International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

A Sequential Imaging Protocol for Blunt Abdominal Trauma: Defining the Complementary Roles of Ultrasonography and Computed Tomography

Dr Akshata Dandigi[1], Dr Ananth Dhotre[2], Dr Md Faheem[3]

[1]Assistant professor, Radio diagnosis Khaja Bandanawaz Institute of Medical Sciences, Kalaburagi
[2]Associate Professor Radio diagnosis, M R Medical College Kalaburagi
[3]Consultant, Dandoti diagnostics, Kalaburagi Radio diagnosis

OPEN ACCESS

Corresponding Author:

Dr Akshata Dandigi
Assistant professor, Radio diagnosis Khaja Bandanawaz Institute of Medical Sciences, Kalaburagi
Email: akshatadandigi25703@gmail.com

Received: 07-04-2026
Accepted: 08-06-2026
Available online: 16-06-2026

ABSTRACT

Background: Blunt abdominal trauma (BAT) is a leading cause of preventable mortality in India, with road traffic accidents accounting for the majority of cases. Rapid, accurate imaging is essential to guide triage and management decisions. While ultrasonography (USG) and contrast-enhanced computed tomography (CECT) are both widely used, their precise complementary roles in a sequential protocol have not been clearly defined from the Indian tertiary care perspective.
Objective: To prospectively evaluate and compare the diagnostic performance of USG and CECT in detecting abdominal organ injuries, hemoperitoneum, and hollow visceral injuries in patients with blunt abdominal trauma, and to validate a USG-first, CT-confirmatory sequential imaging algorithm.
Methods: A prospective observational study was conducted over 18 months (October 2018 – April 2020) at Basaveshwar Teaching and General Hospital, Kalaburagi. Fifty consecutive patients with BAT underwent both USG (GE LOGIQ series) and CECT abdomen (Philips ACCESS). Organ injuries were graded by the AAST Organ Injury Scale. Sensitivity, specificity, PPV, and NPV of USG were calculated with CECT as the reference standard. Imaging findings were correlated with operative findings and clinical outcomes.
Results: Road traffic accidents accounted for 74% of cases; 82% were male, predominantly in the 31–40 year age group. Spleen (46%) was the most frequently injured organ, followed by liver (32%). USG detected 45 of 50 confirmed injuries (overall detection rate 90%) with 100% sensitivity and specificity for splenic and hepatic injuries. USG missed one renal, one pancreatic, one hollow visceral, one urinary bladder, and one retroperitoneal injury — all detected on CECT. CT-operative correlation was 100% in the 11 surgically managed patients.
Conclusion: USG is the ideal initial rapid screening tool in BAT, particularly in hemodynamically unstable patients, with excellent performance for solid organ injuries. CECT is essential for definitive injury characterisation and grading. A USG-first, CT-confirmatory protocol is clinically safe, diagnostically robust, and resource-efficient for Indian tertiary care centres.

Keywords: blunt abdominal trauma, ultrasonography, computed tomography, FAST, AAST organ injury scale, hemoperitoneum, sequential imaging protocol, India.

INTRODUCTION

Blunt abdominal trauma (BAT) is one of the most common causes of morbidity and mortality seen in emergency departments, especially in developing countries like India where road traffic accidents are increasing.[1,2] In India, the burden of BAT is amplified by high-velocity road accidents, poor protective gear compliance, and delayed access to trauma care. The main difficulty is that abdominal injuries are often clinically silent in early stages, and by the time signs appear, the patient may already be hemodynamically unstable.[3]

Imaging has become more reliable than clinical examination alone in evaluating abdominal trauma.[4] Ultrasonography has been the first-line tool of choice given its portability, non-invasive nature, real-time capability, and applicability even in hemodynamically unstable patients.[5,6,7] The Focused Assessment with Sonography in Trauma (FAST) protocol, which detects free intraperitoneal fluid, is now universally integrated into Advanced Trauma Life Support guidelines.

Contrast-Enhanced Computed Tomography (CECT) offers superior anatomical resolution, accurate injury grading, and the capacity to evaluate retroperitoneal structures — areas where USG is inherently limited.[8,9] Reported sensitivities of 92–97.6% and specificities up to 98.7% establish CT as the gold standard for hemodynamically stable patients.[10,11] However, CT is resource-intensive, involves radiation exposure, and requires patient cooperation and hemodynamic stability.

