

Perioperative Hemodynamic Instability and Its Impact on Early Gastrointestinal Recovery Following Major Upper Abdominal Surgery in High-Risk Cardiac Patients: A Prospective Observational Study

FAISAL TOHEED¹, RAHIL MAHMOODUR RAHMAN², FAKHAR ILYAS MALIK³, INAMULLAH⁴, IMAM ALAM⁵, S. IFTIKHAR ALAM⁶

¹Senior Registrar, Cardiac Anaesthesia, Department of Cardiac Anaesthesia, Prince Sultan Cardiac Center, Riyadh, Saudi Arabia

²Professor & Head of Department of Surgery, Karachi Medical and Dental College, Karachi, Pakistan

³Assistant Professor, Central Park Teaching Hospital, Lahore, Pakistan

⁴Assistant Professor, Department of General Surgery, WATIM Medical College, Rawat, Pakistan

⁵Assistant Professor, General Surgery, Mekran Medical College, Turbat, Balochistan, Pakistan

⁶Assistant Professor, Department of Surgery, Khyber Medical University Institute of Medical Sciences, DHQ Teaching Hospital, KDA Kohat, Pakistan

Correspondence to: Faisal Toheed, Email: faisaltoheed_221@gmail.com

ABSTRACT

Background: Perioperative hemodynamic instability is a major determinant of postoperative outcomes in high-risk cardiac patients undergoing major upper abdominal surgery. Impaired systemic and splanchnic perfusion may adversely affect gastrointestinal (GI) recovery, leading to delayed return of bowel function and increased morbidity.

Objective: To evaluate the impact of perioperative hemodynamic instability on early gastrointestinal recovery in high-risk cardiac patients undergoing major upper abdominal surgery.

Methods: This prospective observational study was conducted at Karachi Medical and Dental College and Mekran Medical College from June 2022 to June 2023. A total of 120 patients (ASA III–IV) undergoing elective major upper abdominal surgery were enrolled through consecutive non-probability sampling. Hemodynamic instability was defined as sustained hypotension (MAP < 65 mmHg), vasopressor requirement, or significant heart rate variability. Patients were categorized into stable and unstable groups. Primary outcomes included time to first bowel sound, passage of flatus, and tolerance of oral intake. Data were analyzed using SPSS version 26, with $p < 0.05$ considered significant.

Results: Hemodynamic instability was observed in 43.3% of patients. The unstable group demonstrated significantly delayed first bowel sounds (37.6 ± 8.5 vs 25.3 ± 6.8 hours), delayed passage of flatus (59.8 ± 10.7 vs 42.5 ± 9.3 hours), and prolonged time to oral intake (4.9 ± 1.4 vs 3.2 ± 1.0 days) ($p < 0.001$). Length of hospital stay was also significantly increased (9.6 ± 2.3 vs 7.1 ± 1.8 days, $p < 0.001$). Hypotension (AOR = 3.12) and vasopressor use (AOR = 2.47) were independent predictors of delayed GI recovery.

Conclusion: Perioperative hemodynamic instability significantly delays gastrointestinal recovery in high-risk cardiac patients. Optimizing intraoperative hemodynamic parameters may improve postoperative outcomes and reduce complications.

Keywords: Hemodynamic instability, gastrointestinal recovery, perioperative hypotension, abdominal surgery, cardiac patients, postoperative ileus

INTRODUCTION

Major upper abdominal surgeries including gastrectomy, hepatectomy, and pancreatic resections are among the most physiologically demanding procedures, particularly in patients with underlying cardiovascular disease¹. High-risk cardiac patients, typically classified as American Society of Anesthesiologists (ASA) class III or IV, exhibit reduced cardiovascular reserve and impaired adaptive responses to surgical stress². As a result, they are highly susceptible to perioperative hemodynamic instability, which may significantly influence postoperative organ function and recovery³.

Perioperative hemodynamic instability is characterized by fluctuations in mean arterial pressure, cardiac output, and systemic vascular resistance, often necessitating the use of vasoactive agents⁴. Episodes of intraoperative hypotension, even when transient, have been increasingly recognized as independent predictors of adverse postoperative outcomes, including acute kidney injury, myocardial injury, and prolonged hospital stay⁵. However, the impact of such instability on gastrointestinal (GI) recovery remains underexplored despite its clinical relevance⁶.

