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Analysis of hollow visceral injuries admitted to a level one intensive care unit in South Africa

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Background: Bowel trauma, encompassing injuries to the small and large intestine, represents a significant medical challenge due to its potential for morbidity and mortality. Management of bowel injuries remains surgical, but multiple factors influence the outcome in these patients. This study provides an in-depth analysis of the high-risk features of hollow visceral trauma in the ICU setting and the corresponding mortality rates, shedding light on the critical factors that influence outcomes in these cases.
Methods: Retrospective review of patients admitted to the trauma intensive care unit (ICU) at Inkosi Albert Luthuli Hospital from January 2017 until September 2022 were reviewed to identify risk features associated with morbidity and mortality. Statistical analysis was performed using Python 3.10.
Results: Ninety-four patients were reviewed, the majority (88.3%) were male and median age was 31.5 years. Mortality was 31.9%. The median length of stay in the ICU was 9.0 days (IQR 4–19 days, range 2–94 days). Small bowel injuries were more common than colonic injuries (75.3% vs 63.8%). Multiple colon injuries, renal injuries, extra hepatic biliary injuries and older age were associated with significant increase in mortality.
Conclusion: This study's findings underscore the multifaceted nature of bowel injury management in an ICU population. A comprehensive, multidisciplinary approach that considers injury severity, anatomical site, and patient-specific factors is crucial for achieving favourable outcomes in bowel trauma cases.
Keyword: colon injury, small bowel injury, hollow viscus injury, critical care, trauma

Introduction

Bowel trauma, encompassing injuries to the small and large intestine, represents a significant medical challenge due to its potential for morbidity and mortality.[1] Bowel injury can arise from a variety of causes, including blunt and penetrating injuries, iatrogenic factors, and unintentional trauma.[2] These mechanisms often lead to a spectrum of injuries, ranging from minor contusions to severe perforations or transections. The location and severity of the injury play a pivotal role in determining the subsequent clinical course and prognosis.[2,3]

Certain features of bowel injuries are associated with a higher risk of complications and mortality. One prominent high-risk feature is the extent of injury penetration, with full-thickness perforations of the colon being particularly concerning due to the risk of faecal contamination and subsequent infection.[2-4] Additionally, the presence of associated injuries to adjacent structures, such as the mesentery or blood vessels, can exacerbate the overall clinical picture. Other high-risk features include delayed presentation, the presence of shock on admission, and the involvement of major colonic blood vessels, severity of injury and an increased number of organs injured.[1,4-6]

Numerous demographic factors influence mortality rates among colon trauma patients. Age is a key determinant, as elderly individuals tend to have weaker tissue resilience and a higher prevalence of comorbidities, making them more susceptible to complications.[7,8] Sex also plays a role, with some studies suggesting that females may have a higher mortality risk due to hormonal and anatomical differences.[1,9] Socioeconomic status and access to healthcare services further impact outcomes, as timely diagnosis and appropriate management significantly contribute to survival rates.[9,10]

The clinical presentation of bowel injury can vary widely, from subtle symptoms to overt signs of peritonitis and sepsis. Timely and accurate diagnosis is essential, involving a combination of clinical assessment, imaging modalities (e.g. computed tomography, ultrasound), and laboratory tests (e.g. white blood cell count, C-reactive protein levels).[11,12] Early surgical intervention remains the cornerstone of management for severe bowel injury cases. Minimally invasive techniques, such as laparoscopy, have gained prominence in recent years due to their potential to reduce postoperative complications and shorten hospital stays.[12]

Mortality rates associated with colon trauma can vary widely based on the severity of the injury, patient characteristics, and quality of medical care. Studies have reported mortality rates ranging from 5– 30%, with higher rates observed in cases of penetrating trauma, delayed presentation, and the presence of shock.[5,13] Age, comorbidities, and the degree of contamination are also important prognostic factors. Surgical approach, skill of the surgical team, and perioperative management significantly influence outcomes. Additionally, the development of postoperative complications, such as infection, sepsis, and anastomotic leaks, can further impact mortality rate.[13,14]

Bowel injuries pose a complex clinical challenge with potentially grave consequences. Understanding the high-risk features associated with bowel injury and the corresponding mortality rates is crucial for guiding clinical decision-making and optimising patient outcomes.

