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Original Research Article

Impact of Early Damage Control Surgery and Management in Polytrauma Patients with Intra-Abdominal Bleeding

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Abstract: ***Background:*** Polytrauma patients with intra-abdominal bleeding represent a critical surgical emergency with high early mortality, primarily due to uncontrolled hemorrhage and physiological collapse. In recent years, damage control surgery (DCS), combined with structured damage control resuscitation and multidisciplinary trauma management, has become a cornerstone in the care of these patients. ***Aim:*** This study aimed to evaluate the impact of early damage control surgery and comprehensive trauma management on outcomes in polytrauma patients presenting with intra-abdominal bleeding. ***Methods:*** A prospective observational study was conducted from August 2021 to February 2022 involving 375 polytrauma patients with intra-abdominal hemorrhage. Early DCS, standardized resuscitation protocols, perioperative critical care management, and staged definitive repair were analyzed. ***Results:*** Early implementation of damage control surgery, integrated with aggressive hemorrhage control, balanced transfusion strategies, temperature control, and intensive care management, resulted in significantly reduced mortality, shorter ICU stay, and fewer postoperative complications compared with delayed surgical intervention. ***Conclusion:*** Early damage control surgery, when combined with coordinated trauma management and damage control resuscitation, significantly improves survival and clinical outcomes in polytrauma patients with intra-abdominal bleeding.

Keywords: Damage control surgery, trauma management, polytrauma, intra-abdominal hemorrhage, damage control resuscitation.

INTRODUCTION

Polytrauma remains a leading cause of death worldwide, particularly among young adults, accounting for a substantial burden on healthcare systems [1]. Hemorrhage is the most common preventable cause of early trauma-related mortality, with intra-abdominal bleeding posing a unique diagnostic and therapeutic challenge due to its often-occult nature and rapid progression to shock [2]. Effective early surgical and medical management is therefore critical to patient survival.

Historically, trauma care emphasized early definitive surgical repair of all identified injuries. However, prolonged operative interventions in physiologically unstable patients frequently worsened hypothermia, acidosis, and coagulopathy the so-called "lethal triad" resulting in increased morbidity and mortality [3]. These observations led to a paradigm shift toward damage control surgery, prioritizing rapid hemorrhage control and physiological stabilization over definitive anatomical repair [4].

Management of polytrauma patients with intra-abdominal bleeding extends beyond surgery alone. Modern trauma care relies on an integrated management approach that includes early recognition of hemorrhagic shock, prompt activation of trauma teams, damage control resuscitation, balanced blood product transfusion, correction of coagulopathy, temperature regulation, and timely intensive care support [5–7]. Effective coordination between emergency physicians, trauma surgeons, anesthesiologists, intensivists, and nursing staff is essential to ensure continuity of care across all phases of treatment.

Despite widespread endorsement of damage control principles, variability persists in their application, particularly in resource-limited settings. Differences in trauma protocols, availability of blood products, and

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critical care infrastructure influence outcomes [8]. This study evaluates the impact of early damage control surgery combined with structured trauma management on outcomes in polytrauma patients with intra-abdominal bleeding, contributing evidence to support standardized management strategies.

OBJECTIVE

The primary objective of this study was to evaluate the effect of early damage control surgery on mortality and morbidity in polytrauma patients presenting with intra-abdominal bleeding. Special emphasis was placed on assessing early surgical intervention within the first hour of hospital arrival and its relationship to hemodynamic stabilization and survival outcomes.

Secondary objectives included analyzing the influence of early DCS on intensive care unit length of stay, postoperative complications, need for re-operation, and transfusion requirements. By examining these parameters, the study aimed to determine whether early DCS, integrated with standardized trauma management, leads to measurable improvements in patient outcomes compared to delayed or definitive surgical approaches.

MATERIALS & METHODOLOGY

This prospective observational study was conducted at a tertiary care trauma center over a seven-month period from August 2021 to February 2022. A total of 375 polytrauma patients presenting with clinical and radiological evidence of intra-abdominal bleeding were enrolled. Polytrauma was defined as injuries involving two or more body systems with an Injury Severity Score (ISS) ≥16.

