International Surgery Journal
Muhammad MG et al. Int Surg J. 2025 Nov;12(11):1966-1971
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20253456

Systematic Review

The utility of CT scan for identifying hollow viscus injury in blunt abdominal trauma: a systematic review

Marium Gul Muhammad[1]*, David Winston[1], Nancy Pina[1], Tomasz Kasprzycki[1], Brion McCutcheon[1], Robert Joyner[2], Gopal C. Kowdley[1]

[1]Department of Surgery, Tidalhealth Peninsula Regional Hospital, Salisbury, United States
[2]Richard A Hensen Research Institute, Tidalhealth Peninsula Regional Hospital, Salisbury, United States

Received: 12 August 2025
Revised: 16 September 2025
Accepted: 30 September 2025

***Correspondence:**
Dr. Gopal C. Kowdley,
E-mail: gopal.kowdley@tidalhealth.org

ABSTRACT

Introduction: Computed tomography (CT) is the preferred imaging modality for assessing blunt abdominal trauma and is the gold standard for detecting hollow viscus injuries. CT may occasionally miss significant injuries in such settings. This systematic review examines the incidence of hollow viscus injury in blunt abdominal trauma and evaluates the diagnostic accuracy of the initial trauma CT.
Method: A keyword search for PubMed, SCOPUS, Web of Science and Embase was undertaken. Key words "hollow viscus injury" and "blunt abdominal trauma" were used. Inclusion criteria included blunt abdominal trauma, adult population and English language. This search identified 1826 studies. After abstract screening and full text review, 15 studies met criteria to be included in this review.
Result: All studies were retrospective in design and were from trauma centers. A total of 20199 patients had CT scans upon admissions following blunt trauma. The incidence of hollow viscus injury was found to be 14.45% (n=2920/20199). Location of injuries included stomach 0.079% (n= 16/20199), duodenum 0.41% (n=84/20199), Ileum/jejunum 1.65% (n=333/20199), large intestine 0.81% (n=164/20199) and unspecified bowel injuries 11.5% (n=3049/20199). There were a total of 217/20199 (1.07%) injuries that were missed on the initial CT scan. Patients with hollow viscus injury, but negative initial CT scans, were identified within 36 hours of presentation.
Conclusion: Although CT scan is a very effective and widely used method for identification of hollow viscus injury in blunt trauma, it is not always definitive. Patients with hollow viscus injury that were missed on initial CT scans were identified within 36 hours of presentation.

Keywords: Systematic review, Hollow viscus injury, Blunt trauma, CT

INTRODUCTION

Blunt bowel and mesenteric injuries (BBMI) account for approximately 1.1% of all blunt injuries and 3-5% of blunt abdominal trauma incidents, making them a relatively rare but important subset of blunt trauma cases.[1] The challenge lies in diagnosing BBMI promptly, as delayed identification can lead to severe intra-abdominal complications like abscesses, sepsis, and even mortality following surgical intervention.[2] Presently, diagnostic tools beyond physical examinations include paracentesis, diagnostic peritoneal lavage, focused abdominal sonogram for trauma, CT scans, and laparoscopy.[3] CT scans have notably emerged as the preferred diagnostic method for assessing patients with blunt abdominal trauma.[4]

While certain radiological indicators like free intraperitoneal air strongly imply bowel perforation, other markers such as free intraperitoneal fluid or bowel wall thickening may only suggest potential acute injury without definitive confirmation.[5] Prior research studies

have presented conflicting findings regarding the sensitivity of CT scans in detecting bowel injuries, with some reporting poor sensitivity, while others claim high accuracy, particularly in distinguishing bowel injuries requiring surgical intervention.[6] Authors performed a systematic review to assess the published data on the sensitivity of CT scan imaging for identifying BBMI following blunt abdominal trauma.

The intent of this review is to identify what published evidence shows is the role of CT scans in diagnosing hollow viscus injury, thereby elucidating its role in this setting. The primary outcome of the study was to evaluate the sensitivity of initial CT scan to report hollow viscus injury in the setting of blunt abdominal trauma. The secondary outcome was to report missed injuries on an initial CT scan or false negative results.