This paper aims to provide an in-depth analysis of the high-risk features of hollow visceral trauma in the ICU setting and the corresponding mortality rates, shedding light on the critical factors that influence outcomes in these cases, with a view to offering optimisation of diagnostic and therapeutic approaches for hollow visceral trauma patients in this setting.

Methodology

A retrospective cohort study was conducted in the trauma intensive care unit of the Inkosi Albert Luthuli Central Hospital (IALCH), Durban, South Africa from January 2017 until September 2022. This is a level one designated trauma centre situated within a quaternary level hospital catering for referral hospitals in the city of Durban and the province of KwaZulu-Natal. Although accepting transfers from anywhere in the province, the patients in this study came from 16 referral centres ranging from as close as 3.2 km to as far away as 230 km by road. Many patients would have already received their initial surgical management before being referred to the unit for ICU care, which may include phase two of damage control. Patients included in the study were between 12 and 75 years of age, having sustained hollow visceral trauma. Data were collected by interrogation of a prospectively maintained electronic database. Ethical approval was obtained for this study (BCA207-09 sub-study).

Statistical analysis

Summary statistics for numerical variables are expressed as median, range, and interquartile range values. Numerical variables were compared using the Mann–Whitney-U test. A $\chi 2$ test for independence was used for categorical variables. A p-value of < 0.05 was regarded as statistically significant. All statistical analyses were performed using Python 3.10 (Python Software Foundation, Delaware).

Results

The sample consisted of 94 patients. The median age was 31.5 years (IQR 25–41; range 3–73 years), and 83 (88.3%) were female. The distribution of mechanism of injury is shown in Table I.

Fifty-three patients (56.4%) sustained only hollow viscus injuries with 43.6% sustaining both solid and hollow viscus injuries. Small bowel injuries were the most common injury (75.3%) and sixty patients (63.8%) sustained large intestinal injuries. Transverse colon was the most commonly injured (34%), followed by sigmoid colon (16%), ascending colon (12.8%), caecal (9.6%) and descending colon (8.5%) injuries. Thirty-one patients (32.9%) had more than one injury, either in the same or different regions of the large bowel. Solid organ injuries included hepatic (24.5%), renal (12.8%), splenic (9.6%), pancreatic (7.4%) and extrahepatic biliary (5.3%) injuries. Non-gastrointestinal sites of injuries included orthopaedic (14.9%), vascular (13.8%), diaphragmatic (11.7%), and urogenital (4.3%) including bladder (3.2%) and ureteric (1.1%) injuries.

Table I: Mechanisms of injury

Blunt trauma	
Motor vehicle collision	6 (6.4%)
Blunt assault	3 (3.2%)
Bicycle collision	1 (1.1%)
Crushing injury	1 (1.1%)
Fall from height	1 (1.1%)
Pedestrian-vehicle collision	1 (1.1%)
Unknown	1 (1.1%)
Penetrating trauma	
Gunshot	62 (66.0%)
Stab	17 (18.1%)
Unknown	1 (1.1%)

The median injury severity score (ISS) was 32 (IQR 19–36; range 9–75). ISS did not differ significantly by age, sex, class or mechanism of injury. Patients with each of solid organ, splenic, pancreatic, large intestinal and descending colonic injuries had significantly higher median ISS than those without (Table II).

Sixteen (17%) patients underwent a CT scan before laparotomy. Patients with blunt injuries (35.7%) were significantly more likely to undergo a CT scan before laparotomy than those with penetrating injuries (13.8%; $p = 0.04$).

Fifty-two (55.3%) patients underwent laparotomy within 24 hours of injury, 33 (35.1%) patients underwent laparotomy between 24 and 48 hours after injury, and the remainder underwent laparotomy more than 48 hours after injury. Patients with penetrating injuries underwent laparotomy significantly sooner after injury (median 1 day; IQR 1–2; range 1–4) than those with blunt injuries (median 2 days; IQR 1–2; range 1–7; $p = 0.02$). Patients who underwent a CT scan before surgery underwent laparotomy significantly later after injury (median 2 days; IQR 1–2; range 1–7) than those who did not (median 1 day; IQR 1–2; range 1–4; $p = 0.01$). There were no significant associations between

Table II: Median ISS in patients with injury present or absent

Site of injury	ISS (Median [IQR])		*p*-value
	Absence of injury	Presence of injury	
Descending colon	26 [16–34]	34 [27–41]	0.002
Solid organ	29 [18–34]	41 [34–50]	0.01
Other large bowel	25 [17–34]	34 [24–41]	0.02
Spleen	29 [18–34]	37 [34–43]	0.02
Pancreas	29 [18–34]	36 [29–42]	0.05

time to index laparotomy and mortality, length of stay or repair/anastomotic breakdown.