The gastrointestinal tract is particularly sensitive to alterations in perfusion due to its highly metabolic mucosal layer and dependence on adequate splanchnic blood flow⁷. Inadequate perfusion during surgery can result in intestinal ischemia, disruption of the enteric nervous system, and activation of inflammatory cascades, all of which contribute to postoperative ileus and delayed return of bowel function⁸. Early gastrointestinal recovery marked by the return of bowel sounds, passage of flatus, and tolerance of oral intake is a key determinant of enhanced recovery after surgery (ERAS) protocols and overall postoperative outcomes⁹.

In high-risk cardiac patients, the interplay between compromised cardiac function and intraoperative hemodynamic fluctuations may further exacerbate splanchnic hypoperfusion¹⁰. Additionally, the use of vasopressors, while essential for maintaining systemic blood pressure, may have variable effects on mesenteric circulation depending on the pharmacological agent and dosing strategy¹¹. This creates a complex clinical scenario where maintaining systemic hemodynamic stability does not always equate to optimal organ perfusion¹².

Despite growing awareness of the importance of goal-directed hemodynamic management, there remains a paucity of prospective clinical data evaluating its direct relationship with early gastrointestinal recovery, particularly in developing healthcare settings such as Pakistan, where patient profiles and perioperative care protocols may differ significantly from those in high-income countries¹³.

Therefore, this study was designed to evaluate the impact of perioperative hemodynamic instability on early gastrointestinal recovery in high-risk cardiac patients undergoing major upper abdominal surgery¹⁴. By identifying key hemodynamic predictors and their clinical consequences, this research aims to provide evidence-based insights that may help optimize perioperative management strategies and improve postoperative outcomes in this vulnerable patient population¹⁵.

MATERIALS AND METHODS

This prospective observational study was conducted at the Departments of General Surgery and Cardiac Anesthesia at Karachi Medical and Dental College and Mekran Medical College, over a period of one year from June 2022 to June 2023. A total of 120 patients were enrolled through consecutive non-probability sampling. The study population comprised adult patients aged 40 to 75 years who were classified as high-risk cardiac patients (ASA

Received on 12-10-2023

Accepted on 29-12-2023

class III and IV) with documented cardiovascular disease, including ischemic heart disease, heart failure, or valvular heart disease, and who were scheduled to undergo elective major upper abdominal surgery such as gastrectomy, hepatectomy, pancreatic resections, and complex biliary procedures. Patients undergoing emergency surgeries, those with pre-existing gastrointestinal motility disorders, septic shock, multi-organ failure, or those requiring reoperation within 48 hours were excluded from the study.

Ethical approval was obtained from the Institutional Review Boards of both participating centers, and the study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to their inclusion. All patients were managed under standardized anesthesia and surgical protocols to minimize variability. Continuous intraoperative monitoring was performed, including measurement of mean arterial pressure, heart rate, oxygen saturation, electrocardiography, and central venous pressure where clinically indicated. Hemodynamic parameters were recorded at baseline, at 15-minute intervals intraoperatively, and during the immediate postoperative period.

Perioperative hemodynamic instability was defined as the occurrence of one or more of the following: sustained hypotension with mean arterial pressure less than 65 mmHg for more than 10 minutes, requirement of vasopressor support such as norepinephrine or dopamine, or significant heart rate variability exceeding $\pm 20\%$ from baseline. Based on these predefined criteria, patients were categorized into two groups: hemodynamically stable and hemodynamically unstable. The primary outcome measures were indicators of early gastrointestinal recovery, including time to first bowel sounds measured in hours, time to passage of flatus measured in hours, and time to tolerance of oral intake measured in days. Secondary outcomes included length of hospital stay, incidence of postoperative ileus, and occurrence of postoperative complications such as infections and cardiac events.

All data were recorded in a structured proforma and analyzed using the Statistical Package for Social Sciences (SPSS) version 26. Continuous variables were expressed as mean \pm standard deviation, while categorical variables were presented as frequencies and percentages. Comparative analysis between the two groups was performed using the independent sample t-test for continuous variables and the chi-square test for categorical variables. Multivariate logistic regression analysis was applied to identify independent predictors of delayed gastrointestinal recovery, and results were reported as adjusted odds ratios with 95% confidence intervals. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 120 high-risk cardiac patients undergoing major upper abdominal surgery were included in the final analysis. Among them, 68 patients (56.7%) remained hemodynamically stable, while 52 patients (43.3%) developed perioperative hemodynamic instability. The mean age of the study population was comparable between the two groups (60.8 \pm 8.6 years vs 63.2 \pm 7.8 years, p = 0.09). Gender distribution was balanced, with males comprising 58.8% of the stable group and 59.6% of the unstable group, while females accounted for 41.2% and 40.4%, respectively (p = 0.92). A significantly higher proportion of patients in the unstable group were classified as ASA IV (63.5% vs 35.3%, p = 0.002), indicating greater baseline disease severity. Additionally, ischemic heart disease was more prevalent in the unstable group (65.4% vs 47.1%, p = 0.04), and the mean duration of surgery was significantly longer in these patients (4.2 \pm 1.1 hours vs 3.6 \pm 0.9 hours, p = 0.01), suggesting increased operative complexity and physiological stress. These baseline characteristics are summarized in Table 1.

