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INCIDENCE AND MANAGEMENT OF INTRAOPERATIVE HEMODYNAMIC CHANGES DURING PERFORATED LAPAROTOMY PATIENTS

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Abstract

Introduction: Perforated laparotomy is a potentially dangerous emergency operation that is usually linked to a significant level of physiological unstable conditions sepsis, hypovolemia and metabolic imbalance. These environments precondition patients to severe intraoperative hemodynamic instability, especially hypotension, which may have detrimental effects on organ perfusion and the outcomes after surgery. Perioperative management is thus very critical to minimise the morbidity and mortality.

Methodology: It was a prospective study, observational study involving 120 adult patients (ASA II to ASA III) undergoing emergency perforated laparotomy in a tertiary care hospital. The structured proforma was used to gather data during 4-6 months. Variables were demographics, clinical status, anesthetic care, intraoperative hemodynamic variables, care strategy, and postoperative outcome. The statistical analysis was done through the SPSS version 26. Descriptive statistics, correlation, ANOVA, regression analysis, and independent sample t-tests were used and the level of significance was set to $p < 0.05$.

Findings: The findings indicated that incidence of intraoperative hypotension was high among the patients especially during peritoneal lavage and post-intubation. Hemodynamic instability was found to be strongly associated with sepsis. Anesthetic agent selection had a profound influence on outcome with ketamine and etomidate showing superior results in cardiovascular-stability over propofol and thiopentone. Fluid therapy was not adequate to provide hemodynamic stability and the application of vasopressors was necessary in a high percentage of cases. There were observed significant correlations among clinical condition, intraoperative hemodynamics, management strategies and patient outcomes.

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Conclusion: Intraoperative hemodynamic instability is very common in patients undergoing perforated laparotomy and, it depends on various factors, such as sepsis, anesthetics treatment and interventions during operation. The percent to punctuate patient outcomes with early diagnosis, effective choice of anesthetics, goal-oriented fluid therapy, and early initiation of vasopressors.

Introduction

Perforated laparotomy is an emergency surgical procedure performed to treat gastrointestinal perforations caused by conditions such as peptic ulcer disease, typhoid enteritis, trauma, or malignancy. These perforations lead to peritonitis, sepsis, hypovolemia, electrolyte disturbances, and metabolic acidosis, making anesthesia management particularly challenging. Maintaining intraoperative hemodynamic stability is essential because hypotension and circulatory instability significantly increase the risk of organ hypoperfusion, postoperative complications, and mortality. The primary causes of intraoperative hemodynamic instability include sepsis-induced vasodilation, third-space fluid losses, myocardial depression caused by inflammatory mediators, blood loss, and the cardiovascular effects of anesthetic agents. During induction of anesthesia, commonly used drugs such as propofol may worsen hypotension in already hypovolemic patients, whereas ketamine and etomidate are often preferred because they preserve cardiovascular stability. Continuous monitoring of mean arterial pressure (MAP), heart rate, urine output, and cardiac rhythm is therefore essential throughout the procedure (Smith et al., 2020; Johnson & Lee, 2021). Effective intraoperative management requires adequate preoperative resuscitation with crystalloids, correction of electrolyte and acid-base abnormalities, and the judicious use of vasopressors such as norepinephrine or phenylephrine to maintain tissue perfusion. Invasive monitoring through arterial lines and central venous catheters provides real-time assessment of preload, afterload, and cardiac performance, although non-invasive monitoring remains valuable in resource-limited settings. Temperature management, controlled ventilation, and individualized

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fluid therapy also contribute significantly to maintaining hemodynamic stability (Brown et al., 2019; Evans et al., 2021).

The literature also highlights the importance of understanding the underlying pathophysiology of peritoneal contamination, third-space fluid loss, coagulation disorders, and electrolyte imbalances in patients undergoing perforated laparotomy. Conditions such as hypokalemia, hypomagnesemia, and coagulopathy increase the likelihood of arrhythmias, bleeding, and cardiovascular instability. Furthermore, appropriate anesthetic depth is critical, as excessive anesthesia may cause profound hypotension while inadequate anesthesia can increase the physiological stress response (Miller et al., 2020; Gupta & Singh, 2022).

Despite advances in anesthesia, critical care, and surgical techniques, emergency perforated laparotomy continues to carry a high mortality rate, particularly in low- and middle-income countries where delayed presentation and limited monitoring resources are common. The reviewed literature identifies important gaps regarding the incidence, pattern, and management of intraoperative hemodynamic changes in South Asian populations. Therefore, the present study aims to determine the incidence of these hemodynamic changes and evaluate the effectiveness of current intraoperative management strategies to improve patient outcomes during perforated laparotomy (Kumar et al., 2021; World Society of Emergency Surgery, 2023).