This study was designed to prospectively define the precise role of each modality tertiary care setting, and to validate a protocol-based approach that maximises diagnostic yield while preserving clinical efficiency.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective observational study conducted in the Department of Radiodiagnosis, Basaveshwar Teaching and General Hospital attached to Mahadevappa Rampure Medical College (MRMC), Kalaburagi, Karnataka, India, from October 2018 to April 2020. Ethical clearance was obtained from the Institutional Ethics Committee, MRMC (IEC Reg. No. ECR/889/Inst./KA/2017; Ref. HKES/MRMCK/IEC/201250, dated 15.12.2020). Written informed consent was obtained from all patients or their legal guardians.

Participants

Fifty consecutive patients presenting to the emergency department with blunt abdominal trauma were enrolled after applying the following criteria:

1. Inclusion: All patients with blunt abdominal trauma who underwent both USG and CECT abdomen.
2. Exclusion: Penetrating trauma; hemodynamic instability precluding CT; prior abdominal surgery distorting anatomy; refusal of consent; age < 1 year.

Imaging Protocol

USG was performed using GE LOGIQ P9, GE LOGIQ P5, and GE LOGIQ F6 systems. All patients underwent a standardised FAST examination followed by extended organ-specific assessment. CECT abdomen was performed on a Philips ACCESS scanner with pre-contrast, arterial phase (25–30 seconds), and portal venous phase (70–80 seconds) acquisitions after intravenous contrast administration. Organ injuries were graded according to the American Association for the Surgery of Trauma (AAST) Organ Injury Scale.[11]

Outcome Measures and Statistical Analysis

The primary outcome was the detection rate of organ injuries on USG compared to CECT (reference standard). Secondary outcomes included injury grading accuracy, management decisions, and operative correlation. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of USG were calculated organ-wise. Clinical and operative outcomes were recorded prospectively.

RESULTS

Demographics and Mechanism of Injury

The study cohort comprised 50 patients aged 5–80 years (mean 42.5 years). Males accounted for 41 cases (82%) and females for 9 (18%). The most affected age group was 31–40 years (16 cases; 32%), followed by 41–50 years (12 cases; 24%) and 21–30 years (11 cases; 22%). Road traffic accident (RTA) was the predominant mechanism (37 cases; 74%), followed by fall from height (9 cases; 18%) and assault (4 cases; 8%).

Table 1: Demographic and Injury Characteristics

Parameter	Category	n (%)
Sex	Male	41 (82%)
	Female	9 (18%)
Peak Age Group	31–40 years	16 (32%)
Mechanism	RTA	37 (74%)
	Fall from height	9 (18%)
	Assault	4 (8%)

Overall Detection Rates

USG detected injuries in 45 of 50 cases (overall detection rate 90%), while CECT detected all 50 confirmed cases. USG missed five injuries: one renal, one pancreatic, one hollow visceral, one urinary bladder, and one retroperitoneal haemorrhage. All five missed injuries were retroperitoneal or hollow visceral in nature.

Organ-wise Injury Distribution and Diagnostic Performance

Spleen was the most commonly injured organ (23 cases; 46%), followed by liver (16 cases; 32%). Hemoperitoneum was detected in 40 cases (80%) on both modalities. Table 2 summarises the organ-wise comparison and diagnostic performance of USG.

Table 2: Organ-wise Injury Detection and Diagnostic Performance of USG (CT as Reference Standard)

Organ	USG +ve	CT +ve	Sensitivity	Specificity	PPV	NPV
Spleen	23	23	100%	100%	100%	100%
Liver	16	16	100%	100%	100%	100%
Kidney	2	3	66.6%	100%	100%	97.9%
Hollow Viscera	2	3	66.6%	100%	100%	97.9%
Pancreas	1	2	50%	100%	100%	97.9%
Urinary Bladder	0	1	0%	100%	—	98.0%
Retroperitoneal Haem.	0	1	0%	100%	—	98.0%
Parietal Wall Haematoma	1	1	100%	100%	100%	100%
Hemoperitoneum	40	40	100%	100%	100%	100%

Injury Grading

For splenic injuries (n=23), USG and CT agreed on grades III and IV. However, two cases graded as Grade I on USG were upgraded to Grade II on CT, demonstrating CT's superior grading resolution. For hepatic injuries (n=16), one Grade I on USG was reclassified as Grade II on CT. For renal injuries, the single missed case on USG was a Grade III injury. The sole pancreatic injury missed on USG was a Grade III transection of the body and tail — a finding with critical surgical implications correctly characterised only on CT.

