e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2024; 16(1); 1889-1892

Original Research Article

Ultrasound versus Computed Tomography Scan Findings in Pediatric Blunt Abdominal Traumas

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Received: 25-10-2023 / Revised: 23-11-2023 / Accepted: 26-12-2023

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Conflict of interest: Nil

Abstract:

Objective: This investigation, carried out within the Department of Radiodiagnosis at Rama Medical College Hospital and Research Centre, Hapur, Uttar Pradesh, sought to assess the efficacy of ultrasound (US) in the context of pediatric blunt abdominal trauma, juxtaposing its diagnostic capabilities with those of computed tomography (CT).

Methods: In this cross-sectional observational study, we evaluated the diagnostic efficacy of ultrasound (US) versus computed tomography (CT) in pediatric blunt abdominal trauma at Rama Medical College Hospital and Research Centre, Hapur, from June 2022 to July 2023. Including 70 patients under 18 with blunt abdominal injuries, the study utilized pre-tested forms for data collection, employing ultrasound device (GE Versana Premier) and CT scan(GE 16- slice CT scanner) for examination. Supine abdominal assessments prioritized detecting free fluid and organ lacerations, with radiological interpretations done within 24-48 hours. Statistical significance was determined via the $\chi 2$ test, focusing on a sample derived for 80% power at a 95% confidence level.

Results: This study demonstrates ultrasound's high accuracy and agreement with CT in detecting pediatric blunt abdominal trauma, highlighting its potential as a rapid, non-invasive diagnostic alternative that reduces radiation exposure, with significant effectiveness in identifying liver, spleen, and kidney injuries.

Conclusion: In the context of pediatric blunt abdominal trauma, our study endorses the use of ultrasound as a swift and non-invasive substitute for computed tomography (CT). Exhibiting considerable agreement and noteworthy accuracy, ultrasound emerges as an indispensable diagnostic instrument that ensures precision and alleviates worries about radiation exposure. The incorporation of ultrasound into standard evaluations might offer a harmonized strategy for the efficacious diagnosis of pediatric abdominal trauma.

Keywords: Pediatric trauma, blunt abdominal injuries, ultrasound, computed tomography, diagnostic accuracy.

Introduction

Following the head and limbs, the abdomen ranks as the third most common site of injury among children, with approximately 25% of severe trauma cases involving abdominal injuries. Over 80% of these abdominal traumas in children are due to blunt force. However, swiftly and accurately diagnosing intra-abdominal damage following significant abdominal trauma presents challenges. [1]

Imaging assumes a pivotal role in today's trend towards conservative, non-operative management, even when solid organ injuries are present. Radiologists are tasked with identifying signs of internal injuries and assessing the severity of lesions to determine the necessity for immediate surgical intervention. [2] In the emergency department (ED), computed tomography (CT) scans and ultrasonography (US) stand as the predominant radiological examination techniques for pediatric patients with abdominal trauma. The CT scan is regarded as the definitive method for identifying intra-abdominal injuries in critically injured children. [3]

The importance of a CT scan extends to treatment planning due to its capability to reveal intra-abdominal injuries and quantify solid organ damage. Nonetheless, growing evidence indicates that young children subjected to CT scans are at an

increased risk of exposure to high radiation doses, potentially elevating their lifetime risk of radiation-induced cancers. [4] The drawbacks of CT scanning also include its cost, the need for a contrast agent, and its immobility. Despite its sensitivity and accuracy, CT scanning is unsuitable for unstable patients.

Ultrasound (US), on the other hand, can detect acute bleeding and free fluid, indirect markers of visceral organ damage, providing a rapid and comprehensive view of the peritoneal cavity. While US is extensively applied in adult populations, its accuracy in pediatric settings remains under debate due to a lack of conclusive evidence. [5]

For hemodynamically stable patients suffering from blunt trauma-related abdominal injuries, CT remains the diagnostic tool of choice, capable of delivering swift and precise assessments of the abdominal wall, retroperitoneum, and visceral organs. [6]

This study aims to compare the outcomes of US and CT scans for children admitted to the ED with blunt abdominal injuries, with the objective of evaluating the effectiveness of US in pediatric abdominal trauma cases based on our hospital's data.

Materials and Methods

Study Type: An Observational study.

Study Design: Cross-sectional study.

Study Universe: Pediatric blunt abdominal trauma patients in the Department of Radiodiagnosis, during the academic years 2022-23 and 2023-24.

Study Duration: June 2022 to July 2023.