Forty-five patients (54.2%) received hand-sewn bowel repair, while 26 (31.3%) underwent stapled repair, and 12 (14.5%) underwent both. Sixteen patients (17%) required stomas. Patients with rectal (80%), sigmoid colonic (46.7%) and renal (41.7%) injuries were significantly more likely to require stomas than those without (13.5%, $p < 0.001$; 11.4%, $p < 0.001$; and 13.4%, $p = 0.02$, respectively).

Fifty-two patients (55.3%) underwent damage control surgery (DCS). All patients with pancreatic ($p = 0.02$) and caecal ($p = 0.01$) injuries underwent DCS. Presence of colon injury was positively associated with DCS compared to patients who did not have colonic injuries (67.9% vs. 41.2%, $p = 0.01$). Patients who underwent DCS were significantly more likely to undergo stapled (43.9%) or both stapled and hand-sewn (17.1%) repairs than those who did not (21.1% and 5.3%, respectively; $p = 0.007$). Stomas were significantly more likely to be performed for DCS patients (25%) than for non-DCS patients (7.9%, $p = 0.04$).

Patients who underwent DCS (82.4%) required blood transfusions significantly more frequently than those who did not (35.1%, $p < 0.001$). The presence of colonic injury was associated with blood transfusion (71.2% vs. 48.5%, $p = 0.03$). Patients with penetrating trauma (67.9%) received blood transfusions significantly more frequently than those with blunt trauma (35.7%, $p = 0.02$). The grade of liver injury was positively associated with the need for blood transfusion ($p = 0.02$), with all patients with grade 3 to 5 injuries compared to only 16.7% of patients with grade 1 or 2 injuries requiring blood transfusions.

Sixty-four (68.1%) patients underwent relook laparotomy. The median number of relook laparotomies was 1 (IQR 0–2; range 0–5). All patients who underwent DCS and did not die underwent relook laparotomy. Patients with each of ileal, pancreatic, hepatic and large intestinal injuries underwent significantly higher numbers of relook laparotomies than those without. Twenty-two patients (23.4%) required surgical intervention other than laparotomy, namely orthopaedic (14.9%), vascular (4.3%), neuro- (3.2%), maxillofacial (2.1%) and plastic (1.1%) surgery.

All patients with descending colonic injuries required inotropic support, whereas 58.3% of patients without descending colonic injuries required inotropic support ($p = 0.02$). Fifty-seven (62%) patients required inotropic support. Patients with penetrating injuries (66.7%) required inotropic support significantly more frequently than those with blunt injuries (35.7%, $p = 0.03$). Patients who underwent DCS (82.4%) required inotropic support significantly more frequently than those who did not (32.4%, $p < 0.001$). Patients who received blood transfusions (77.6%) required inotropic support significantly more frequently than those who did not (35.3%, $p < 0.001$).

Thirty (31.9%) patients died in the ICU while 64 (68.1%) were discharged. Older patients had a significantly higher mortality rate, with 37 years the median age of patients who died (IQR 31–44) versus 29 years for those who were discharged (IQR 24–38, $p = 0.002$). Patients with extrahepatic biliary, duodenal, transverse colonic and descending colonic injuries had significantly higher mortality rates than those without (Table III). Patients with more than one injury, either in the same or different regions of the large bowel had significantly higher mortality rates than those without.