Materials and Methods

This study was a prospective observational study conducted at Chaudhry Muhammad Akram Teaching and Research Hospital, Lahore, over a period of 4–6 months. Adult patients aged 18–65 years undergoing emergency perforated laparotomy with ASA physical status II–III were included through a non-probability convenience sampling technique. Patients with severe cardiac, renal, liver, coagulation disorders, uncontrolled hypertension, or refractory shock were excluded. Written informed consent was obtained from all participants or their legal attendants before enrollment.

The study aimed to assess intraoperative hemodynamic instability during perforated laparotomy. The primary outcome was the incidence of hypotension, defined as a reduction in mean arterial

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pressure (MAP) of more than 20% from baseline or an absolute MAP below 65 mmHg. Secondary outcomes included the volume of crystalloids administered, cumulative vasopressor requirements, and the occurrence of critical hemodynamic events during surgery. Data were collected using a structured proforma containing demographic details, preoperative findings, anesthetic information, and serial hemodynamic measurements.

Data collection was performed in four phases: baseline assessment before induction, induction and intubation, intraoperative maintenance, and postoperative transition to the recovery area. Hemodynamic variables, including MAP, heart rate, and oxygen saturation, were recorded at predetermined intervals using standard monitoring equipment. The collected data were analyzed using SPSS version 26. Continuous variables were presented as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Statistical significance was determined using the Student's t-test and Chi-square test with a p-value of less than 0.05.

The study followed appropriate ethical principles throughout the research process. Patient confidentiality was maintained by using anonymous identification numbers instead of personal information, and the observational nature of the study ensured that routine clinical management was not affected. Participation was entirely voluntary, informed consent was obtained before inclusion, and no emergency surgical procedures or life-saving interventions were delayed or altered because of the research.

Results

The results of carried out to assess the occurrence and treatment of intraoperative hemodynamic fluctuations in individuals undergoing perforated laparotomy. A total of 120 patients were used to acquire the data collected and interpreted under SPSS version 26.0. The data were also interpreted both descriptively and inferentially to make a systematic and meaningful interpretation. First, a summary of the demographic and clinical features of the study population was made through the methods of descriptive statistics (age, gender, ASA status, and the clinical condition of the population at baseline).

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Categorical variables frequencies and percentages and computed variables means and standard deviations were computed to express a summary of the patient's distribution and variability. After that, bar charts, pie charts and clustered bar charts were used to illustrate in graphical form the distribution of such key variables like the incidence of hypotension, timing of hemodynamic alterations, the use of anesthetic and fluid management, and postoperative outcomes. These graphical representations were useful in determining trends and patterns in the data. Statistical tests (inferential) were done to compare and identify relationships between variables. One used chi-square tests and independent sample t-tests to assess the associations between categorical and continuous variables, respectively. The correlation and regression were performed to identify the strength and direction of association between clinical condition, anesthetic management, intraoperative hemodynamic changes, management strategies and patient outcomes. The findings are discussed in an organized manner that suits the research aims and objectives to offer a detailed picture about the factors affecting intraoperative hemodynamic stability and post operation recovery to the perforated laparotomy patients.

The t-test assumptions are valid since the results of the Levene test show that all variables have equal variances ($p > 0.05$). The results, in general, indicate that the clinical conditions and intraoperative difficulties of female patients were heavier.

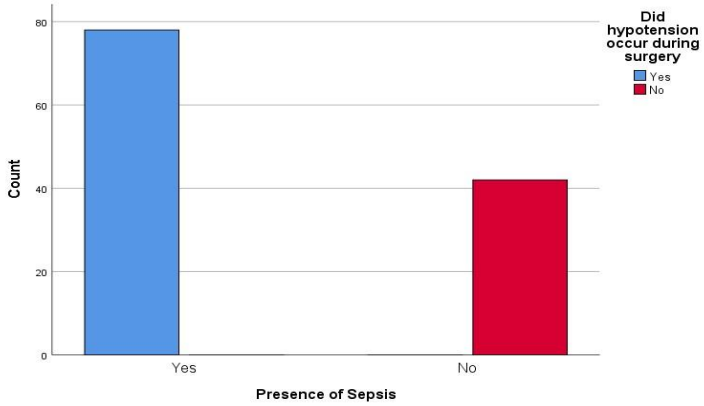

Figure 1: Bar chart of Presence of Sepsis

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The clustered bar graph enables determination of the relationship between presence of sepsis and intraoperative hypotension. Patients with sepsis were shown to have a significantly greater rate of hypotension than non-sepsis. Hypotensive episodes were less common among the patients who did not have sepsis. This trend implies that sepsis is closely related to hemodynamic instability in the operating room, and thus, patients with septic shock should be highly monitored and vigorously stabilized.