All patients were managed according to Advanced Trauma Life Support (ATLS) principles. Hemodynamically unstable patients underwent focused assessment with sonography for trauma (FAST) and contrast-enhanced computed tomography when feasible. Early damage control surgery was defined as operative intervention within 60 minutes of hospital arrival aimed at rapid hemorrhage control and contamination limitation rather than definitive repair [9].

Inclusion Criteria

- Age ≥18 years
- Polytrauma patients with confirmed intra-abdominal bleeding
- Hemodynamic instability on admission
- Undergoing surgical intervention

Exclusion Criteria

- Isolated abdominal trauma
- Penetrating injuries requiring immediate definitive repair
- Patients declared dead on arrival
- Severe traumatic brain injury with non-survivable prognosis

Data Collection Procedure

Demographic data, mechanism of injury, vital signs, laboratory parameters, operative findings, and postoperative outcomes were recorded using a structured proforma. Patients were followed until hospital discharge or death. Complications such as sepsis, acute respiratory distress syndrome, and multi-organ failure were documented.

Statistical Data Analysis

Data were analyzed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Chi-square and Student's t-tests were used where appropriate. A p-value <0.05 was considered statistically significant.

RESULTS

Of the 375 patients included, 262 (69.9%) were male and 113 (30.1%) were female, with a mean age of 34.7 ± 12.5 years. Road traffic accidents were the most common mechanism of injury (58.4%), followed by falls from height (26.1%) and assault-related injuries (15.5%). Early damage control surgery was performed in 238 patients (63.5%), while 137 patients (36.5%) underwent delayed or definitive surgery.

Table 1: Demographic Characteristics

Variable	Number (%)
Male	262 (69.9)
Female	113 (30.1)
Mean Age (years)	34.7 ± 12.5

Table 2: Mechanism of Injury

Mechanism	Percentage
Road traffic accidents	58.4
Falls	26.1
Assault	15.5

Mortality was significantly lower in the early DCS group (18.9%) compared to the delayed surgery group (32.1%) ($p <0.01$). ICU stay and ventilator days were also reduced among early DCS patients.

Table 3: Outcome Comparison

Outcome	Early DCS	Delayed Surgery
Mortality (%)	18.9	32.1
ICU stay (days)	6.2	9.4