METHODS

Following the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines, we completed a systematic review of the published scientific literature designed to synthesize the data available describing the utility of the CT scan for identifying hollow viscus injury.[7]

A keyword search of PubMed, SCOPUS, Web of science and Embase was undertaken. The key words "hollow viscus injury", "blunt abdominal trauma" and "bowel injury" were used. Papers were searched for papers published after 2003.

Inclusion criteria required blunt abdominal trauma, hollow viscus injury, initial CT scan, adult population to be the focus of the study and the study must have been written in English. Exclusion criteria included pediatric population, solid organ injury and case reports. Missed injuries were defined as injuries or findings not reported on initial CT scan and were found later, either with repeat CT scan or during surgery. This search identified 1826 studies with 787 removed as duplicates, 863 studies were irrelevant resulting in 171 studies for full text review. Each abstract and title were screened by 2 reviewers (i.e., authors of this study) resulting in either agreement for moving the study forward to full text review, excluding the study, or resulting in disagreement between the reviewers. Disagreements were adjudicated by all study authors. Unanimous consensus determined the inclusion or exclusion of the study. Full text screening excluded 156 studies based on exclusion criteria. This resulted in 15 studies being retained for data extraction (Figure 1). Retrospective studies highlighting blunt abdominal trauma and its imaging detection, primarily on CT scans, were included in the systematic review.

Following data extraction, a study quality assessment was conducted based on the criteria identified in the revised Downs and Black checklist.[8] The revised checklist includes ten items on reporting, three items on external validity, thirteen items on internal validity, and one item on power.

The power item was assessed using modified criteria reported in previous studies and determined by whether the study included a power analysis (0=not included, 1=included). The checklist yields a final numerical score ranging from 0–28 for randomized controlled trials and 0–25 for non-randomized controlled trials. Quality was evaluated using the previously described scoring ranges of strong (21–28), moderate (14–20), limited (7–13), and poor (<7).

RESULTS

All studies, as compiled in Table 1, were from trauma centers and retrospective in design. These studies encompassed 20199 patients who had abdominal CT scans upon initial evaluation following blunt trauma. Many patients did not receive CT imaging upon initial evaluation for blunt trauma. Hollow viscus injury was noted in 14.45% (n=2920). Genders of the patients were males (n=424), female (n=186) and gender unknown (n=2310). Injury locations were stomach 0.079% (n= 16), duodenum 0.41% (n= 84), Ileum/jejunum 1.65% (n=333), large intestine 0.81% (n=164), and unspecified bowel injuries 11.5% (n=2323). Hollow viscus injury was not identified in 217 patients (217/20199=1.07%).

Table 1: Synopsis of data from studies included in this systematic review.

S. no.	Study	Total no. of patients with CT scans	Total no. of patients with hollow viscus injury on CT scan	Injuries noted/missed injuries	Gender	Quality of the study
1.	Fakhry et al[9]	203	72	69/3	Male: 49 Female: 23	Strong
2.	Fakhry et al[10]	3258	1615	1429/186	Unknown: 1615	Strong
3.	Firetto et al[11]	831	34	34/0	Male: 31 Female: 3	Strong
4.	Young et al[12]	2000	94	93/1	Male: 41 Female:53	Moderate
5.	Liao et al[13]	6164	188	176/12	Male: 146 Female: 42	Moderate
6.	Hefny et al[14]	419	21	19/2	Male: 18	Moderate

Continued.