Table III: Mortality rates associated with anatomical sites of injuries

Anatomical site of injury	Mortality rate (%)	*p*-value
Intra-abdominal solid organ		
Kidney	50	0.15
Pancreas	42.9	0.51
Liver	34.8	0.73
Spleen	33.3	0.92
Non-gastrointestinal		
Extrahepatic biliary system	100.0	0.001
Urogenital system	50.0	0.43
Diaphragm	45.5	0.31
Vascular	30.8	0.92
Orthopaedic	28.6	0.77
Gastrointestinal		
Stomach	38.9	0.48
Large intestine	38.3	0.08
Descending colon	62.5	0.05
Transverse colon	53.1	0.002
Caecum	44.4	0.40
Sigmoid colon	40	0.46
Ascending colon	33.3	0.91
Multiple large intestinal injuries*	51.6	0.01
Small intestine	36.6	0.09
Duodenum	60	0.04
Ileum	50	0.12
Jejunum	31	0.82
Multiple small intestinal injuries**	30.2	0.81
Rectum	0	0.12

* More than one injury, either in the same or different regions of the large intestine
** More than one injury, either in the same or different regions of the small intestine

All patients who underwent nephrectomy died in the ICU, while the mortality rate among patients with renal injuries who did not undergo nephrectomy was 33.3% ($p = 0.05$). Patients who underwent DCS (46.2%) had significantly higher mortality rates than those who did not (7.9%, $p < 0.001$). Patients who received blood transfusions (43.1%) and inotropic support (47.4%) had significantly higher mortality rates than those who did not (14.7%, $p = 0.005$; and 8.6%, $p < 0.001$, respectively). The mortality rates of patients who were initiated on parenteral, enteral and oral feeds were 53.3%, 20.8% and 0%, respectively ($p < 0.001$).

The median length of stay in the ICU was 9 days (IQR 4–19, range 2–94). Patients who underwent relook laparotomy (median 14 days, IQR 7–26) had significantly longer ICU stays than those who did not (median 4.5 days, IQR 3–8, $p < 0.001$). Furthermore, there was significant correlation between the number of relook laparotomies performed on a patient and their length of stay ($r = 0.49$, $p < 0.001$). Patients who were initiated on parenteral (median 15 days, IQR 9–28) and enteral (median 12 days, IQR 7–24) had significantly longer ICU stays than those who were initiated on oral feeds (median 8.0 days, IQR 3–10, $p < 0.001$). Patients who experienced repair breakdown (median 24.5 days, IQR 16–37) had significantly longer ICU

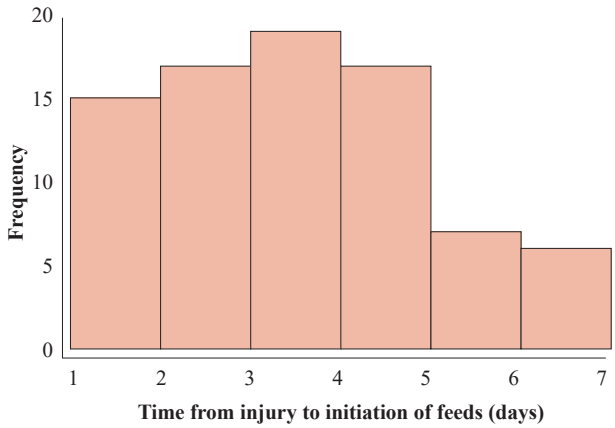

Figure 1: Time from injury to initiation of feeds

stays than those who did not (median 8.5 days, IQR 4–16, $p = 0.001$).

The mean time from injury to initiation of feeds was 4 days (SD 1.5; range 1–7; Figure 1). Fifty-three (57.6%) patients were initiated on enteral feeds, while 15 (16.3%) were initiated on parenteral feeds and 13 (14.1%) on oral feeds. Eleven (12%) patients died before feeds were initiated. Patients who were initiated on oral feeds were initiated sooner (3.1 ± 1.4 days) than those who were initiated on enteral feeds (4.1 ± 1.5 days) or parenteral feeds (4.6 ± 1.4 days) ($p = 0.03$). Patients who required inotropic support were initiated on feeds significantly later (4.4 ± 1.3 days) than those who did not (3.5 ± 1.6 days, $p = 0.008$). Patients who underwent DCS (26%) and relook laparotomy (21%) were initiated on parenteral feeds significantly more frequently than those who did not (5.3%, $p < 0.001$; and 6.7%, $p = 0.04$, respectively), with higher numbers of relook laparotomies being associated with higher rates of initiation on parenteral feeds ($p = 0.001$).