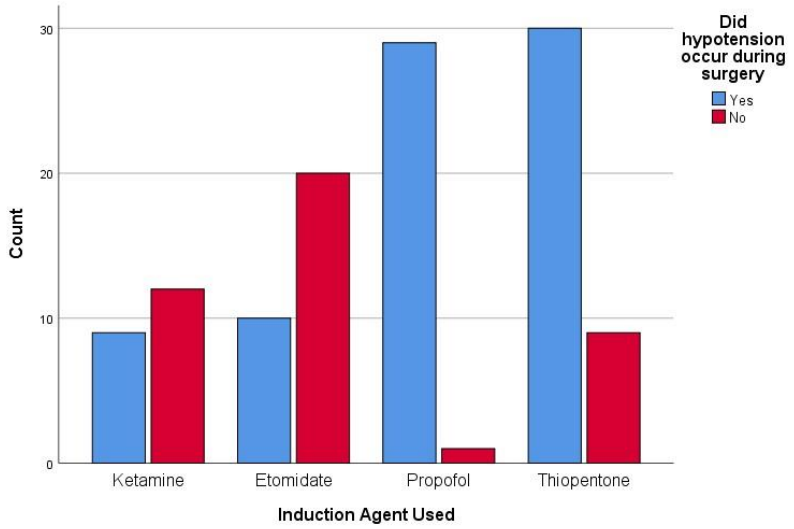

Figure 2: Bar chart of Induction Agent Used

The bar chart of the induction agents with the incidence of the intraoperative hypotension is clustered. Advanced age patients who were given propofol and thiopentone showed the most prevalence of hypotension, which implies that these two drugs are more hemodynamically unstable than others. Ketamine and etomidate were not linked to an increased number of hypotensive events, which indicated superior cardiovascular stability. The patients with no hypotension were found to be higher in the ketamine and etomidate groups. These results suggest that the induction agent type plays a significant role in determining the intraoperative hemodynamics.

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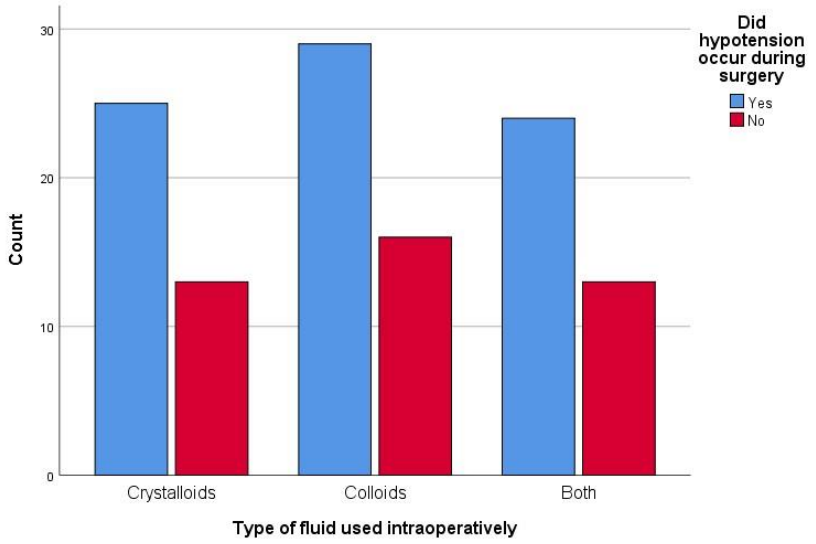

Figure 3: Bar chart of Type of fluid used intraoperatively

The bar chart can be seen as clustered showing the correlation between the type of fluid applied during intra-operative period and the incidence of hypotension. Higher number of hyposensitive cases was recognized in all the types of fluids with highest frequency being colloids followed by crystalloids and combined use. Hypotension was observed in all groups however the rates of patient not experiencing hypotension were relatively low. These results imply that the prevention of intraoperative hypotension by fluid type alone may not be complete, which underscores other programs to be used to combat this condition, including vasopressors and close monitoring.

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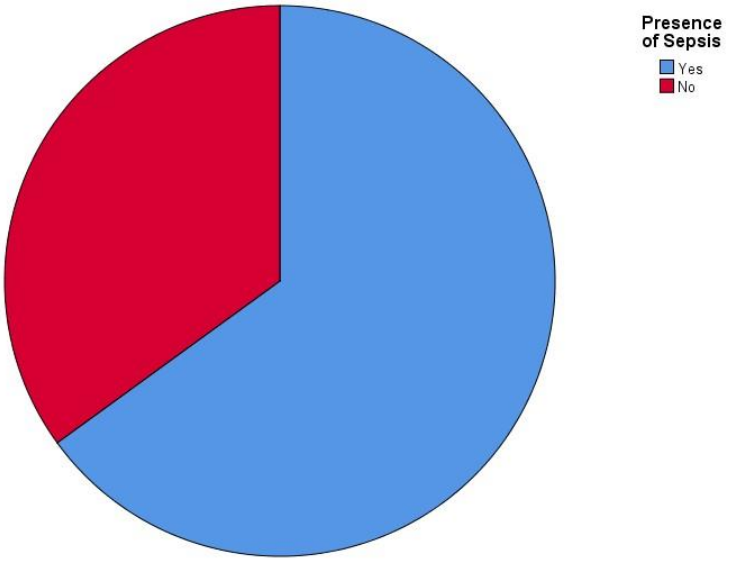