S. no.	Study	Total no. of patients with CT scans	Total no. of patients with hollow viscus injury on CT scan	Injuries noted/missed injuries	Gender	Quality of the study
					Female: 3	
7.	Chen et al[15]	597	34	34/0	Unknown: 34	Limited
8.	Okishio et al[16]	73	73	73/0	Male: 47 Female: 26	Moderate
9.	Polat et al[17]	48	27	27/0	Male: 23 Female: 4	Strong
10.	Bekker et al[18]	1066	439	439/0	Unknown: 439	Strong
11.	Delaplain et al[19]	754	69	68/1	Male: 38 Female: 31	Strong
12.	Gonser et al[20]	22179	156	152/4	Unknown:156	Strong
13.	Magu et al[21]	32	32	28/4	Male: 31 Female: 1	Moderate
14.	Joseph et al[22]	337	30	26/4	Unknown: 30	Moderate
15.	Scaglione et al[23]	1518	36	36/0	Unknown: 36	Moderate

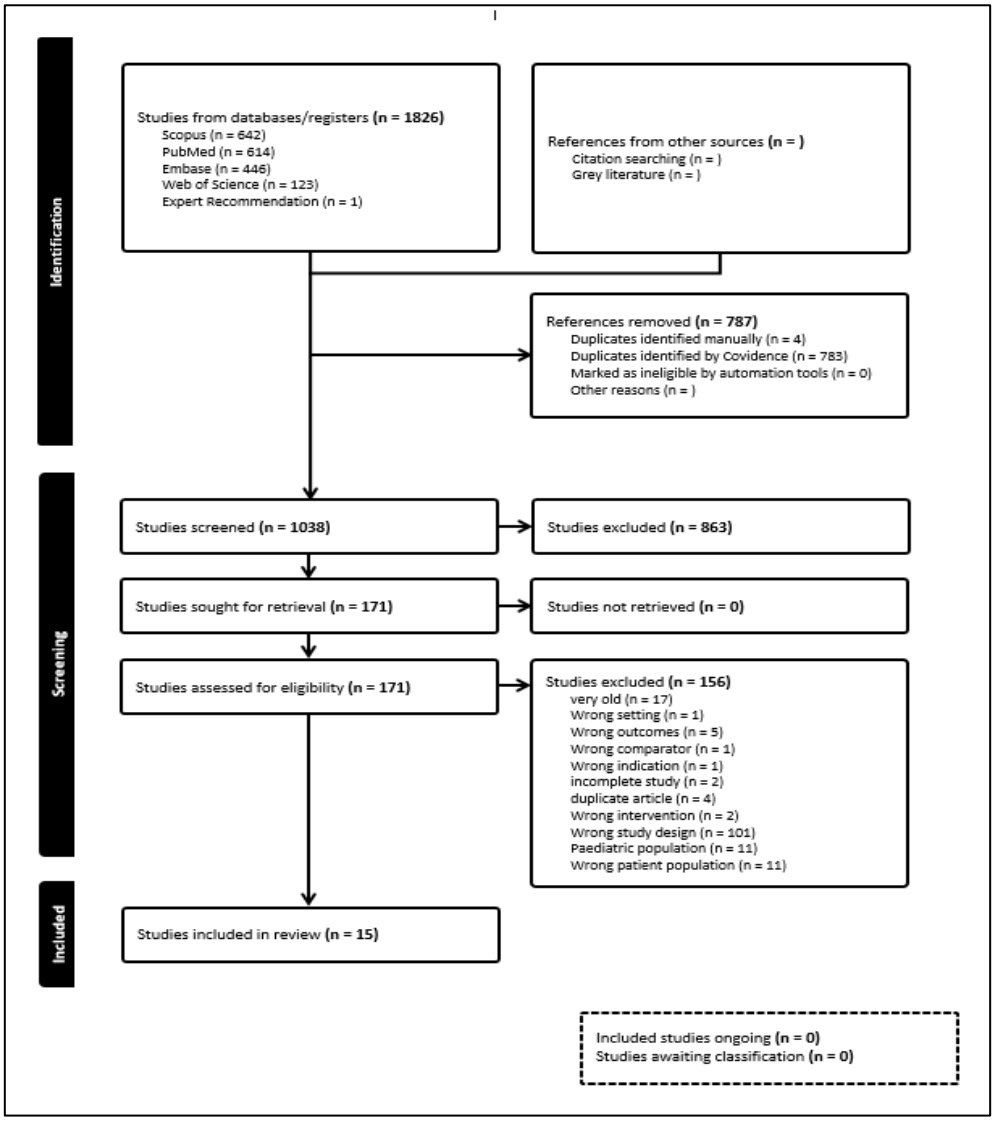

Figure 1: PRISMA flow diagram of literature search and selection.

