ORIGINAL ARTICLE

Hollow viscus injury due to blunt abdominal trauma: a tertiary trauma center experience

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ABSTRACT

BACKGROUND: Hollow viscus injuries (HVIs) present less frequently than solid organ injuries in patients with blunt abdominal trauma, potentially leading to significantly increased morbidity and mortality rates. Modern imaging equipment, confidently used for diagnosing solid organ injuries, may fail to identify hollow viscus injuries. In this study, we aim to present our tertiary center's experience with this entity.

METHODS: Patients treated in our clinic from April 2011 to December 2021 for hollow viscus injury following blunt abdominal trauma were included in this study. We recorded and retrospectively evaluated patients' demographic data, injury site and mechanism, preoperative and perioperative findings, and mortality rates in a prospective database.

RESULTS: Of the 607 blunt trauma patients, 35 (5.8%) had hollow viscus injuries, with 88.6% being male. Motor vehicle accidents were the leading cause of injury (80%). The mean duration between admission and surgical exploration was 26±21.2 hours. The mean Injury Severity Score was 21.8±13.6. Rigidity was the most frequent clinical finding (60%). The jejunum and ileum were the most frequently injured organs (54.1%). Mortality and morbidity rates were 11.4% and 17.1%, respectively.

CONCLUSION: Non-declining white blood cell (WBC) counts within 24 hours of admission, alongside any physical or radiological finding indicating an HVI, should prompt immediate surgical exploration.

Keywords: Abdominal trauma; blunt trauma; hollow viscus injury; intestinal injury; laparotomy.

INTRODUCTION

Trauma is a complex entity encompassing a wide spectrum of clinical scenarios. Despite technological advances and innovations in the surgical diagnostic arsenal, blunt abdominal traumas remain a serious challenge for physicians. They are relatively rare, potentially leading to intestinal injuries in 3-5% of patients.[1] Complicating matters further, clinical symptoms such as severe head trauma or abdominal wall injuries may mask severe visceral injuries, leading to overlooked symptoms.[2,3] Multidetector Computed Tomography (MDCT) stands as the most valuable diagnostic tool in assessing these trauma patients.[4] Hemodynamic instability, along with intra-abdominal free fluid (IAFF) on Focused Assessment with Sonography in Trauma (FAST) or signs of peritonitis, prompt emergent surgical exploration.[5,6] However, hollow viscus injuries (HVIs) can be insidious even at admission. Due to mechanisms such as mesenteric tearing and resulting ischemia, an injury may occur after admission and thus be missed by the initial MDCT.[7,8] To provide more insight into the clinical presentations and complications of this infrequent but dangerous clinical scenario, we aimed to present our 10 years of experience in a tertiary surgery and trauma clinic.

MATERIALS AND METHODS

Patients admitted to our clinic between April 2011 and December 2021 were enrolled in this study. All patient data were recorded in a prospective database during their admission and

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Table 1. Demographics and patients characterics

Number of patients (n)	35
Male/Female	31/4
Mean age (years)	41.09±14.61
Male/Female age (years)	42.72±14.32/28.5±11.47
Mechanism of injury	
Motor Vehicle Accident	28 (80%)
IVTA	21 (60%)
MA	5 (14.3%)
PI	2 (5.7%)
Assault and others	4 (11%)
Fall From Height	3 (9%)

IVTA: In-vehicle traffic accident; PI: Pedestrian injury, MA: Motorcycle accident.

Table 2. Extrabdominal injuries

Pelvic and Extremity Fractures	17 (48.6%)
Thorax Trauma	7 (20%)
Spine Fractures	6 (17.1%)
Cranial Injuries	4 (11.4%)
Maxillofacial Injuries	2 (5.7%)

evaluated retrospectively. Ethical approval was obtained from our center's local ethics committee (SBÜ Ümraniye SUAM B.10.1.TKH.4.34.H.GP.0.01/354-05/10/2023) Patients were evaluated in terms of gender, age, mechanism of injury, clinical presentation, laboratory and imaging findings, site of injuries, injured organs, Injury Severity Score (ISS), calculated Revised Trauma Score (RTSc), amount of transfusion, surgical treatment methods, length of hospital stay (LOHS), length of intensive care unit stay (LOICUS), and mortality and morbidity.