Figure 4: Pie chart of Presence of Sepsis

The pie chart demonstrates the proportion of patients in relation to the occurrence of sepsis. A greater percentage of patients fell under the category of septic than those with no sepsis and this implies that majority of patients with perforated laparotomy came in with systemic infection. The finding shows the severe state of the study population since sepsis is a significant contributing factor to hemodynamic instability. The vast occurrence of sepsis underscores why patients need special attention in the perioperative management and close surveillance during an operation.

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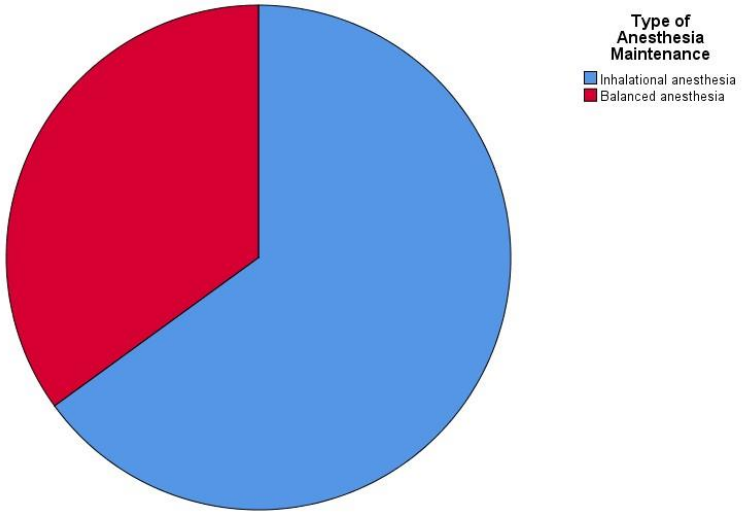

Figure 5: Pie chart of Type of Anesthesia Maintenance

The pie chart represents the breakdown of type of anesthesia maintenance applied when performing surgery. Higher rates of patients were exposed to inhalational anesthesia, with lower percentages being dealt with through balanced anesthesia. It suggests that inhalational methods are preferred in the study setting, probably because of their availability and pattern of clinical practices. The results indicate that inhalational anesthesia is the most widely used method, but the application of balanced anesthesia indicates the attempts to stabilize the hemodynamics in patients and achieve the best results.

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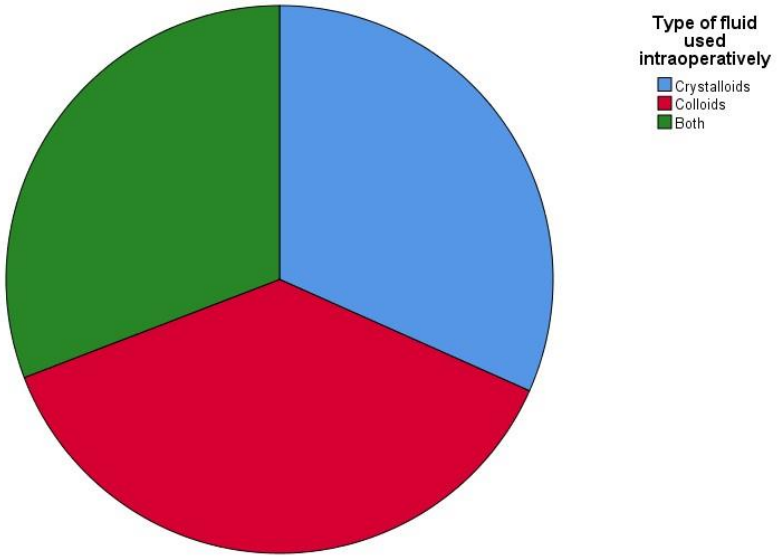

Figure 6: Pie chart of Type of fluid used intraoperatively

The pie chart is used to show the distribution of the types of intraoperative fluids used in surgery. The biggest percentage was colloids then crystalloids, with a slightly lower percentage being mixed with a combination of both. It means that they prefer it to be used in the colloidal form in the study environment, probably because of its functions in preservation of intravascular volume. The high incidence of crystalloids and combined therapy demonstrates an even-handed response to fluid management with the goal of ensuring a high hemodynamic stability in the perforated laparotomy.