The types of injuries missed were commonly small bowel, colon, and duodenal injuries. Patients with hollow viscus injury, but negative initial CT scans were identified within 8-36 hours of presentation. These patients were identified either on a repeat CT scan or peritonitis on delayed physical exams. The table presents the total number of patients with hollow viscus injury, the number of injuries noted versus missed injuries, gender distribution, and the quality rating of each study. The studies are categorized based on their respective patient populations, with injuries reported as either noted or missed, alongside the gender breakdown (male/female) and the study's quality classification (Strong, Moderate, or Limited).

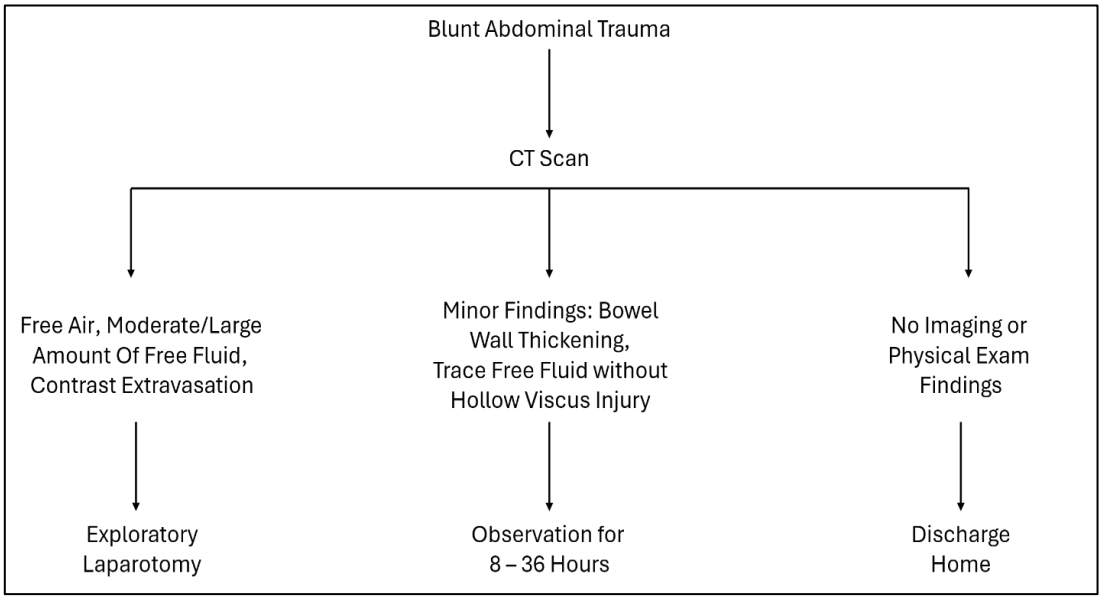

Figure 2: Intervention decision tree based on this systematic review.

DISCUSSION

With an occurrence rate of 1%–3% in patients experiencing blunt abdominal trauma, bowel and mesenteric injuries rank third in frequency, following spleen and liver injuries.[5] Common findings reported on initial CT scan following blunt abdominal trauma were pneumoperitoneum, free fluid, bowel wall thickening, mesenteric stranding, contrast extravasation, retroperitoneal bleed & chance fracture in our systematic review which are consistent with findings reported in study conducted by Brofman et al.[6]

Small bowel injuries account for approximately 70–80% of blunt bowel trauma injuries, with the jejunum and ileum involved in about 80.9% and the duodenum in 10–15%, as reported by Bonomi et al and Kaewlai et al. Other affected organs include the colon (5–20%), stomach (4.3%), and appendix (0.4%), in decreasing order of frequency.[4,5] In the systematic review, we found that the overall prevalence of small bowel injury was 69.8%, with jejunum/ileum involvement accounting for 55.7% and duodenal injuries accounting for 14.07%, similar to the rates found in these studies.[4,5]

