

RETROSPECTIVE ANALYSIS OF ULTRASOUND AS A DIAGNOSTIC TOOL FOR PAEDIATRIC ABDOMINAL TRAUMA

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Abstract

Background: Paediatric abdominal trauma presents diagnostic challenges, and the use of ultrasound as a primary diagnostic tool requires evaluation for effectiveness, efficiency, and patient outcomes. The objective of this study is to assess the accuracy, speed, and efficiency of ultrasound in diagnosing paediatric abdominal trauma, comparing it with CT scans, and evaluating its impact on patient outcomes, cost-effectiveness, and user satisfaction. **Materials and Methods:** A retrospective analysis of 100 paediatric patients who underwent ultrasound for suspected abdominal trauma was conducted. Data were collected on diagnostic accuracy (positive, negative, false positives/negatives), procedure time, patient throughput, comparison with CT findings, immediate interventions, hospital stay duration, cost-effectiveness, and feedback from physicians and patients. **Result:** Accuracy of Ultrasound Diagnosis: Ultrasound identified internal injuries in 85% of cases, with a 5% rate of false positives and 2% false negatives. Speed and Efficiency: The average ultrasound examination duration was 15 minutes, enhancing patient throughput in the emergency department. Comparison with CT Scans: Ultrasound findings were consistent with CT scan results in 90% of cases, with the added benefit of avoiding radiation exposure. Patient Outcomes: Ultrasound findings led to immediate intervention in 30% of cases and were associated with a reduced hospital stay in 70% of the cases. Cost-Effectiveness: Ultrasound proved more cost-effective than CT, mainly due to the reduced need for follow-up imaging. Physician and Patient Satisfaction: The ultrasound was reported to be user-friendly with a quick learning curve, and patients experienced less discomfort and anxiety compared to other diagnostic modalities. **Conclusion:** Ultrasound demonstrates high sensitivity and efficiency as a diagnostic tool for paediatric abdominal trauma, with favourable outcomes in patient care, cost-effectiveness, and user satisfaction. Its use as a first-line diagnostic modality is supported, though some limitations in diagnostic scope should be considered.

INTRODUCTION

Abdominal trauma in paediatric patients presents a unique set of challenges in emergency medicine due to the varied presentation of injuries and the inherent differences in physiology and anatomy compared to adults.^[1] The immediate and accurate diagnosis of abdominal injuries is crucial, as delays or inaccuracies can lead to significant morbidity or mortality. Traditionally, computed tomography (CT) scans have been the gold standard for diagnosing abdominal injuries due to their high sensitivity and specificity.^[2] However, the use of CT scans, especially in paediatric patients, raises concerns due to the associated ionizing radiation and the potential for future malignancies. This concern has led to a

growing interest in alternative diagnostic modalities, particularly ultrasound, which offers a non-invasive, radiation-free, and cost-effective approach.^[3,4]

Ultrasound has been increasingly utilized in emergency settings, offering real-time visualization of internal organs and blood flow.^[5] Its application in abdominal trauma has shown promise, particularly in settings where rapid decision-making is essential. The portability of ultrasound machines also adds to its utility in diverse medical settings, including emergency rooms and trauma centres.^[6,7] Additionally, ultrasound is a dynamic tool that allows for the assessment of patients in various positions, essential in cases where patient mobility is limited due to pain or injury.

Despite these advantages, the effectiveness of ultrasound in paediatric abdominal trauma is still a topic of active research. One of the critical concerns is the operator-dependent nature of ultrasound, which could lead to variability in diagnostic accuracy. Furthermore, certain types of abdominal injuries, such as those involving hollow organs or retroperitoneal structures, can be challenging to visualize and assess accurately using ultrasound.

The evolving landscape of emergency paediatric care, with an increasing emphasis on minimizing invasive procedures and reducing radiation exposure, underscores the need for a comprehensive evaluation of ultrasound as a diagnostic tool in paediatric abdominal trauma. Several studies have explored its use in adult patients, but the paediatric population has distinct characteristics that warrant focused research. Children have different injury patterns, physiological responses, and treatment needs compared to adults, making it imperative to evaluate the efficacy and limitations of ultrasound specifically in this demographic.

Additionally, the economic implications of using ultrasound as a first-line diagnostic tool in paediatric abdominal trauma are significant. The cost-effectiveness of ultrasound, compared to more expensive and resource-intensive modalities like CT scans, could lead to substantial savings for healthcare systems while ensuring high-quality patient care. Patient and physician satisfaction are also crucial factors, as they directly impact the quality of care and patient outcomes. The comfort and anxiety levels of paediatric patients during diagnostic procedures, and the ease of use and learning curve of ultrasound for healthcare providers, are essential components of overall healthcare delivery.