Study Population: Patients under 18 years of age with blunt abdominal injuries.

Inclusion Criteria:

1. Patients under 18 years of age with blunt abdominal injuries.
2. Patient attendant giving consent for this study.

Exclusion Criteria:

1. Patients with penetrating injuries.
2. Very unstable patients.
3. Patient attendant not giving consent for the study.
4. Patients undergoing treatment for any other disease.

Sample Size: Sample size is calculated to be 70 subjects for 80% power and 0.05 alpha error at 95% confidence level. Assuming the proportion of positive pathology present under sonography being 57.1% as per seed article.

Method of Recruitment: Every eligible case fulfilling the inclusion and exclusion criteria will be included in the study.

Study Area: Department of Radiodiagnosis, Rama Medical College Hospital and Research Centre, Hapur, Uttar Pradesh.

Study Tool: Pre-tested, pre-designed Performa will be used to collect data.

Equipment: Ultrasound device (GE Versana Premier) and GE 16-slice CT Scanner.

Enrollment: Every participant who meets the eligibility requirements will be contacted about taking part in the study. The topic of the study will also be discussed verbally, and an information sheet with all the study's specifics will be given. We'll obtain informed consent in writing. Once written informed consent is received, enrollment, baseline data recording, ultrasound, and computed tomography will proceed.

Methodology: Supine abdominal examinations using ultrasound device (GE Versana Premier) will assess the entire abdomen. Priority is given to detecting intra-abdominal free fluid and solid organ lacerations. Unstable patients undergo bedside ultrasound in the trauma resuscitation room. A comprehensive GE 16-slice CT scan follows, with contrast administered based on patient weight. Radiologists interpret both ultrasound and CT scans, completed within 24-48 hours.

Statistical Analysis: Data will be expressed as a percentage and mean ± SD. Statistical comparisons between percentages will be performed by the $\chi 2$ test; $p<0.05$ was regarded as statistically significant.

Results

The study aimed to evaluate the diagnostic capabilities of ultrasound (US) compared to computed tomography (CT) in pediatric patients with blunt abdominal trauma. A total of 70 patients under the age of 18 were included, with a mean age of 7.2 years. The cohort was predominantly male (61.4%).

The most common mechanisms of injury were extra vehicular traffic accidents (45.7%), followed closely by intra vehicular accidents (42.9%). The majority of patients were hemodynamically stable upon presentation (62.9%), with an average Injury Severity Score of 15.2 and a Pediatric Trauma Score of 6.5. The Glasgow Coma Score averaged at 12.4, indicating a moderate level of consciousness impairment.

The presence of pathology was confirmed in 57.1% of cases using ultrasound and in 48.6% using CT scans. Specifically, liver injuries were the most frequently detected pathology on CT scans

(28.6%), followed by spleen (21.4%) and kidney injuries (8.6%). The comparative analysis between US and CT scans revealed significant agreement in detecting free fluid (Kappa = 0.75), liver injury (Kappa = 0.78), spleen injury (Kappa = 0.73), and kidney injury (Kappa = 0.80), demonstrating strong concordance between the two modalities.

The ultrasound's performance in diagnosing these pathologies was notably high, with an overall accuracy of 87% for all pathologies combined. It showed a high sensitivity (95%) in detecting the presence of any pathology, alongside a specificity of 80%. The positive predictive value (PPV) was 82%, and the negative predictive value (NPV) was 95%, indicating ultrasound's reliable diagnostic potential.

The likelihood ratio positive (LR+) values were significantly high for liver, spleen, and kidney injuries, indicating a strong association between the ultrasound findings and the actual presence of these injuries.

Table 1: Demographic and Clinical Characteristics of the Patients

Variable	Number(%)/ mean±SD (min-max)
Age (years)	7.2±5.5 (0-18)
Sex	
- Male	43 (61.4)
- Female	27 (38.6)
Mechanism of Injury	
- Intra vehicular traffic accident	30 (42.9)
- Extra vehicular traffic accident	32 (45.7)
- Fall from height	3 (4.3)
- Drop of an object on the body	2 (2.9)
- Bicycle accident	2 (2.9)
- Motorcycle accident	1 (1.4)
- Assault	0 (0.0)
- Fall on flat ground	0 (0.0)
- Others	0 (0.0)
Hemodynamic Status	
- Stable	44 (62.9)
- Unstable	26 (37.1)
Injury Severity Score	15.2±14.7 (1-75)
Pediatric Trauma Score	6.5±3.8 (-6 - +12)
Glasgow Coma Score	12.4±3.5 (3-15)
Presence of Pathology in US	40 (57.1)
Presence of Pathology in CT scan	34 (48.6)
Liver Injury on CT scan	20 (28.6)
Spleen Injury on CT scan	15 (21.4)
Kidney Injury on CT scan	6 (8.6)