However, the prevalence of colon involvement in our review was 27.4%, which is considerably higher than the rates reported in those studies. Intra-abdominal complications, including sepsis, abscess, and even death, can occur following surgical repair due to delayed diagnosis. According to Thompson et al even eight hours of delay may be associated with a higher risk of morbidity in cases of blunt bowel injury.[24] A delay of more than 5 hours between admission and laparotomy was found to be an independent risk factor for mortality in a retrospective analysis of 195 patients with hollow viscus & mesenteric injuries by Malinoski et al.[25] According to the statistical analysis by Mingoli et al delays in treatment longer than six hours and an increase in WBC count during the initial ER evaluation are strongly linked to postoperative morbidity.[26]

Among patients with blunt trauma, those who experienced postoperative complications had a significantly longer average treatment delay (22.5±3.6 hours) than those who did not (6.1±1.4 hours). Additionally, the analysis showed that patients with bowel injuries treated 24 hours after ER admission had a 100% chance of developing postoperative complications, with treatment delays of 12 and 24 hours having positive predictive values for postoperative morbidity of 73.5% and 100%, respectively. This is in line with data that indicates these patients require surgery in less than 24 hours, preferably in less than 8 hours.[9]

Given the high risk associated with false negatives, patients with multiple suspicious findings of bowel or mesenteric injury on CT should undergo urgent surgical

exploration, especially when unexplained or nonspecific findings are present.[1,3] Several of these studies indicate that only performing CT scan is unreliable in diagnosing BBMI, even though it is currently the best non-invasive modality available for doing so.[27] According to Sharma et al out of 23 patients, or 35% of the patients, did not receive a BBMI diagnosis at first, Bhagvan et al reported that in 588 patients with small bowel perforation, the incidence of false-negative CT scans was 13%.[1,8,28]

Wadhwa et al, reported that 62% of patients with stable hemodynamic status (31 cases) underwent surgery based on abdominal contrast-enhanced CT (CECT) findings. Notably, in 10 patients (30%), hollow viscus injuries (HVI) were not identified during the initial clinical and radiological evaluations, including CT scans. Among these undetected injuries, there were 2 cases of mesenteric injury, 2 small bowel injuries, and 6 large bowel injuries.[29] Previous studies have also reported that bowel injuries are often overlooked in patients with blunt abdominal trauma. These findings underscore the need for a high level of clinical suspicion and thorough tertiary surveys to ensure timely diagnosis and appropriate treatment.[29,30]

The algorithm outlined in this study (Figure 2) is designed to guide the management of patients with blunt abdominal trauma, specifically in relation to the detection of hollow viscus injuries. It incorporates major and minor CT findings to determine the appropriate clinical course of action. The algorithm begins with the identification of major CT findings, such (perforation, free air, moderate/large amount of free fluid or bowel discontinuity). When these major findings are present, the algorithm recommends immediate surgical intervention, guiding the patient directly to the operating room (OR) for exploration.

In cases where minor CT findings are identified, such as (subtle bowel wall thickening, minimal fluid collection), the algorithm suggests a period of observation ranging from 8 to 36 hours. During this observation period, patients are closely monitored for any progression of symptoms or changes in their clinical status, after which a decision regarding surgery or discharge is made. For patients with no significant findings on CT or physical examination, the algorithm recommends discharge as these individuals are deemed to have a low likelihood of injury. Clinical and imaging findings that do not suggest a major or minor injury are used to ensure that patients are safely managed and do not require further intervention. This structured decision-making approach helps ensure that patients are appropriately triaged, minimizing unnecessary surgical interventions while promptly addressing those who require urgent care. The algorithm was developed to improve consistency in clinical decision-making and reduce diagnostic delays in the management of blunt abdominal trauma.

The study has several limitations. First, all papers identified were retrospective in design, and only patients with blunt abdominal trauma were included. Additionally, studies involving solid organ injuries were excluded, which reduced the number of studies considered. Lastly, the accuracy of the data may be affected by potential documentation errors in medical records.