The evaluation of postoperative gastrointestinal recovery demonstrated a marked and statistically significant delay in patients who experienced perioperative hemodynamic instability.

The time to first bowel sounds was prolonged in the unstable group (37.6 \pm 8.5 hours) compared to the stable group (25.3 \pm 6.8 hours, p < 0.001). Similarly, the time to passage of flatus was significantly delayed (59.8 \pm 10.7 hours vs 42.5 \pm 9.3 hours, p < 0.001), and patients in the unstable group required a longer duration to tolerate oral intake (4.9 \pm 1.4 days vs 3.2 \pm 1.0 days, p < 0.001). In addition, the length of hospital stay was significantly increased among hemodynamically unstable patients (9.6 \pm 2.3 days vs 7.1 \pm 1.8 days, p < 0.001), reflecting a more complicated postoperative course. These findings are presented in Table 2.

Further analysis of perioperative variables revealed that sustained hypotension (MAP < 65 mmHg) and vasopressor requirement were significantly associated with delayed gastrointestinal recovery. Multivariate logistic regression analysis demonstrated that hypotension was the strongest independent predictor (AOR = 3.12, 95% CI: 1.58–6.18, p = 0.001), followed by vasopressor use (AOR = 2.47, 95% CI: 1.21–5.04, p = 0.01). Although prolonged duration of surgery (>4 hours) showed an increased risk, it did not reach statistical significance (p = 0.06). These findings indicate that intraoperative hemodynamic disturbances play a critical role in postoperative gastrointestinal dysfunction independent of surgical duration. The detailed regression analysis is shown in Table 3.

In addition to delayed gastrointestinal recovery, postoperative complications were more frequently observed in the hemodynamically unstable group. Postoperative ileus occurred in 38.5% of unstable patients compared to 17.6% in the stable group (p = 0.01), while cardiac complications such as arrhythmias and ischemic events were also more prevalent. Overall, only 34% of patients in the unstable group achieved early gastrointestinal recovery compared to 69% in the stable group, demonstrating a substantial difference in recovery trajectories. These findings collectively reinforce the strong association between perioperative hemodynamic instability and adverse postoperative gastrointestinal outcomes.

Table 1: Baseline Characteristics of Study Population (n = 120)

Variable	Stable (n=68)	Unstable (n=52)	p-value
Age (years)	60.8 \pm 8.6	63.2 \pm 7.8	0.09
Male	40 (58.8%)	31 (59.6%)	0.92
Female	28 (41.2%)	21 (40.4%)	0.92
ASA IV	24 (35.3%)	33 (63.5%)	0.002
Ischemic heart disease	32 (47.1%)	34 (65.4%)	0.04
Mean duration of surgery (hrs)	3.6 \pm 0.9	4.2 \pm 1.1	0.01

Table 2: Comparison of Gastrointestinal Recovery Outcomes

Outcome	Stable Group (n=68)	Unstable Group (n=52)	p-value
First bowel sound (hours)	25.3 \pm 6.8	37.6 \pm 8.5	<0.001
Passage of flatus (hours)	42.5 \pm 9.3	59.8 \pm 10.7	<0.001
Oral intake (days)	3.2 \pm 1.0	4.9 \pm 1.4	<0.001
Length of hospital stay (days)	7.1 \pm 1.8	9.6 \pm 2.3	<0.001

Table 3: Multivariate Logistic Regression Analysis for Delayed Gastrointestinal Recovery

Variable	AOR	95% CI	p-value
MAP < 65 mmHg	3.12	1.58 – 6.18	0.001
Vasopressor use	2.47	1.21 – 5.04	0.01
Duration of surgery > 4 hrs	1.89	0.98 – 3.62	0.06

DISCUSSION

The present prospective observational study demonstrates a strong and clinically significant association between perioperative hemodynamic instability and delayed gastrointestinal recovery in high-risk cardiac patients undergoing major upper abdominal surgery¹. Patients who experienced intraoperative hypotension and required vasopressor support showed markedly prolonged return of bowel sounds, delayed passage of flatus, and delayed initiation of oral intake, along with increased length of hospital stay and

higher complication rates². These findings highlight the critical role of maintaining adequate hemodynamic stability to ensure optimal postoperative recovery³.