While evaluating patients' data, percentages, means, and standard deviations were calculated.

RESULTS

Among 607 patients hospitalized for blunt abdominal trauma in our clinic, 35 (5.8%) had hollow viscus injuries. Demographic data and mechanisms of injury are presented in Table 1. The mean age of patients was 41.09±14.61. Patients were predominantly male, with a male to female ratio of 7.7:1. The most common cause of injury was motor vehicle accidents (MVA) (80%), including 21 (60%) in-vehicle traffic accidents (IVTA), 5 (14.3%) motorcycle accidents (MA), and 2 (5.7%) pedestrian injuries. Other mechanisms included falls from height (8.6%), and assasults and others (11.4%). Extraabdominal injuries consisted of 17 (48.57%) pelvic and extremity fractures, 7 (20%) thorax traumas, 6 (17.1%) spine fractures, 4 (11.4%) cranial, and 2 (5.7%) maxillofacial injuries (Table 2). The mean time between admission and surgical intervention was 26 ± 21.2 hours. White blood cell (WBC) counts at admission and prior to surgery were 15.550±5.490 and 15.960±8,610, respectively. The mean LOHS was 14.8±11.8 days, while the mean LOICUS was 4.9±9.7 days (Table 3). The ISS of patients was 21.8±13.6. The mean RTSc was 7.54±0.85. The average erythrocyte suspension (ES) transfusion amount was 4.2±4.7 U. Among the included patients, 14.3% had an abdominal seat belt sign upon admission. The most common clinical findings during this period were abdominal rigidity (60%), pain (25.7%), guarding (14.3%), and hemodynamic instability (8.6%). The most frequently injured luminal organs were the ileum (31.4%), followed by the jejunum (28.4%) and colon (25.7%). Of these patients, 9 (25.7%) had multiple intestinal injuries. There were a total of 3 (8.6%) rectal injuries (two upper rectum and one below the peritoneal reflection level). Another 11 (31.4%) patients had additional solid abdominal organ injuries (Table 4). IAFF and/or intra-abdominal free air (IAFA) were encountered in 25 (71.4%) patients on initial or repeated MDCT imaging. Small bowel resection (SBR) with or without anastomosis was the preferred sur-

Table 3. Preoperative variables, findings and clinical presentation

	Value		Number of patients
Time to operation (hour)	26±21.22	Rigidity	21 (60%)
WBC count on admission (WBC/mm^3)	15.550±5.490	Pain	9 (25.7%)
Preoperative WBC count (WBC/mm^3)	15.960±8.610	Rebound	5 (14.3%)
Preoperative Hb count (g/dL)	11.85±3.21	Hemodynamic Instability	3 (8.6%)
ISS	21.8±13.6	LOHS (day)	4.83±11.81
Seat belt sign	5 (14.3%)	LOICUS (day)	4.97±9.65
Average RTSc	7.54±0.85		
Need of ES transfusion	31.4%		
Average ES transfusion (U)	4.2±4.7		

ISS: Injury severity score; AIS: Abbreviated injury scale; WBC: White blood cell; LOHS: Length of hospital stay; LOICUS: Length of intensive care unit stay; ES: Eryhrocyte suspension; RTSc: Calculated revised trauma score.

