

DIAGNOSTIC ACCURACY AND SAFETY OF ULTRASONOGRAPHY FOR INTESTINAL MALROTATION IN THE PEDIATRIC POPULATION

HANIF N^{1*}, SIDDIQUE S¹, GORAYA A², AARAJ S³, AKBAR W¹, SIDDIQUE S⁴

¹Department of Radiology, PGMI/AMC/LGH Lahore, Pakistan

²Department of Paediatric Radiology, UCHS & The Children 's Hospital Lahore, Pakistan

³Department of Paediatrics, Shifa International Hospital Islamabad, Pakistan

⁴Department of Medicine, East Medical Ward, Mayo Hospital Lahore, Pakistan

*Correspondence author email address: nadiach@hotmail.com

(Received, 27th February 2024, Revised 20th May 2024, Published 20th June 2024)

Abstract: *Intestinal malrotation is a critical condition in pediatric patients that requires accurate and timely diagnosis. Ultrasonography is a non-invasive imaging modality frequently used to diagnose this condition. Objective: To evaluate ultrasonography's diagnostic accuracy and safety for detecting intestinal malrotation in pediatric patients. Methods: This retrospective study was conducted at Lahore General Hospital from January 2023 to January 2024. The study included children who underwent ultrasound for suspected malrotation during this period. Ultrasounds were performed by pediatric sonographers and interpreted by radiologists. The ultrasound examination was deemed indeterminate if normal anatomy was not delineated or the diagnosis was not confirmed. Data were analyzed to determine the sensitivity and specificity of ultrasonography in diagnosing intestinal malrotation. Results: Ultrasound examinations were performed on 230 patients for suspected malrotation. The mean age of the participants was 1.4 years. Among these, 61.7% (142) were neonates, with 36% (51/142) presenting on the first day of life. 218 (94.7%) patients had normal ultrasound findings, with no false-negative results reported. Malrotation was diagnosed through ultrasound in 7 (3%) patients, two of whom had associated malrotation. Five out of these seven patients were neonates. No false-positive results were reported after surgical confirmation. Additionally, 5 (2.17%) patients had indeterminate ultrasound findings. The sensitivity and specificity of ultrasonography for diagnosing intestinal malrotation were 100%. Conclusion: The study concludes that ultrasonography is a safe, accurate, and effective diagnostic tool for intestinal malrotation in pediatric patients. It is a feasible option for clinical practice due to its high diagnostic accuracy and non-invasive nature.*

Keywords: Clinical Practice, Intestinal Malrotation, Sensitivity, Specificity, Ultrasonography

Introduction

Intestinal malrotation and midgut volvulus are potentially devastating complications. A population-based study showed intestinal malrotation decreases with age, with 15 in 1 million children < 1 year and 10 in 1 million children aged 1 to 2 years.(1). The investigation of choice for intestinal malrotation is the upper gastrointestinal contrast study (UGICS) (2, 3). UGICS has high sensitivity but can decrease in the case of volvulus. UGICS exposes patients to ionizing radiation hazards and has a 15% false positive rate and a 3% false negative rate. Literature shows that ultrasound (US) imaging is a valuable tool for the diagnosis of malrotation but has a high false negative rate of 30%(4, 5). Previously, the diagnosis of malrotation was based on the principle of the inverse relationship between the superior mesenteric artery and the superior mesenteric vein. This is now considered unreliable because gas-filled bowel loops can obscure the relationship of vessels. Some studies suggest that ultrasound can be used to diagnose malrotation depending on the positioning of the duodenum. However, the sample size of these studies is small; thus, the results can't be generalized.(4, 6)This study evaluates the diagnostic accuracy and safety of ultrasonography for intestinal malrotation in pediatric patients.