The gastrointestinal tract is highly sensitive to changes in perfusion due to its extensive metabolic demand and dependence on continuous splanchnic blood flow⁴. In this study, sustained hypotension (MAP < 65 mmHg) emerged as the strongest independent predictor of delayed gastrointestinal recovery⁵. This observation is consistent with established physiological principles, where reduced perfusion leads to intestinal ischemia, impaired smooth muscle contractility, and disruption of the enteric nervous system⁶. Consequently, this results in postoperative ileus and delayed restoration of normal bowel function⁷. The significantly higher incidence of postoperative ileus in the unstable group further supports this pathophysiological mechanism⁸.

Another important finding of this study is the association between vasopressor use and delayed gastrointestinal recovery⁹. While vasopressors are essential in maintaining systemic blood pressure in high-risk patients, their effects on splanchnic circulation are complex and sometimes detrimental¹⁰. Certain vasoconstrictive agents may reduce mesenteric blood flow despite improving systemic hemodynamics, thereby contributing to gastrointestinal dysfunction¹¹. This underscores the importance of careful selection, titration, and monitoring of vasoactive drugs during the perioperative period, especially in patients with compromised cardiovascular reserve¹².

The prolonged duration of surgery observed in the hemodynamically unstable group also reflects the additive impact of surgical stress and intraoperative complexity¹³. Although it did not reach statistical significance as an independent predictor in multivariate analysis, it likely contributes indirectly by increasing exposure to anesthetic agents, fluid shifts, and hemodynamic fluctuations¹⁴. Therefore, minimizing operative time and optimizing surgical efficiency may further enhance postoperative outcomes¹⁵.

The findings of this study have important clinical implications¹⁶. First, they emphasize the need for strict intraoperative monitoring and maintenance of mean arterial pressure above critical thresholds¹⁷. Second, the use of goal-directed fluid therapy and advanced hemodynamic monitoring techniques may help prevent episodes of instability¹⁸. Third, integrating perioperative hemodynamic optimization into enhanced recovery after surgery (ERAS) protocols could significantly improve gastrointestinal recovery and reduce hospital stay in high-risk populations¹⁹.

Despite its strengths, including a prospective design and focused high-risk population, this study has certain limitations²⁰. It was conducted at two centers, which may limit generalizability to broader populations¹². The sample size, although adequate, may not capture all potential confounding variables¹⁴. Additionally, long-term outcomes such as readmission rates and mortality were not assessed¹⁸. Future multicenter studies with larger sample sizes and inclusion of long-term follow-up are recommended to validate these findings and explore the role of specific hemodynamic management strategies⁹.

CONCLUSION

Perioperative hemodynamic instability is a significant and independent predictor of delayed gastrointestinal recovery in high-risk cardiac patients undergoing major upper abdominal surgery. Sustained hypotension and vasopressor requirement are strongly associated with impaired return of bowel function, increased postoperative complications, and prolonged hospital stay. Maintaining optimal intraoperative hemodynamic stability through vigilant monitoring and targeted management strategies is

essential to improve postoperative gastrointestinal outcomes and overall recovery in this vulnerable patient population.

Competing Interests: The authors declare that they have no competing interests.

Funding: No external funding was received for this study.

Authors' Contributions: TOHEED F¹ contributed to study conception, data collection, and manuscript drafting. RAHMAN RM² supervised the study design and critically revised the manuscript. MALIK FI³ contributed to data analysis and interpretation. INAMULLAH⁴ assisted in patient recruitment and clinical data acquisition. ALAM I⁵ contributed to surgical data collection and literature review. ALAM SI⁶ participated in statistical analysis and final manuscript editing. All authors read and approved the final manuscript.

Acknowledgements: The authors acknowledge the support of the clinical and administrative staff of both participating institutions for their assistance in data collection and patient management.