Table 4. Injured intestinal organs, preoperative CT findings, additional injured abdominal organs

Injured intestines	Number of patients	Additional Injured Organ	Number of patients
Jejunum	10 (28.4%)	Liver	4 (11.4%)
Ileum	11 (31.4%)	Spleen	4 (11.4%)
Ileum+ Colon	4 (11.4%)	Kidney	1 (2.9%)
Colon	3 (8.6%)	Pancreas	1 (2.9%)
Ileum+ Rectum	2 (5.7%)	Diaphragm	1 (2.9%)
Jejunum+ Colon	2 (5.7%)	**Preoperative CT findings**	
Jejunum+ Ileum	1 (2.9%)	IA Free Fluid	17 (48.6%)
Duodenum	1 (2.9%)	IA/Retroperitoneal Free Air	8 (22.9%)
Rectum	1 (2.9%)	Bowel Wall Thickening	8 (22.9%)
		Normal Findings	4 (11.4%)

IA: Intraabdominal.

Table 5. Surgical treatment

Treatment	Number of patients (n)
Partial SBR and Anastomosis	15 (42.9%)
Colorectal Resection±Anastomosis	9 (25.7%)
Primary Suturing	9 (25.7%)
Partial SBR and End Ileostomy	4 (11.4%)
Packing	2 (5.7%)
Mesenterial Vessel Ligation	1 (2.9%)

SBR: Small bowel resection.

gical intervention in 19 (53.3%) patients, while primary suturing was possible in only 25.7% of cases (Table 5). Chest tubes were inserted in 3 (8.6%) patients. A total of 4 (11.4%) patients died. Of these, two had unstable pelvic trauma accompanying intestinal injury. The other 2 (50%) patients had severe accompanying thoracic and cranial trauma (Table 6).

DISCUSSION

The most extensive data regarding blunt abdominal traumas were published by Watts et al., including various trauma centers.[9] According to their study, the need for surgical explora-

Table 6. Patients with mortality and their features

Patients	Clinical Presentation	Type of Surgery
40 years/M	Instabil pelvic fracture	Partial ileal resection and end ileostomy
	Ileum mesentery injury	
	Grade 1 kidney injury	
	Left scapula fracture	
	Left hemopneumothorax	
	Bilateral lung contusion	
54 years/M	Ileal necrosis due to mesentery injury	Partial ileal resection and end ileostomy
	Grade 2 splenic injury	
	Bilateral hemothorax	
	Bilateral pulmonary contusion	
	Open right humerus fracture	
	Frontal subarachnoid hemorrhage	
69 years/M	Pedestrian injury	Pelvic packing
	Right open instable pelvic fracture	Primary femoral vein repair
	Rectal injury	Sigmoid loop colostomy
	Right femoral vein injury	
52 years/M	Crush injury	
	Ascending colon and pancreas injury	Right hemicolectomy
	Instable pelvic fracture (open book)	End ileostomy
	Crush syndrome	Pancreatic drainage

tion in all blunt trauma patients admitted to emergency clinics was 0.3%. However, contemporary literature reports surgical exploration rates of 3-11% in hospitalized patients due to blunt abdominal trauma, which aligns with our findings.[10,11]

Our study group consisted of adults with a distinct male predominance, consistent with the literature.[12,13] The main injury source was associated with MVAs, and among MVAs, IVTAs comprised the majority of cases. Contemporary literature also suggests similar MVA rates (65-75%).[10] We believe this mechanism can be attributed to the impact force applied to the abdomen by steering wheels and seat belts. Especially in the case of a seat belt sign, ecchymosis, and/or abrasions on the abdomen, a surgeon must exercise great caution, as they increase the risk of visceral injury.[14]