Methodology

The retrospective study was conducted in Lahore General Hospital from January 2023 to January 2024. The study included children who underwent ultrasound for suspected malrotation during the study period. Demographic details and clinical data related to malrotation, imaging, and surgical outcomes were extracted from patients' records. The ethical board of the hospital approved the study. All ultrasounds were performed by pediatric sonographers and interpreted by radiologists. The US was used to identify the superior mesenteric artery and superior mesenteric vein. A contracted medium (water) was used to trace the duodenum's entire course. The child was placed supine, and the scan was conducted on the transverse plane. A nasogastric tube was used to administer fluid bolus. After identifying the pylorus, the first part of the duodenum (D1) was determined by tracing the path of the liquid bolus. The transducer was moved superiorly to identify the second part (D2). The fluid bolus then passes into the third part (D3), which is medially between the aorta and superior mesenteric vessels. The transducer was then moved superiorly to the origin of the superior mesenteric artery to identify D4. Extension of D4 till the origin of the superior mesenteric artery indicates normal duodenojejunal flexure. It is essential to adequately fill the stomach and monitor the peristaltic wave to ensure that the continuous loop is being scanned. The redundant loops make it challenging to trace

[Citation: Hanif, N., Siddique, S., Goraya, A., Aaraj, S., Akbar, W., Siddique, W., (2024). Diagnostic accuracy and safety of ultrasonography for intestinal malrotation in the pediatric population. *Biol. Clin. Sci. Res. J.*, 2024: 906. doi: <https://doi.org/10.54112/bcsrj.v2024i1.906>]

the entire course. It may be essential to scan back and forth till the fluid bolus appears in the next part. Recording the bolus passage helps prove a continuous loop and delineate duodenal anatomy. The ultrasound examination was considered indeterminate if normal anatomy was not delineated or diagnosis was not confirmed.

SPSS version 23.0 was used for data analysis. Inferential and descriptive statistical analysis was conducted. Continuous data was presented as mean, standard deviation, and categorical data as frequency and percentage. Specificity and sensitivity were calculated.

Results

Two hundred thirty patients underwent ultrasound for suspected malrotation (Table I). The mean Age of the

participants was 1.4 years. 61.7% (142) patients were neonates, with 36% (51/142) presenting at day 1 of age.

218 (94.7%) patients had regular ultrasound study. None of these patients underwent explorative laparoscopy /laparotomy or had recurring symptoms. No false negative results were reported.

Seven (3%) patients had malrotation diagnosed through ultrasound examination; two of these had associated malrotation. Five of the seven patients were newborns. Surgery was performed in all these patients, and diagnostic findings were confirmed by operative findings. No false positives were reported.

5 (2.17%) patients had indeterminate ultrasound findings. These five patients underwent an upper gastrointestinal contrast study, and no evidence of malrotation was found. Sensitivity and specificity were 100%. Results are summarized in Figure I.

Table I Age-wise distribution of ultrasonic findings

Age	Malrotation on ultrasound			Total
	Yes	Indeterminate	No	
Child (>1 year)	2	1	47	50
Infant	0	1	37	38
Neonate	5	3	134	142
Total	7	5	218	230