CONCLUSION

Although CT scan is highly effective and the most often used method for identification of bowel injury in blunt trauma, it is not always definitive. Careful observation with clinical exam and repeat imaging are essential to minimize missing a delayed presentation of viscus injury in the trauma setting. Figure 2 summarizes our recommended algorithm for assessment of hollow viscus injury in blunt trauma.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Bhagvan S, Turai M, Holden A, Ng A, Civil I. Predicting hollow viscus injury in blunt abdominal trauma with computed tomography. World J Surg. 2013;37(1):123-6.
2. Coleman JJ, Zarzaur BL. Surgical management of abdominal trauma: hollow viscus injury. Surg Clin. 2017;97(5):1107-17.
3. Faget C, Taourel P, Charbit J, Ruyer A, Alili C, Molinari N, et al. Value of CT to predict surgically important bowel and/or mesenteric injury in blunt trauma: performance of a preliminary scoring system. European Radiol. 2015;25(12):3620-8.
4. Kaewlai R, Chatpuwaphat J, Maitriwong W, Wongwaisayawan S, Shin CI, Lee CW. Radiologic imaging of traumatic bowel and mesenteric injuries: a comprehensive up-to-date review. Korean J Radiol. 2023;24(5):406.
5. Bonomi AM, Granieri S, Gupta S, Altomare M, Cioffi SP, Sammartano F, et al. Traumatic hollow viscus and mesenteric injury: role of CT and potential diagnostic–therapeutic algorithm. Upd Surg. 2021;73(2):703-10.
6. Brofman N, Atri M, Hanson JM, Grinblat L, Chughtai T, Brenneman F. Evaluation of bowel and mesenteric blunt trauma with multidetector CT. Radiograph. 2006;26(4):1119-31.
7. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;3:72.
8. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. J Epidemiol Comm Health. 1998;52(6):377-84.
9. Fakhry SM, Allawi A, Ferguson PL, Michetti CP, Newcomb AB, Liu C, et al. Blunt small bowel