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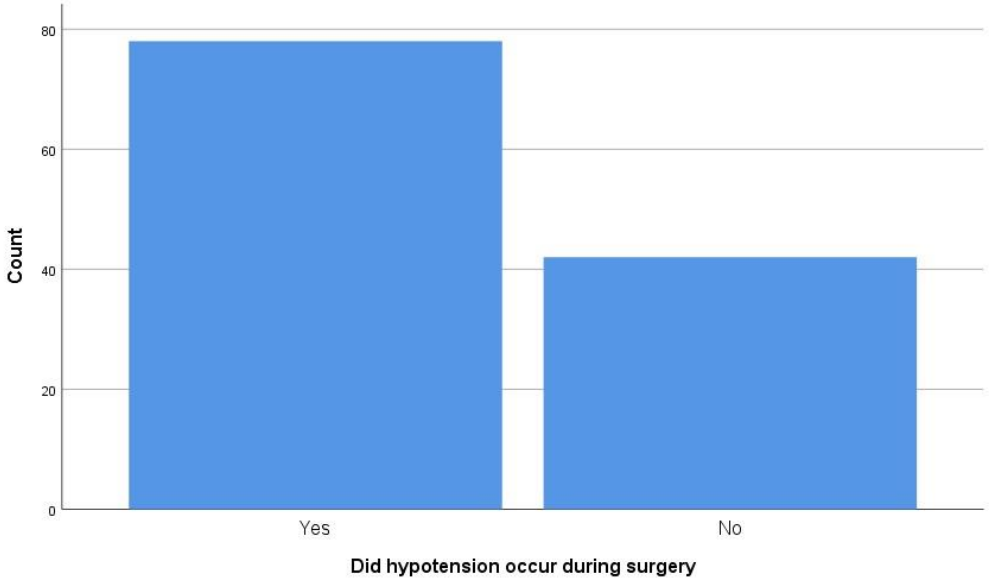

Figure 7: Bar chart of Did hypotension occur during surgery

The bar chart shows the incidence of intraoperative hypotension in the participants in the study. Largely more patients suffered hypotension during surgery than those who did not. This implies that hypotension is a frequent complication of patients who have undergone perforated laparotomy. The fact that hypotensive episodes are high in number means that intraoperative monitoring and proper management at the earliest time through the use of proper fluid therapy and vasopressors are necessary to alleviate hemodynamic stability and surgical outcomes.

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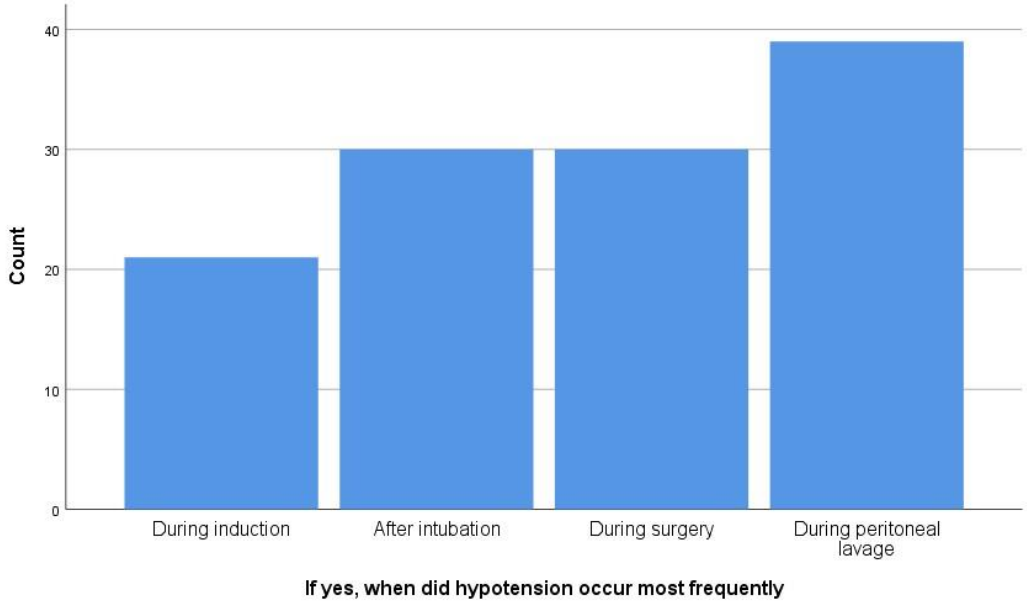

Figure 8: Bar chart of If yes when did hypotension occur most frequently

The bar chart as the times of intraoperative hypotension in different stages of the surgery. Hypotension was most common during peritoneal lavage, next is the occurrence after intubation and surgery with the least frequency being during induction. This trend implies that surgical manipulation especially lavage plays a major role in causing hemodynamic instability. The results emphasize the important periods during which it is necessary to closely monitor and timely interfere to avoid severe hypotensive events and guarantee patient safety in case of perforated laparotomy.