Twelve (12.8%) patients had breakdown of intestinal surgical repair or anastomosis. The median period of time between operation and breakdown was 9 days (IQR 6–13; range 2–20). Patients who had ileal (35.7%) and caecal (33.3%) injuries were more likely to have repair breakdown than those who did not (8.8%, $p = 0.005$; and 10.6%, $p = 0.05$, respectively). Patients who had breakdown underwent significantly more relook laparotomies than patients who did not ($p < 0.001$) with 33.3% of patients with breakdowns and only 1.2% of patients without breakdowns undergoing 4 or more relook laparotomies.

Discussion

This study contributes to the understanding of the bowel injury patient in the trauma ICU population, their outcomes and the factors that have impact on their survival.

The predominance of male patients in this study is consistent with existing literature, which often attributes higher rates of trauma injuries to males. The median age of 31.5 years suggests that abdominal trauma affects a relatively young population, emphasising the impact on productive years of life.[1,9,12]

The study's proportions of blunt and penetrating trauma are consistent with other Southern African publications.[15] Penetrating injuries, particularly those from gunshots, dominate the study cohort, reflecting the higher prevalence of firearm-related incidents in certain settings. The prevalence of gunshot wounds underscores the importance of public health initiatives aimed at curbing gun violence and its associated medical consequences.[15,16]

In terms of the anatomical site of injury, the high incidence of small and large intestinal injuries highlights the vulnerability of these regions. The study's detailed breakdown of injuries by type provides a comprehensive overview of the damage sustained, enabling clinicians to anticipate potential complications and tailor interventions accordingly.

The study's analysis of laparotomy timing in relation to injury mechanism is significant. The shorter interval between injury and laparotomy for patients with penetrating trauma suggests that clinicians recognise the urgency associated with these injuries.[17-19] However, the delayed laparotomies following preoperative CT scans warrant further investigation to assess whether this interval influences patient outcomes.[1,2,15]

The use of DCS is notable, especially for patients with large intestinal injuries. DCS has become an essential strategy in managing severe trauma cases, allowing for temporary stabilisation before definitive repair, and reducing the risk of complications such as sepsis and multiorgan failure.[15,19]

The high rates of blood transfusions among patients with penetrating trauma and large intestinal injuries reflect the severity of these cases. The association between the need for blood transfusion and DCS underscores the physiological stress that patients undergoing this procedure experience, warranting closer monitoring and intervention.[15,16,19]

The prevalence of inotropic support in patients with penetrating injuries and descending colonic injuries points to the severity of these cases and the resulting hemodynamic instability. The requirement for inotropic support in patients who received blood transfusions might suggest a complex interplay between the severity of injury, fluid resuscitation, and cardiovascular function.[20]

The study's mortality rate of 31.9% is a stark reminder of the challenges associated with hollow visceral injuries. The significantly higher mortality rates among patients with specific injury types, such as extrahepatic biliary, duodenal, descending colonic, and transverse colonic injuries, underscore the need for tailored interventions and vigilant postoperative care for these cases. The increased mortality rate with transverse and descending colon injuries may be explained by the increased bacterial load in these anatomical regions.

The association between DCS and higher mortality rates demands careful consideration of the timing and appropriateness of this intervention. While DCS can be life-saving, its use must be weighed against the risks it poses to patients' overall condition.[15,16,19]

This study has certain limitations, including its retrospective nature and potential for selection bias. To counter this the data was extracted from a prospective electronic medical record with template-based recording to avoid missing data. Prospective studies with larger cohorts could provide more robust insights into the factors influencing outcomes in bowel trauma cases. Additionally, exploring long-term outcomes, quality of life, and functional recovery would enhance the understanding of the broader impact of bowel injuries on patients' lives.

Conclusion

This study's findings underscore the multifaceted nature of hollow visceral injury management in an ICU population. The insights gained from analysing demographics, injury characteristics, management strategies, physiological support, and outcomes will guide clinicians in optimizing care for patients with hollow viscus injuries. A comprehensive, multidisciplinary approach that considers injury severity, anatomical site, and patient-specific factors is crucial for achieving favourable outcomes in these cases.

Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

Ethical approval was obtained from the University of KwaZulu-Natal Biomedical Research Ethics Committee (Ref: BCA207/09).

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