perforation (SBP): an Eastern Association for the Surgery of Trauma multicenter update 15 years later. J Trauma Acute Care Surg. 2019;86(4):642-50.
10. Fakhry SM, Watts DD, Luchette FA, EAST Multi-Institutional HVI Research Group. Current diagnostic approaches lack sensitivity in the diagnosis of perforated blunt small bowel injury: analysis from 275,557 trauma admissions from the EAST multi-institutional HVI trial. J Trauma Acute Care Surg. 2003;54(2):295-306.
11. Firetto MC, Sala F, Petrini M, Lemos AA, Canini T, Magnone S, et al. Blunt bowel and mesenteric trauma: role of clinical signs along with CT findings in patients' management. Emerg Radiol. 2018;25(5):461-7.
12. Young K, Benson M, Higgins A, Dove J, Hunsinger M, Shabahang M, Blansfield J, Torres D, Widom K, Wild J. In the modern era of CT, do blunt trauma patients with markers for blunt bowel or mesenteric injury still require exploratory laparotomy. The American Surg. 2017;83(7):722-7.
13. Young K, Benson M, Higgins A, Dove J, Hunsinger M, Shabahang M, Blansfield J, Torres D, Widom K, Wild J. In the modern era of CT, do blunt trauma patients with markers for blunt bowel or mesenteric injury still require exploratory laparotomy. American Surg. 2017;83(7):722-7.
14. Hefny AF, Kunhivalappil FT, Matev N, Avila NA, Bashir MO, Abu-Zidan FM. Usefulness of free intraperitoneal air detected by CT scan in diagnosing bowel perforation in blunt trauma: experience from a community-based hospital. Injury. 2015;46(1):100-4.
15. Chen ZB, Zhang Y, Liang ZY, Zhang SY, Yu WQ, Gao Y, Zheng SS. Incidence of unexplained intra-abdominal free fluid in patients with blunt abdominal trauma. Hepatobiliary & Pancreatic Diseases International: HBPD INT. 2009;8(6):597-601.
16. Okishio Y, Ueda K, Nasu T, Kawashima S, Kunitatsu K, Kato S. Surgical intervention for blunt bowel and mesenteric injury: indications and time intervals. European J Trauma Emerg Surg. 2021;47(6):1739-44.
17. Polat A, Aydin R, Nural M, Gul S, Polat A, Aslan K. Bowel and mesenteric injury in blunt trauma: diagnostic efficiency and importance of experience in using multidetector computed tomography. Ulusal Travma Ve Acil Cerrahi Dergisi-Turkish J Trauma Emerg Surg. 2014;6:417-22.
18. Bekker W, Smith MT, Kong VY, Bruce JL, Laing G, Manchev V, et al. Isolated free fluid on computed tomography for blunt abdominal trauma. Annals Royal Coll Surg England. 2019;101(8):552-7.
19. Delaplain PT, Tay-Lasso E, Biffl WL, Schaffer KB, Sundel M, Behdin S, et al. Excluding hollow viscus injury for abdominal seat belt sign using computed tomography. JAMA Surg. 2022;157(9):771-8.
20. Gonser-Hafertepen LN, Davis JW, Bilello JF, Ballow SL, Sue LP, Cagle KM, Venugopal C, Hafertepen SC, Kaups KL. Isolated free fluid on abdominal computed tomography in blunt trauma: watch and wait or operate. J American Coll Surg. 2014;219(4):599-605.
21. Magu S, Agarwal S, Gill RS. Multi detector computed tomography in the diagnosis of bowel injury. Indian J Surg. 2012;74(6):445-50.
22. Scaglione M, Castelguidone ED, Scialpi M, Merola S, Diettrich AI, Lombardo P, et al. Blunt trauma to the gastrointestinal tract and mesentery: is there a role for helical CT in the decision-making process. European J Radiol. 2004;50(1):67-73.
23. Scaglione M, Castelguidone ED, Scialpi M, Merola S, Diettrich AI, Lombardo P, et al. Blunt trauma to the gastrointestinal tract and mesentery: is there a role for helical CT in the decision-making process. European J Radiol. 2004;50(1):67-73.
24. Thompson SR, Holland AJ. Perforating small bowel injuries in children: influence of time to operation on outcome. Injury. 2005;36(9):1029-33.
25. Malinoski DJ, Patel MS, Yakar DO, Green D, Qureshi F, Inaba K, et al. A diagnostic delay of 5 hours increases the risk of death after blunt hollow viscus injury. J Trauma Acute Care Surg. 2010;69(1):84-7.
26. Mingoli A, La Torre M, Brachini G, Costa G, Balducci GB. Hollow viscus injuries: predictors of outcome and role of diagnostic delay. Therap Clin Risk Man. 2017;3:1069-76.
27. Scaglione M, Castelguidone ED, Scialpi M, Merola S, Diettrich AI, Lombardo P. Blunt trauma to the gastrointestinal tract and mesentery: is there a role for helical CT in the decision-making process. European J Radiol. 2004;50(1):67-73.
28. Sharma OP, Oswanski MF, Singer D, Kenney B. The role of computed tomography in diagnosis of blunt intestinal and mesenteric trauma (BIMT). J Emerg Med. 2004;27(1):55-67.
29. Wadhwa M, Kumar R, Trehan M, Singla S, Sharma R, Ahmed A, Sharma R. Blunt abdominal trauma with hollow viscus and mesenteric injury: a prospective study of 50 cases. Cureus. 2021 Feb 12;13(2):11321.
30. Lawson CM, Daley BJ, Ormsby CB, Enderson B. Missed injuries in the era of the trauma scan. J Trauma Acute Care Surg. 2011;70(2):452-8.

Cite this article as: Muhammad MG, Winston D, Pina N, Kasprzycki T, McCutcheon B, Joyner R, et al. The utility of CT scan for identifying hollow viscus injury in blunt abdominal trauma: a systematic review. Int Surg J 2025;12:1966-71.