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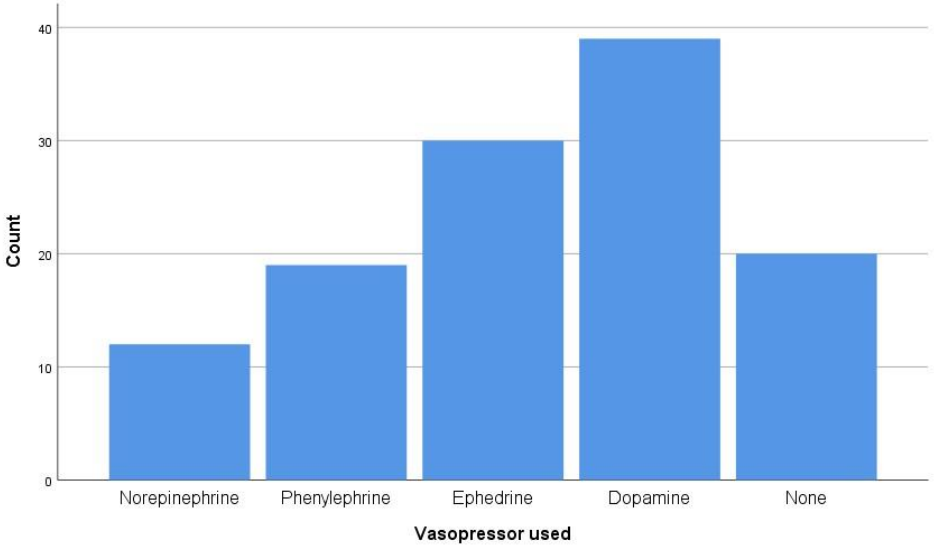

Figure 9: Bar chart of Vasopressor used

The bar chart shows the rate of vasopressors utilized in surgery. The most commonly used agent was dopamine followed by ephedrine and phenylephrine whereas norepinephrine was rarely used. Many patients did not need any vasopressor. The trend is an indication that clinical practice and needs of patients are not consistent, and dopamine is likely to be the preferred one in this context. The study findings underscore the need to choose the right vasopressors as determined by hemodynamic conditions to achieve stability intraoperatively.

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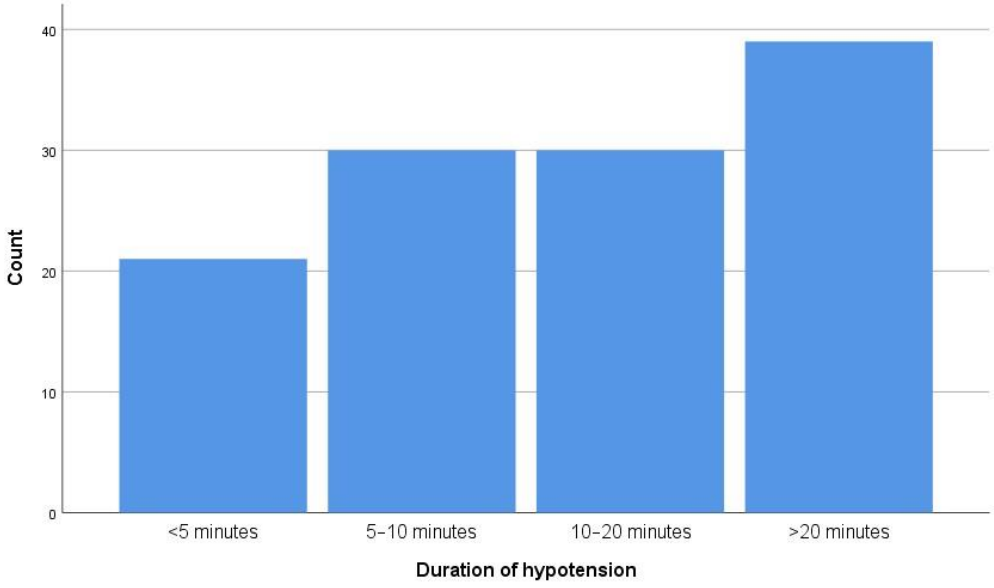

Figure 10: Bar chart of Duration of hypotension

The bar chart shows the period of intraoperative hypotension of patients. The most cases had the duration of more than 20 minutes hypotension followed by 5-10 minutes and 10-20 minutes respectively, and the fewest were less than 5 minutes. This shows that the hypotension was prevalent throughout the surgery. This leads to the probability of an organ hypoperfusion and complicates the postoperative period and the importance of prompt intervention and efficient hemodynamics regulation.