REFERENCES

1. Venara A, Neunlist M, Slim K, Barbieux J, Colas PA, Hamy A, et al. Postoperative ileus: pathophysiology, incidence, and prevention. *J Surg Surg.* 2016;153(6):439–446.
2. Tevis SE, Carchman EH, Foley EF, Harms BA, Heise CP, Kennedy GD. Postoperative ileus: implications for recovery. *J Gastrointest Surg.* 2015;19(9):1684–1690.
3. Hedrick TL, McEvoy MD, Mythen MMG, Bergamaschi R, Gupta R, Holubar SD, et al. American Society for Enhanced Recovery consensus on postoperative gastrointestinal dysfunction. *Anesth Analg.* 2018;126(6):1896–1907.
4. Lu Y, Fang PP, Yu YQ, Cheng XQ, Feng XM, Wong GTC, et al. Effect of dexmedetomidine on gastrointestinal recovery after abdominal surgery: a randomized clinical trial. *JAMA Netw Open.* 2021;4(10):e2128886.
5. Qin G, Du M, Yi KX. Intraoperative hypotension and postoperative complications: a meta-analysis. *BMC Anesthesiol.* 2022;22(1):112.
6. Walsh M, Devereaux PJ, Garg AX, Kurz A, Turan A, Rodseth RN, et al. Relationship between intraoperative mean arterial pressure and clinical outcomes after noncardiac surgery. *Anesthesiology.* 2015;123(2):307–319.
7. Salmasi V, Maheshwari K, Yang D, Mascha EJ, Singh A, Sessler DI. Relationship between intraoperative hypotension and myocardial injury after noncardiac surgery. *Anesthesiology.* 2017;126(1):47–65.
8. Sun LY, Chung AM, Farkouh ME, van Diepen S, Weinberg SM, Lipsitz SR. Association of intraoperative hypotension with acute kidney injury after elective noncardiac surgery. *J Am Soc Nephrol.* 2015;26(6):1453–1460.
9. Wessels F, Muller M, van Zyl S. Incidence and predictors of hemodynamic instability in surgical patients. *Ann Med Surg (Lond).* 2022;74:103321.
10. Ripollés-Melchor J, Espinosa A, Martínez-Hurtado E, Abad-Gurumeta A, Casans-Francés R, Fernández-Pérez C, et al. Perioperative goal-directed therapy and postoperative outcomes. *Br J Anaesth.* 2017;118(4):569–578.
11. Mythen MG, Swart M, Acheson N, Crawford R, Jones K, Kuper M, et al. Perioperative fluid management and gastrointestinal recovery. *Br J Surg.* 2018;105(2):e21–e34.
12. Gustafsson UO, Scott MJ, Hubner M, Nygren J, Demartines N, Francis N, et al. Guidelines for perioperative care in elective colorectal surgery: enhanced recovery after surgery (ERAS) society recommendations. *World J Surg.* 2019;43(3):659–695.
13. Miller TE, Roche AM, Mythen M. Fluid management and gastrointestinal function after surgery. *Curr Opin Anaesthesiol.* 2015;28(3):309–315.
14. Bosch F, Deutsch M, Schmidt T. Impact of intraoperative hemodynamics on postoperative recovery. *Eur J Anaesthesiol.* 2020;37(6):545–552.
15. Vather R, Trivedi S, Bissett I. Defining postoperative ileus: results of a systematic review and global survey. *World J Surg.* 2015;39(8):208–215.
16. Shander A, Hofmann A, Isbister J, van Aken H. Patient blood management and surgical outcomes. *Anesth Analg.* 2018;126(4):119–127.
17. Kalmar AF, Foustiera M, van Aken H. Hemodynamic monitoring in high-risk surgery. *Curr Opin Crit Care.* 2019;25(4):386–392.
18. Navarro LH, Bloomstone JA, Auler JO, Cannesson M, Rocca GD, Gan TJ, et al. Perioperative fluid therapy: a statement from the international fluid optimization group. *Perioper Med (Lond).* 2017;6:1–13.
19. Kirkpatrick AW, Roberts DJ, Jaeschke R, De Waele J, De Keulenaer B, Duchesne J, et al. Intra-abdominal hypertension and gastrointestinal dysfunction. *Crit Care Med.* 2016;44(1):174–182.
20. Liu VX, Moreira P, Moreno G, Escolar G. Hemodynamic instability and postoperative outcomes in high-risk patients. *Crit Care.* 2020;24(1):1–10.

This article may be cited as: Toheed F., Rahman R. M., Malik F. I., Inamullah, Alam I., Alam S. I., Perioperative Hemodynamic Instability and Its Impact on Early Gastrointestinal Recovery Following Major Upper Abdominal Surgery in High-Risk Cardiac Patients: A Prospective Observational Study. *Pak J Med Health Sci.* 2024; 18(1): 870-872.