Table 3: Splenic and Hepatic Injury Grading — USG vs. CT

Grade	Spleen (n=23)		Liver (n=16)		Kidney (n=3)	
	USG	CT	USG	CT	USG	CT
Grade I	14	12	9	8	1	0
Grade II	0	2	4	5	1	2
Grade III	8	8	2	2	0	1
Grade IV	1	1	1	1	0	0

Management and Outcomes

Of the 50 patients, 39 (78%) were managed conservatively with full clinical recovery. Eleven (22%) underwent surgical intervention; CT findings correlated precisely with operative findings in all 11 cases, confirming CT's indispensable role in preoperative planning. Two postoperative deaths were recorded (4%), both in patients with high-grade multi-organ injuries.

Table 4: Management and Clinical Outcome

Outcome	Conservative (n=39)	Operative (n=11)
Survived / Improved	39	9

Outcome	Conservative (n=39)	Operative (n=11)
Deaths	0	2

DISCUSSION

The findings of this study reinforce the established paradigm that BAT evaluation requires a complementary, protocol-based imaging approach rather than reliance on a single modality.[12] The male predominance (82%) and peak injury incidence in the 31–40 year productive age group are consistent with published Indian data, reflecting the demographics of road traffic accident victims in the country.[13,14]

The spleen's position as the most commonly injured organ (46%) in our series is well-documented in both Indian and international literature, attributable to its exposed location, lack of bony protection, and highly vascular parenchyma.[9,20] Hepatic injuries (32%) constituted the second most common finding. Notably, USG achieved 100% sensitivity and specificity for both splenic and hepatic injuries, aligning closely with prior prospective Indian studies.[16,18]

The most clinically significant finding of this study, however, is not where USG performs well — it is where USG fails. All five missed injuries were retroperitoneal or hollow visceral: one renal, one pancreatic, one hollow visceral, one urinary bladder, and one retroperitoneal haemorrhage. Retroperitoneal organs are difficult to assess on ultrasound due to overlying bowel gas, and hollow viscus injuries show only indirect signs on ultrasound which can be easily missed. Pneumoperitoneum, mesenteric thickening, subtle free fluid can be missed on USG in the acute trauma setting.

The missed pancreatic injury in our series deserves particular emphasis. It was a Grade III transection of the body and tail — a high-stakes injury where delayed diagnosis leads to pseudocyst formation, fistula, and sepsis.[19] CT correctly identified the transection and peripancreatic fluid, enabling timely surgical intervention. This case highlights the limitation of USG in detecting pancreatic injuries and the need for CT in trauma patients.

Our CT-operative correlation of 100% (11/11 surgical cases) validates the reliability of CECT findings as the basis for operative decision-making.[10,11] This is consistent with findings from Kharbanda et al.[15] and Chudasama and Darji[13] who similarly reported superior CT performance for preoperative planning in blunt trauma.

Taken together, these findings support a clearly defined sequential protocol: USG as the initial, rapid triage tool — particularly in hemodynamically unstable patients where CT is contraindicated — followed by CECT for all USG-positive cases, USG-negative but clinically symptomatic cases, and cases where USG quality is suboptimal.[12,16] Hemodynamically stable patients with a convincingly negative USG and no clinical signs may be monitored without immediate CT, reducing unnecessary radiation exposure and resource consumption.[17]

A limitation of this study is the relatively small sample size of 50 patients, which limits subgroup analysis, particularly for less common injuries such as pancreatic and bladder trauma. A multicentre prospective study with a larger cohort would strengthen the generalisability of these findings. Additionally, the use of a single-phase CT in some early cases may have limited sensitivity for active vascular extravasation.

CONCLUSIONS

Ultrasonography is an essential, irreplaceable first-line tool in blunt abdominal trauma — rapid, portable, and highly accurate for splenic, hepatic, and hemoperitoneum detection.[6,7] However, its inability to reliably evaluate the retroperitoneum and hollow viscera mandates CECT for definitive injury characterisation in all haemodynamically stable patients.[9,10]

USG is a quick and useful first investigation, especially in unstable patients, and performs well for solid organ injuries. A sequential USG-first, CECT-confirmatory protocol is safe, practical, and cost effective for managing blunt abdominal trauma. This study provides prospective evidence supporting this protocol from a government teaching hospital setting, adding to the growing body of regional Indian data on trauma imaging.[12,16]

DECLARATIONS

Ethics Approval and Consent: Ethical clearance was obtained from the IEC, MRMC, Kalaburagi (Reg. No. ECR/889/Inst./KA/2017). Written informed consent was obtained from all participants.

