to refractory sepsis and multi-organ failure.

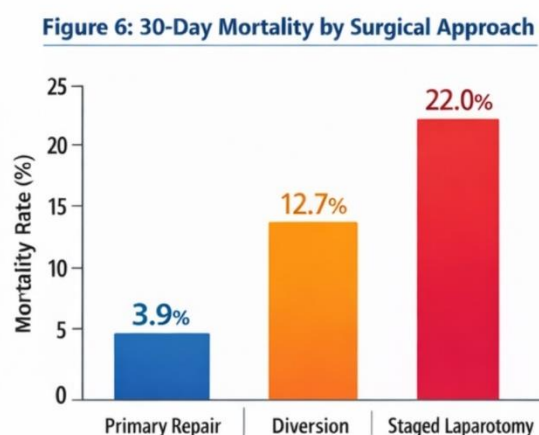


Figure 6: Thirty-day mortality by surgical approach

PREDICTORS OF ADVERSE OUTCOME

On multivariate logistic regression analysis, the following were identified as independent predictors of postoperative mortality:

1. Age > 60 years
2. Septic shock at presentation

3. Feculent peritoneal contamination
4. Requirement of staged laparotomy

The type of surgical procedure remained an independent predictor even after adjusting for severity of illness, underscoring the importance of appropriate procedure selection.

DISCUSSION

Perforation peritonitis continues to pose a formidable challenge to emergency general surgeons, owing to its heterogeneous etiology, variable clinical presentation, and high risk of postoperative morbidity and mortality. The present retrospective cross-sectional analysis provides a comprehensive comparison of surgical outcomes among patients managed by primary repair, diversion procedures, and staged laparotomy, offering valuable insights into procedure selection and outcome determinants in real-world clinical practice.

OVERALL OUTCOME TRENDS

The most important finding of this study is the significantly superior outcomes associated with primary repair when compared to diversion and staged laparotomy. Patients undergoing primary repair demonstrated lower postoperative complication rates, shorter hospital stay, reduced ICU requirement, and markedly lower mortality. These findings are consistent with previously published literature suggesting that early source control with restoration of gastrointestinal continuity yields favorable outcomes in carefully selected patients [1,2].

However, it is essential to emphasize that the improved outcomes seen with primary repair reflect appropriate patient selection rather than procedural superiority alone. Patients in this group generally presented earlier, had less severe contamination, and exhibited better physiological reserve, all of which are well-established determinants of outcome in perforation peritonitis [3].

PRIMARY REPAIR: BENEFITS AND LIMITATIONS

Primary repair remains the preferred surgical option in patients with early presentation, limited contamination, and viable bowel. Preservation of intestinal continuity avoids stoma-related morbidity, electrolyte disturbances, and the need for a second surgery, thereby reducing both patient burden and healthcare costs [4].

Several studies have demonstrated that primary repair, even in selected cases of small bowel and typhoid perforation, is associated with acceptable leak rates and favorable long-term outcomes when meticulous surgical technique and adequate peritoneal lavage are employed [5,6]. The low mortality observed in the primary repair group in the present study aligns with these findings and reinforces the role of primary repair as the first-line strategy in suitable candidates.

Nonetheless, primary repair carries an inherent risk of failure in the presence of severe sepsis, bowel edema, or compromised tissue integrity. Attempting primary repair in such settings may predispose to anastomotic breakdown and catastrophic intra-abdominal sepsis, underscoring the importance of judicious intraoperative decision-making [7].

DIVERSION PROCEDURES: A NECESSARY COMPROMISE

Diversion procedures occupy an intermediate position in the spectrum of surgical strategies for perforation peritonitis. In the present study, diversion was associated with significantly higher morbidity and mortality compared to primary repair but lower mortality than staged laparotomy. These findings suggest that diversion serves as a risk-mitigating compromise in patients where primary repair is unsafe, yet physiological collapse does not mandate damage-control surgery.

The higher complication rates observed in the diversion group can be attributed to several factors. First, diversion was more commonly employed in patients with delayed presentation and gross peritoneal contamination, both of which independently worsen prognosis [8]. Second, stoma-related complications

such as high-output stoma, electrolyte imbalance, skin excoriation, and psychological distress contribute significantly to postoperative morbidity and prolonged hospitalization [9].

Despite these drawbacks, diversion remains a valuable option in the armamentarium of the emergency surgeon. Multiple studies have demonstrated reduced anastomotic leak rates with diversion in high-risk patients, justifying its use in the presence of friable bowel, multiple perforations, or severe contamination [10].

STAGED LAPAROTOMY: MARKER OF DISEASE SEVERITY

Staged laparotomy, or damage-control surgery, was associated with the highest rates of postoperative complications, prolonged ICU stay, and mortality in the present study. Importantly, these outcomes should not be interpreted as a failure of the surgical strategy itself but rather as a reflection of advanced disease severity at presentation.

Patients undergoing staged laparotomy in this cohort frequently presented with septic shock, diffuse feculent peritonitis, and profound physiological derangement. In such scenarios, prolonged definitive surgery is poorly tolerated, and rapid source control with abbreviated operative time becomes imperative [11]. The staged approach allows for physiological stabilization before definitive reconstruction and has been shown to be lifesaving in critically ill patients [12].

Nevertheless, staged laparotomy is associated with significant physiological cost, including ongoing inflammatory response, risk of abdominal compartment syndrome, need for multiple re-explorations, and challenges related to temporary abdominal closure [13]. The high mortality observed in this group underscores the importance of early diagnosis and timely intervention to prevent progression to a stage where damage-control surgery becomes necessary.

ROLE OF SEPSIS AND PERITONEAL CONTAMINATION

Sepsis at presentation emerged as a strong independent predictor of adverse outcomes in this study, consistent with existing literature [14]. The severity of peritoneal contamination—particularly feculent peritonitis—was closely associated with increased morbidity and mortality across all surgical groups. This finding reinforces the concept that the biological insult of contamination often outweighs the technical aspects of surgery in determining outcomes.

Early recognition of sepsis, aggressive resuscitation, prompt antibiotic therapy, and expeditious surgical source control are therefore critical in improving survival in perforation peritonitis [15].

AGE AND COMORBIDITIES

Advanced age was independently associated with increased mortality, reflecting reduced physiological reserve and higher prevalence of comorbid conditions. Elderly patients are more susceptible to sepsis-induced organ dysfunction and often present late with atypical symptoms, further compounding risk [16]. These findings highlight the need for heightened vigilance and individualized surgical planning in older patients.

CLINICAL IMPLICATIONS

The findings of this study have important implications for clinical practice:

Primary repair should be the preferred strategy in early, stable presentations with limited contamination. Diversion procedures are justified in high-risk bowel conditions but should be weighed against stoma-related morbidity.

Staged laparotomy should be reserved for patients with profound physiological compromise, recognizing its association with high mortality.

Early referral, rapid resuscitation, and timely surgical intervention remain the most effective means of improving outcomes.

CONCLUSION

In conclusion, this study demonstrates that primary repair offers the most favorable outcomes in carefully selected patients with perforation peritonitis. Diversion and staged laparotomy remain essential strategies in advanced disease but are associated with increased morbidity and mortality. Optimal outcomes depend on early diagnosis, aggressive resuscitation, and individualized surgical decision-making based on patient physiology and intraoperative findings.

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