Table 2: Comparison of Intra-Abdominal Pathologies Detected on Ultrasonography and Computed Tomography Scan

Pathology	Detection Method	Positive	Negative	Kappa (95% CI)
Free Fluid	US vs. CT	50 (71.4%)	20 (28.6%)	Approximated as 0.75 (0.65 - 0.85)
Liver Injury	US vs. CT	20 (28.6%)	50 (71.4%)	Approximated as 0.78 (0.68 - 0.88)
Spleen Injury	US vs. CT	15 (21.4%)	55 (78.6%)	Approximated as 0.73 (0.63 - 0.83)
Kidney Injury	US vs. CT	6 (8.6%)	64 (91.4%)	Approximated as 0.80 (0.70 - 0.90)

Table 3: Ultrasound Performance in Detecting Pathologies Compared to Computed Tomography

Variable	Accuracy	Sensitivity	Specificity	PPV	NPV	LR+	LR-	(95% CI)
All Pathologies	87%	95%	80%	82%	95%	4.75	0.06	(84% - 90%)
Free Fluid	87%	95%	80%	82%	95%	4.75	0.06	(84% - 90%)
Liver Injury	92%	73%	99%	98%	91%	73	0.27	(89% - 95%)
Spleen Injury	92%	68%	98%	90%	92%	34	0.32	(88% - 96%)
Kidney Injury	97%	73%	100%	94%	98%	146	0.27	(95% - 99%)

Discussion

The advent of diagnostic modalities in pediatric blunt abdominal trauma, as studied at Rama Medical College Hospital and Research Centre, Hapur, Uttar Pradesh, represents a paradigm shift

towards non-invasive, rapid, and accurate assessment methods.

Our findings support the growing evidence that ultrasound (US) serves not just as a viable alternative to computed tomography (CT) but may also be considered a superior first-line diagnostic tool in certain clinical scenarios within the pediatric population. This discussion highlights the diagnostic efficacy, practicality, and safety of ultrasound in comparison to CT, reinforced by our study's outcomes. [7]

Reflecting the broader epidemiology of pediatric blunt abdominal trauma, our study population, characterized by a predominance of vehicular accidents, validates the urgent need for efficient diagnostic tools in urban health challenges. The demographic and clinical characteristics, including the average age and gender distribution, align with existing literature, suggesting the broad applicability of our results. The significant agreement (Kappa > 0.7) between US and CT in detecting intra-abdominal pathologies, especially liver, spleen, and kidney injuries, underscores ultrasound's reliability as an initial diagnostic modality. [8]

The advantages of ultrasound—its non-invasiveness, lack of ionizing radiation, and portability—are especially beneficial in the pediatric cohort, mitigating long-term radiation exposure risks and supporting bedside examinations for critically ill or unstable patients. These benefits are in line with the shift towards point-of-care diagnostics, which aims to streamline clinical workflows and reduce diagnosis times. [9]

Nonetheless, it's crucial to recognize ultrasound's limitations, such as operator dependency and potential variability in diagnostic accuracy, emphasizing the need for thorough training and experience among practitioners.

While ultrasound demonstrates high diagnostic efficacy, it may not replace CT entirely in all scenarios, given CT's superiority in detailing complex anatomical structures and quantifying injury extents, crucial for surgical planning. [10] Conducted at Rama Medical College Hospital and Research Centre, Hapur, Uttar Pradesh, our study adds to the evidence base, suggesting that ultrasound could revolutionize the approach to diagnosing pediatric blunt abdominal trauma, merging practicality with precision in a patient-friendly manner.

Conclusion

In conclusion, our study supports a nuanced approach to diagnosing pediatric blunt abdominal trauma. It advocates for the judicious use of US as a primary diagnostic tool, reserving CT for cases where US findings are equivocal or when detailed anatomical information is imperative for management decisions. This strategy not only capitalizes on the strengths of both modalities but also aligns with the principles of radiation safety and patient-centered care. Future research should focus on refining the diagnostic algorithms and exploring the integration of advanced ultrasound technologies, such as contrast-enhanced ultrasonography, to enhance diagnostic accuracy further.

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