Conflicts of Interest: None declared.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements: The authors thank the Department of Surgery, Basaveshwar Teaching and General Hospital, for their cooperation in operative correlations.

REFERENCES

1. Stone CK, Humphries RL. Current Diagnosis & Treatment: Emergency Medicine. 6th ed. New York: McGraw-Hill; 2007.
2. Mohapatra S, Pattanayak SP, Rao KRRM, Bastia B. Options in the management of solid visceral injuries from blunt abdominal trauma. Indian J Surg. 2003;65:263–8.
3. Richards JR, Knopf NA, Wang L, Magahan JP. Blunt abdominal trauma in children: evaluation with emergency US. Radiology. 2002;222:749–54.
4. Shih HC, Wen YS, Ko TJ, et al. Non-invasive evaluation of blunt abdominal trauma: prospective study using diagnostic algorithms to minimise non-therapeutic laparotomy. World J Surg. 1999;23:265–70.
5. Dolich MO, McKenney MG, Varela JE, et al. 2,576 ultrasounds for blunt abdominal trauma. J Trauma. 2001;50:108–12.
6. McKenney KL, Nunez DB, McKenney MG, et al. Sonography as primary screening technique for blunt abdominal trauma: experience with 899 patients. AJR Am J Roentgenol. 1998;170:979–85.
7. Bode JP, Niezen RA, van Vugt AB, et al. Abdominal ultrasound as a reliable indicator for conclusive laparotomy in blunt abdominal trauma. J Trauma. 1993;34:27–31.
8. Boulanger BR, Brenneman FD, McLellan BA, et al. A prospective study of emergent abdominal sonography after blunt trauma. J Trauma. 1995;39:325–30.
9. Novelline RA, Rhea JT, Bell T. Helical CT of abdominal trauma. Radiol Clin North Am. 1999;37:591–612.
10. Shuman WP. CT of blunt abdominal trauma in adults. Radiology. 1997;205:297–306.
11. Moore EE, Cogbill TH, Jurkovich GJ, et al. Organ injury scaling V: spleen and liver (1994 revision). J Trauma. 1995;38:323.
12. Mallik K, Vashisht S, Thakur S, Srivastava DN. Comparative evaluation of ultrasonography and CT in patients with abdominal trauma: a prospective study. Indian J Radiol Imaging. 2000;10:237–43.
13. Chudasama S, Darji N. Role of USG and MDCT in blunt abdominal trauma. Int J Sci Res. 2019;8(12):208–12.
14. Ravindernath M, Reddy G. Comparison of efficacy of CT scan and ultrasound in patients with blunt abdominal trauma. Int J Adv Med. 2017;4(2):370–4.
15. Kharbanda A, Mital M, Saran S, Verma SR. Multimodality imaging approach to blunt abdominal trauma in a tertiary care centre in North India. West Afr J Radiol. 2020;27:40–5.
16. Parthasarathi A, Gautham M, Kishor VH. Role of ultrasonography and computed tomography in evaluation of blunt abdominal trauma. J Med Sci Clin Res. 2013;1(2):236–51.
17. Liu M, Lee CH, P'eng FK. Prospective comparison of diagnostic peritoneal lavage, CT scanning, and ultrasonography for the diagnosis of blunt abdominal trauma. J Trauma. 1993;35(2):267–70.
18. Sanjeev Suman, Babita, Singh GN. Study on abdominal trauma patients comparatively by ultrasonography and CT. Int J Contemp Med Res. 2017;4(4):872–3.
19. Gupta A, Stuhlfaut JW, Fleming KW, et al. Blunt trauma of the pancreas and biliary tract: a multimodality imaging approach to diagnosis. Radiographics. 2004;24:1381–95.
20. Federle MP, Courcoulas AP, Powell M, et al. Blunt splenic injury in adults: clinical and CT criteria for management, with emphasis on active extravasation. Radiology. 1998;206:137–42.