Aim and Objectives

Aim: The aim of this study is to conduct a comprehensive evaluation of the effectiveness, efficiency, and impact of using ultrasound as a diagnostic tool in paediatric abdominal trauma.

Objectives:

To assess the diagnostic accuracy of ultrasound in identifying internal injuries in paediatric patients with suspected abdominal trauma.

To evaluate the speed and efficiency of ultrasound examinations in emergency settings, focusing on procedure time and patient throughput.

To compare the findings of ultrasound with those of CT scans in terms of diagnostic consistency and radiation exposure.

To analyse the impact of ultrasound on patient outcomes, including immediate interventions and hospital stay duration.

To determine the cost-effectiveness of using ultrasound compared to CT scans in paediatric abdominal trauma cases.

To gather feedback from physicians and patients regarding the ease of use, learning curve, comfort, and anxiety levels associated with ultrasound.

MATERIALS AND METHODS

Study Setting: This study was conducted at BRLSABVM Medical College, located in Pendri, Rajnandgaon, Chhattisgarh, India. The institution is equipped with a full-service emergency department and a radiology unit capable of performing both ultrasound and CT scans.

Study Period: The study was carried out over a one-year period, from June 2022 to May 2023.

Study Design: This was a prospective observational study designed to evaluate the effectiveness of ultrasound as a diagnostic tool in paediatric abdominal trauma.

Study Population: The study population included paediatric patients (aged 0 to 18 years) who presented to the emergency department of BRLSABVM Medical College with suspected abdominal trauma.

Inclusion criteria

- Age between 0 and 18 years.
- Clinical suspicion of abdominal trauma, either blunt or penetrating.
- Consent from parents or legal guardians for participation in the study.

Exclusion criteria

- Patients who required immediate surgical intervention upon presentation, without the possibility of prior ultrasound evaluation.
- Patients with known chronic abdominal conditions that could interfere with the interpretation of ultrasound findings.

Sample Size: The sample size was determined based on the average number of paediatric trauma cases presenting to the emergency department over the previous year. A total of 100 patients meeting the inclusion criteria were enrolled in the study.

Data Collection: Data were collected using a structured data collection form, which included patient demographics, nature of the trauma, findings from the ultrasound examination, results of any subsequent CT scans (if performed), and patient outcomes.

Ultrasound Examination: Ultrasound examinations were performed by radiologists or emergency medicine physicians trained in paediatric ultrasonography. Standardized protocols were followed for abdominal ultrasound, focusing on detecting free fluid, organ lacerations, and other signs of internal injury. The duration of each ultrasound examination and the findings were recorded.

Comparison with CT Scans: CT scans were performed as deemed clinically necessary by the treating physician. The results of the CT scans were used as a reference standard to evaluate the accuracy of the ultrasound findings.

Outcome Measures: The primary outcome measures included the accuracy of ultrasound in diagnosing internal injuries (sensitivity, specificity, positive predictive value, and negative predictive value), the time taken for the ultrasound examination, patient throughput in the emergency department,

correlation of ultrasound findings with CT scan results, patient outcomes (immediate interventions, hospital stay), cost comparison with CT scans, and feedback on ease of use and patient comfort.

Data Analysis: Data were analysed using appropriate statistical methods. Sensitivity, specificity, positive and negative predictive values of ultrasound were calculated. Comparative analyses between ultrasound and CT findings were performed using the chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Ethics Committee of BRLSABVM Medical College, Pendri, Rajnandgaon, Chattisgarh, India. Informed consent was obtained from the parents or legal guardians of all participants. The study was conducted in accordance with the ethical standards of the Declaration of Helsinki.

RESULTS

Accuracy of Ultrasound Diagnosis

The evaluation of ultrasound effectiveness in diagnosing pediatric abdominal trauma revealed:

Positive Findings: In 85% of cases (85 out of 100), ultrasound successfully identified internal injuries, demonstrating high diagnostic sensitivity.

Negative Findings: In 15% of cases (15 out of 100), ultrasound revealed no internal injuries, which was later corroborated by CT scans or clinical follow-up.

False Positives/Negatives: The study observed a small margin of error, with 5% false positives (5 out of 100) and 2% false negatives (2 out of 100).

Speed and Efficiency

Ultrasound's operational efficiency was assessed:

Average Time for Procedure: The average duration for conducting an ultrasound examination was 15 minutes.

Patient Throughput: The rapid execution of the ultrasound examination facilitated enhanced patient turnover in the emergency department.

Comparison with CT Scans

The comparison between ultrasound and CT scans revealed:

Correlation with CT Findings: Ultrasound findings were consistent with CT scan results in 90% of the cases.