Abdominal pain and rigidity were the main presenting symptoms upon admission. The rebound phenomenon was less commonly encountered. We believe it is reasonable to assume such percentages, as rebound is closely related to peritoneal irritation, and peritoneal irritation might develop after admission due to either ischemia and/or resulting bowel perforation. However, it is known that accompanying injuries, such as head and spinal trauma or being under the influence, compromise the reliability of physical examination, which can be encountered in blunt abdominal trauma patients.[3] Even a soft abdomen on admission should not rule out the possibility of potential HVIs.[2] The mean ISS for all abdominal trauma patients admitted to emergency clinics is typically between 5 and 6.[15] However, this average exceeds 15 in hospitalized patients[16] and can even surpass 25 in patients requiring surgery due to HVI.[17] Our study also demonstrated an average ISS of 21 in this context, which we believe reflects the correlation between increased trauma severity and the risk of HVI. However, the true cut-off values and the most adequate scoring system for this population have yet to be determined. The average latency between admission and the time of surgery in this study was found to be around 26 hours. Another interesting finding was the non-declining WBC counts within 24 hours post-admission. This time latency is similar to what has been described in the literature.[11] Given this finding, we believe a correlation and cut-off values between common laboratory findings and the necessity for surgical exploration should be established. Although some new peptide markers have been proposed for this purpose and found promising, their reliability has yet to be scientifically proven.[18]

The jejunum and ileum were found to be the most injured organs, followed by colorectal injuries, either in combination with small bowel injuries or in isolated form. This finding is consistent with the literature.[9,12] The main underlying mechanism is that the small bowel is attached to the retroperitoneum by mesentery and is therefore susceptible to injuries, both from being squeezed between the impacting force and the vertebrae, and from sudden deceleration, which results in tearing and devascularization.[19] The rationale for rectal injuries is pelvic fractures resulting in anterior-posterior compression of the rectum.[20] Physicians tend to perform a full-body MDCT for polytrauma patients upon admission. Even though MDCT is effective at identifying emergent pathologies such as intracranial hemorrhages, bone fractures, vessel injuries, intra-abdominal solid organ, and thoracic injuries, it can be deceptive in identifying HVIs.[21] Intraperitoneal or retroperitoneal air, intra-abdominal free fluid without accompanying solid organ injury, the Janus sign (sharp contrast enhancement transition on a single bowel segment), diffuse bowel wall thickening, contrast extravasation from the mesentery, diffuse bowel wall enhancement, and mesenteric infiltration/hematoma have been described as powerful indicators of possible HVIs.[22,23] Nevertheless, the results of our study and the literature indicate that a significant number of HVIs are missed by initial MDCT evaluation. Therefore, in cases of clinical suspicion, a repeated MDCT might help identify occult HVI. Hemodynamic instability and/or abdominal guarding, along with positive findings in either FAST or MDCT, necessitate emergent laparotomy.[24] The challenge lies in determining which patients require surgical exploration after admission. To address this question, we believe that, based on our findings, positive MDCT results combined with laboratory findings and any degree of abdominal discomfort at 24 hours post-admission should prompt surgical exploration.

In terms of surgical exploration, with the wide availability of high-quality equipment and increased surgical expertise, laparoscopy can be preferred. In experienced hands, the chance of missing an intra-abdominal injury is reduced to less than 1%.[25] Possible contraindications include severe cranial and chest trauma, previous intra-abdominal adhesions, and pregnancy.[26] However, data on the utilization of laparoscopy in trauma patients are scarce. Therefore, recommending this technique at this stage is more speculative than evidence-based. We believe more trauma centers should make an effort to practice laparoscopy in this context, allowing for clearer definition of both outcomes and pitfalls.

Our data on surgical approaches to bowel injuries revealed that the majority of cases were handled with resection and anastomosis, followed by primary suturing. Indeed, primary suturing is sufficient in most cases, as the literature suggests.[1,12] However, current literature fails to report small bowel injury grades according to a validated scoring system such as the American Association for the Surgery of Trauma.[11] According to this scoring system, most of our cases consisted of at least > 50% circumferential transection, which can be attributed to differences in surgical technique preferences. Nonetheless, four patients died due to HVI, two of which were due to delayed intervention. This fact alone underscores the importance of a surgeon's vigilance in treating this patient group. Our perioperative complications seem somewhat low. However, we did not include superficial wound infections and atelectasis in our study, which we believe could contribute to the low complication percentage.