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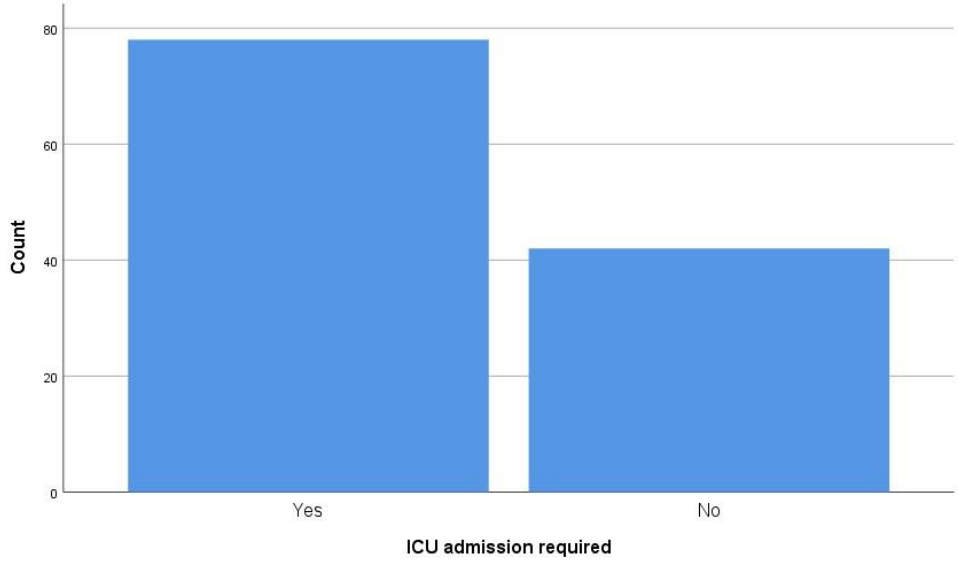

Figure 11: Bar chart of ICU admission required

As depicted in the bar chart, a low percentage of patients did not need ICU admission as opposed to those who needed it. This implies that the majority of the patients subjected to perforated laparotomy were in a critical situation that demanded intensive postoperative care and attention. The severity of intraoperative hemodynamic instability and complications can be assessed by the high level of ICU admission. These results underline the importance of proper ICU provisions and attentive perioperative care to enhance patient outcomes and lessen postoperative risks.

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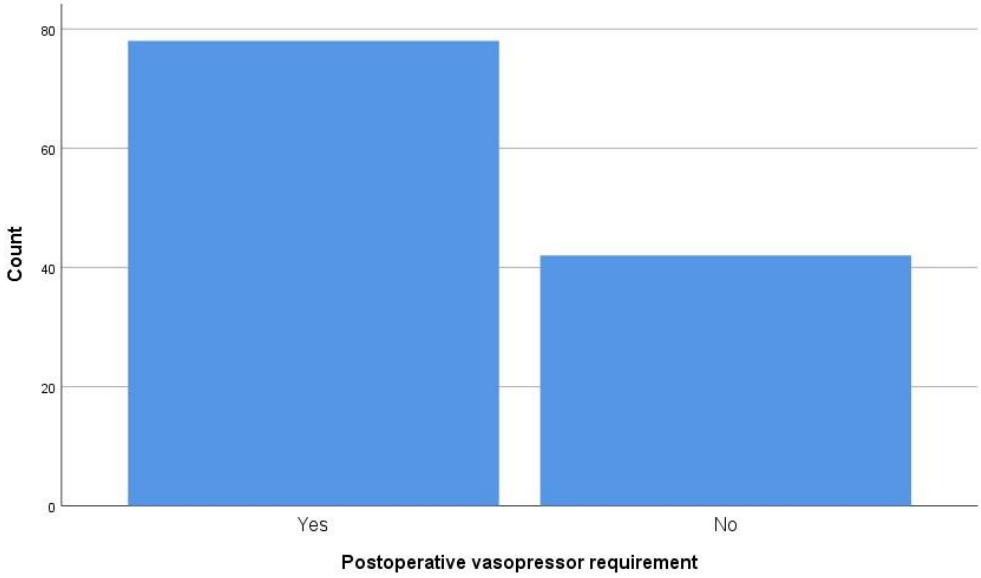

Figure 12: Bar chart of Postoperative vasopressor requirement

The bar chart demonstrates that most of the patients needed postoperative support with vasopressors versus others. It implies that hemodynamic instability remained a common problem among patients who still were experiencing hemodynamic instability after surgery. The greater use of vasopressors indicates the severity of the underlying conditions like sepsis and intraoperative hypotension. These results indicate that additional monitoring and management of hemodynamic parameters the postoperative phase help to stabilize the patients, and prevent the occurrence of complications.