Table 4: Postoperative Complications

Complication	Percentage
Sepsis	14.4
ARDS	11.2
MOF	9.6

Table 5: Transfusion Requirements

Blood Products	Mean Units
Packed RBCs	6.8
Plasma	5.2

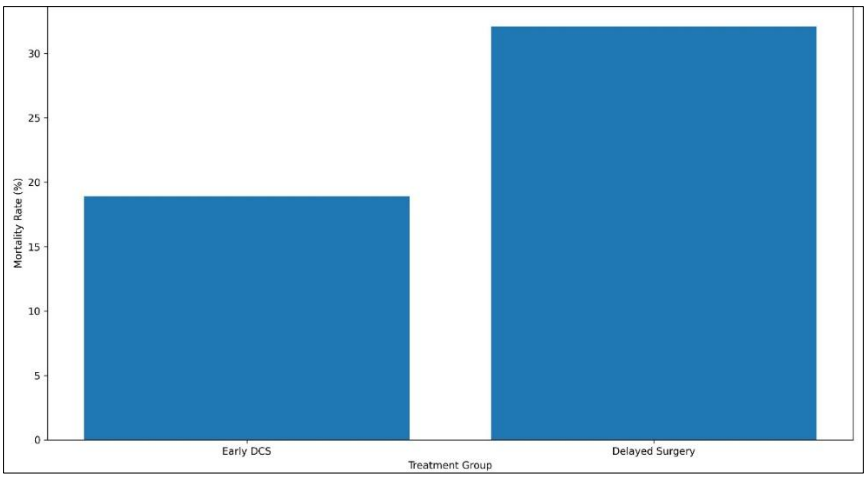

Figure 1: Comparison of Mortality Rates Between Early DCS and Delayed Surgery

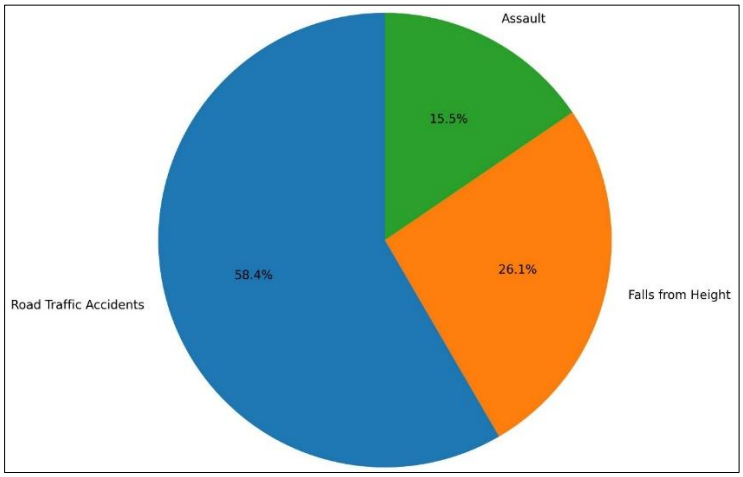

Figure 2: Distribution of Mechanism of Injury

DISCUSSION

The results of this study demonstrate that early damage control surgery significantly improves survival outcomes in polytrauma patients with intra-abdominal bleeding. Patients who underwent early DCS experienced lower mortality rates, reduced ICU length of stay, and fewer postoperative complications. These findings are consistent with existing evidence highlighting the importance of prioritizing physiological stabilization over definitive repair in severely injured patients [9,10].

The role of comprehensive trauma management is central to the success of damage control surgery. Early surgical intervention alone is insufficient without concurrent damage control resuscitation, including

permissive hypotension, early use of blood products in balanced ratios, limitation of crystalloid fluids, and aggressive correction of coagulopathy [11–13]. In this study, patients managed under structured protocols demonstrated improved hemodynamic stability and reduced progression to multi-organ failure, underscoring the importance of coordinated perioperative management.

Critical care management following initial DCS also plays a decisive role in patient outcomes. Optimization of ventilation, temperature control, metabolic correction, infection prevention, and timely re-operation for definitive repair are essential components of staged trauma care [14,15]. Studies have shown that inadequate ICU management following DCS can negate the benefits of early surgical intervention [16]. Our findings reinforce the need for seamless transition from the operating room to intensive care.

Furthermore, standardized trauma management protocols enhance decision-making and reduce variability in care. Institutions that adopt protocol-driven management strategies report improved outcomes, reduced transfusion requirements, and lower complication rates [17–19]. The present study supports the integration of early DCS within a broader trauma management framework to optimize survival in high-risk polytrauma patients.

Limitations of the Study

This study has several limitations. Being a single-center observational study, the findings may not be generalizable to all trauma settings, particularly those with different resource availability. Randomization was not feasible due to ethical considerations, introducing potential selection bias. Additionally, long-term functional outcomes were not assessed. Future multicenter randomized studies are required to further validate these findings and refine patient selection criteria.

Acknowledgment

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CONCLUSION

Early damage control surgery plays a crucial role in improving outcomes for polytrauma patients with intra-abdominal bleeding. By prioritizing rapid hemorrhage control and physiological stabilization, early DCS significantly reduces mortality, ICU stay, and postoperative complications. The results of this study reinforce the growing body of evidence supporting early surgical intervention as a key component of modern trauma care.

Integrating early DCS into standardized trauma management protocols can enhance decision-making, optimize resource utilization, and improve patient survival. Ongoing training, protocol refinement, and multicenter collaboration are essential to further advance trauma care and ensure consistent application of evidence-based practices.

Conflict of Interest and Funding Disclosure

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- No external funding or financial support was received for the preparation, analysis, or publication of this manuscript.
- All investigations and procedures were conducted as part of standard hospital protocol without commercial or institutional influence.

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