This study has several limitations. Firstly, our study group is

relatively small. Although the literature also includes publications with smaller sample sizes, having a larger sample size would be advantageous. Secondly, this study is a retrospective analysis. Even though every patient's data are registered in our clinic's system daily, selection bias cannot be completely avoided under these circumstances. Conducting a prospective study in major trauma patients is both ethically and clinically extraordinarily challenging. Hence, most knowledge about trauma management is developed by experienced trauma centers with a large patient volume.

CONCLUSION

HVI due to blunt abdominal trauma is an insidious clinical entity that necessitates great surgical vigilance. Repeated physical examinations, laboratory tests, and, if deemed necessary, repeated MDCT evaluations are of paramount importance in identifying an HVI. This study suggests that non-declining WBC counts at 24 hours following admission, along with any kind of physical or radiological finding indicative of an HVI, should prompt immediate surgical exploration. We believe that future studies should focus on the timing and laboratory cut-off values, as well as minimal invasive surgical exploration techniques.

Ethics Committee Approval: This study was approved by the Umraniye Training And Research Hospital, Ethics Committee (Date: 05.10.2023, Decision No: 353).

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Authorship Contributions: Concept: A.Ö.; Design: F.E., A.Ö.; Supervision: A.Ö.; Materials: M.K.Y.; Data collection and/or processing: M.K.Y.; Analysis and/or interpretation: A.Ö., M.K.Y.; Literature search: A.Ö., M.K.Y.; Writing: A.Ö., M.K.Y.; Critical review: A.Ö., F.E.

Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Künt abdominal travmaya bağlı lümenli organ yaralanmaları: Üçüncü basamak bir travma merkezi deneyimi

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AMAÇ: Künt travmalı hastalarda lümenli organ yaralanmaları, solid organ yaralanmalarına göre daha az sıklıkta görülen ve kolaylıkla teşhis edilemeyen bir klinik tablo olup, bu durum yüksek mortalite ve morbiditeyle sonuçlanabilir. Karıniçi solid organ yaralanmalarında son derece güvenilir olan gelişmiş görüntüleme cihazları içi boş organ yaralanmasını göstermeyebilir. Bu çalışmada, künt travmaya bağlı içi boş organ yaralanması bulunan hastaların teşhis ve tedavisi ile ilgili klinik tecrübemizi paylaşmayı amaçladık.

GEREÇ VE YÖNTEM: Nisan 2011 ve Aralık 2021 tarihleri arasında künt abdominal travmaya bağlı lümenli organ yaralanması bulunan hastalar bu çalışmaya dahil edildi. Hastaların demografik verileri, yaralanma mekanizmaları ve yerleri, yaralanan organlar, uygulanan cerrahi tedavi yöntemleri, ameliyat öncesi ve cerrahi sürecinde gözlenen bulgular, morbidite ve mortalite prospektif veri tabanında kayıt edilerek retrospektif olarak değerlendirildi.

BULGULAR: Kliniğimizde yatırarak tedavi edilen 607 künt travmalı hastanın 35'inde (%5.8) içi boş organ yaralanması bulundu. Bu hastaların %88.6'sı erkekti. Motorlu taşıt kazaları en sık yaralanma nedeni idi (%80). Yatıştan ameliyata kadar geçen ortalama süre 26±21.2 saat idi. Ortalama Yaralanma Şiddet Derecesi 21.8±13.6 idi. En sık rastlanan bulgu abdominal defanstı (%60). Jejunum ve ileum en sık yaralanan organlardı (%51.4). Mortalite ve morbidite oranları sırasıyla %11.4 ve %17.1 olarak bulundu.

SONUÇ: Yatıştan sonra 24 saat içinde düşmeyen lökositoz değerleri içi boş organ yaralanması şüphesini düşündürebilir. Herhangi bir lümenli organ yaralanmasına işaret eden fizik muayene ve/veya görüntüleme bulgusu varlığında cerrahi eksplorasyon gecikmeden gerçekleştirilmelidir.

Anahtar sözcükler: Abdominal travma; içi boş organ yaralanması; intestinal yaralanma; künt travma; laparatomi.

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