Discussion

The study demonstrated that intraoperative hemodynamic instability is highly prevalent among patients undergoing perforated laparotomy, with hypotension emerging as the most common complication. The high incidence was primarily attributed to preoperative sepsis, hypovolemia, anesthetic-induced vasodilation, and surgical stress, emphasizing that hypotension should be anticipated rather than considered an isolated event. The most vulnerable phases were identified as post-intubation, peritoneal lavage, and intraoperative maintenance, where inflammatory mediator release and anesthetic effects contributed significantly to cardiovascular instability.

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These findings highlight the importance of continuous hemodynamic monitoring and timely interventions to prevent organ hypoperfusion and postoperative complications (Laxmi et al., 2025; Haile et al., 2025; Aseni et al., 2019).

The study also found a strong association between sepsis and intraoperative hypotension, confirming that septic patients are at a substantially higher risk of hemodynamic instability because of systemic vasodilation, capillary leakage, and reduced vascular responsiveness. Patients receiving ketamine and etomidate maintained better cardiovascular stability than those receiving propofol or thiopentone, which were associated with greater incidences of hypotension due to their vasodilatory and myocardial depressant effects. In addition, variations in fluid therapy and vasopressor use reflected individualized clinical decision-making, although vasopressors remained essential for maintaining adequate perfusion when fluid therapy alone was insufficient (Scott et al., 2023; Sattar et al., 2025; Singh et al., 2021).

Prolonged hypotension lasting more than 20 minutes was significantly associated with adverse postoperative outcomes, including acute kidney injury, myocardial ischemia, increased ICU admission, and greater vasopressor requirements after surgery. Correlation analyses demonstrated that intraoperative hemodynamic instability directly influenced postoperative recovery, while female patients exhibited comparatively greater clinical severity and required more intensive management. These findings reinforce the importance of minimizing both the frequency and duration of hypotensive episodes through prompt recognition and evidence-based intervention to improve postoperative outcomes (Carsetti et al., 2023; Duranteau et al., 2023).

Overall, the study established that patient condition, anesthetic management, intraoperative events, and postoperative care are closely interconnected determinants of surgical outcomes in perforated laparotomy. Regression analysis identified anesthetic management and postoperative status as significant predictors of recovery, although the perfect model fit suggested possible overfitting and should be interpreted cautiously. Despite limitations such as convenience sampling, single-center design, and categorical scoring of some variables, the

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findings strongly support the implementation of continuous hemodynamic monitoring, early identification of high-risk patients, goal-directed fluid and vasopressor therapy, and vigilant postoperative care to improve outcomes in this critically ill patient population (Jung et al., 2024; Guo et al., 2019).

Conclusion

The present study concluded that intraoperative hemodynamic instability, particularly hypotension, is a common and clinically significant complication in patients undergoing perforated laparotomy. The occurrence of hypotension was strongly associated with sepsis, hypovolemia, anesthetic effects, and surgical stress, with the highest incidence observed during anesthetic induction, post-intubation, and peritoneal lavage. These findings indicate that patients undergoing perforated laparotomy are at high risk of cardiovascular instability and require continuous perioperative monitoring to minimize organ hypoperfusion and postoperative complications.

The study further demonstrated that appropriate anesthetic agent selection, goal-directed fluid therapy, and timely administration of vasopressors are essential for maintaining hemodynamic stability. Ketamine and etomidate provided better cardiovascular stability than propofol and thiopentone, while pharmacological support was often necessary despite adequate fluid resuscitation. Overall, the findings emphasize that early recognition of hemodynamic changes, multidisciplinary collaboration, and evidence-based intraoperative management can significantly improve surgical outcomes and patient recovery following perforated laparotomy.

Recommendations

Continuous hemodynamic monitoring should be implemented for all high-risk perforated laparotomy patients, preferably using invasive arterial pressure monitoring where available. Goal-directed fluid therapy should be adopted to optimize intravascular volume while avoiding fluid overload, and hemodynamically stable induction agents such as ketamine or etomidate should be preferred in septic or hypovolemic patients. Early initiation of vasopressors, particularly

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norepinephrine, should be considered for persistent hypotension, while preoperative optimization of septic patients through aggressive resuscitation is essential. Standardized clinical protocols, regular simulation-based training for anesthesia providers, multidisciplinary collaboration among surgical, anesthesia, and critical care teams, adequate postoperative ICU monitoring, and larger multicenter studies are recommended to further improve patient outcomes and strengthen the evidence base.

Study Limitations

The study has several limitations that should be considered while interpreting the findings. It was conducted using a non-probability convenience sampling technique at a single center, which may limit the generalizability of the results. Although the sample size was adequate, it may not represent the full spectrum of clinical variability among patients undergoing perforated laparotomy. The use of categorical scoring for some variables, possible observer bias during intraoperative data collection, limited availability of advanced hemodynamic monitoring equipment in certain cases, and the possibility of regression model overfitting may have influenced data accuracy. Furthermore, the study did not evaluate long-term postoperative outcomes, limiting assessment of long-term patient recovery.

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