Radiation Exposure: Utilizing ultrasound allowed patients to avoid the radiation exposure typically associated with CT scans.

Patient Outcomes

The impact of ultrasound on patient outcomes showed:

Immediate Intervention: Ultrasound findings necessitated immediate surgical or medical intervention in 30% of cases.

Hospital Stay: Early diagnosis through ultrasound was associated with a reduced length of hospital stay in approximately 70% of the cases.

Cost-Effectiveness

The economic evaluation indicated:

Cost Comparison: Ultrasound was significantly more cost-effective than CT scans, primarily due to the reduced need for follow-up imaging.

Physician and Patient Satisfaction

Feedback from physicians and patients indicated:

Ease of Use: Physicians reported the ultrasound to be user-friendly with a quick learning curve.

Patient Comfort: Compared to other diagnostic modalities, patients experienced less discomfort and anxiety with ultrasound.

Table 1:

No. Of Bones Examined	Right	left	No. of Radius in which Foramen is Present	No. of Radius in which Foramen is Absent
50	22	28	49	1

Table 2:

Position of foramen	Right	Left
Anterior Surface	20	26
Posterior Surface	1	1
Lateral Surface	1	0
Absent	0	1
Total	22	28

DISCUSSION

Interpretation of Findings

Our study conducted at BRLSABVM Medical College, Pendri, aligns with existing literature, affirming the utility of ultrasound in pediatric abdominal trauma.^[8,9] The observed high sensitivity rate (85%) of ultrasound in identifying internal injuries corroborates with findings by Ben-Ishay et al. (2015) and Fox et al. (2011), who also reported ultrasound's efficacy in rapidly assessing free fluid

and organ damage in paediatric patients.^[10-14] The false positive rate (5%) and false negative rate (2%) in our study are in line with those reported by Mohammadi and Ghasemi-Rad (2012) and Waheed et al. (2018), emphasizing the importance of experienced operators and standardized protocols in ultrasound examinations.^[8,13]

The average 15-minute duration for ultrasound examinations and its role in enhancing patient throughput echo the findings of Allen et al. (2014), highlighting ultrasound's potential to expedite

clinical decision-making in emergency settings.^[11] Furthermore, our study's 90% correlation rate of ultrasound findings with CT scans supports its validity as an initial diagnostic modality, though the 10% discrepancy underscores the need for CT scans in certain complex cases, as discussed by Iqbal et al. (2014) and Sargent et al. (2022).^[9,12]

Patient Outcomes

The immediate intervention in 30% of cases and the association of ultrasound with reduced hospital stays in 70% of our cases are notable. These findings are consistent with the broader literature, suggesting ultrasound's clinical effectiveness and its role in improving patient care, as seen in the studies by Holmes et al. (2007) and Fox et al. (2011).^[14,15]

Cost-Effectiveness

The cost-effectiveness of ultrasound, as indicated in our economic analysis, supports its broader implementation in resource-limited settings. This observation aligns with the current emphasis on cost-conscious care in healthcare systems, as discussed in the literature.^[11]

Physician and Patient Satisfaction

The positive feedback regarding the ease of use and the quick learning curve of ultrasound in our study mirrors the findings of Ben-Ishay et al. (2015), highlighting its practicality in emergency settings.^[10] Additionally, the preference for ultrasound by patients due to less discomfort and anxiety is a crucial consideration in pediatric care, as also observed in the studies by Allen et al. (2014) and Waheed et al. (2018).^[11,13]

Limitations: Despite these promising findings, the study acknowledges certain limitations. The operator-dependent nature of ultrasound is a significant factor, as it can influence diagnostic accuracy. The study's setting in a single centre also limits the generalizability of the results. Further multicentric studies with larger sample sizes could provide more comprehensive insights.

Future Research: Future research should focus on longitudinal studies to evaluate the long-term outcomes of patients diagnosed with ultrasound in paediatric abdominal trauma. Additionally, exploring the integration of ultrasound in trauma protocols and training programs would be beneficial.

CONCLUSION

In conclusion, the study affirms the utility of ultrasound as a rapid, effective, and patient-friendly diagnostic tool in paediatric abdominal trauma. While it is not without limitations, its benefits in terms of diagnostic accuracy, efficiency, patient safety, and cost-effectiveness make it a valuable modality in emergency paediatric care.

Our study highlights ultrasound as a highly effective diagnostic tool for paediatric abdominal trauma. It demonstrates a high accuracy rate (85% sensitivity), efficiency (15-minute average procedure time), and patient safety (reduced radiation exposure).

Additionally, its cost-effectiveness and positive feedback from both physicians and patients further support its integration into emergency paediatric care, despite certain limitations like operator dependency and a need for further research to generalize findings.

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