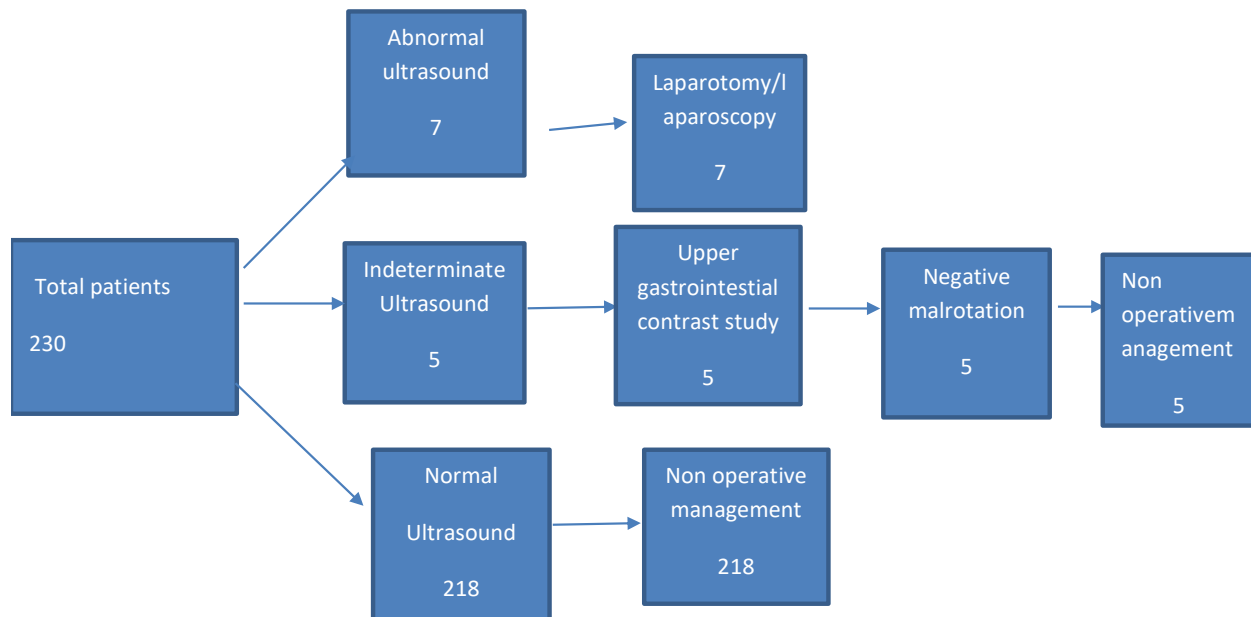


Figure I Summary of clinical outcomes and ultrasound examination

Discussion

Intestinal malrotation and volvulus are major health concerns, and it is essential to diagnose any child who presents with bilious vomiting in a timely. Upper gastrointestinal contrast study (UGICS) is the gold standard for investigating intestinal malrotation. On UGICs, the presence of proximal jejunal loops on the right side of the abdomen, duodenojejunal flexure to the right, and whirlpool sign associated with volvulus are defining features of malrotation. However, it may yield false positive or false negative results, especially in children with lax ligaments,

scoliosis, splenomegaly, and gastric dilation(7). Ultrasound has been suggested as a valuable adjunct to diagnose malrotation. Notably, the intestinal whirlpool sign and the inverse relationship of the superior mesenteric artery and the superior mesenteric vein are cited as accurate diagnostic features(8, 9). However, the inverse relationship between a superior mesenteric artery and the superior mesenteric vein alone is not a reliable marker(10). Previous studies showed that the whirlpool sign and delineation of normal anatomy in ultrasound is a productive way of diagnosing malrotation; however, water as a contrast medium was not used in that

[Citation: Hanif, N., Siddique, S., Goraya, A., Aaraj, S., Akbar, W., Siddique, W., (2024). Diagnostic accuracy and safety of ultrasonography for intestinal malrotation in the pediatric population. *Biol. Clin. Sci. Res. J.*, 2024: 906. doi: <https://doi.org/10.54112/bcsrj.v2024i1.906>]

study due to the risk of tracing adjacent loops (11, 12). In this study, we used water as a contrast medium for identifying the relationship of the superior mesenteric artery and vein, the entire course of duodenum until and duodenojejunal flexure, and the whirlpool sign for volvulus. The retro mesenteric transverse course of D3 between the aorta and superior mesenteric artery indicates normality and rules out malrotation. In this study, all positive ultrasound diagnoses of malrotation were confirmed by surgery, indicating no false positive results; this was in line with the findings of a previous study, which suggested ultrasound is a productive tool for accurate diagnosis of intestinal malrotation(13). 95% of patients with routine ultrasounds did not undergo surgery or presented with symptoms that indicated a correct diagnosis. This validates the effectiveness of ultrasound in diagnosing malrotation. 2.17% of patients with indeterminate findings who underwent UGIC were subsequently proven damaging for malrotation. This indicates the usefulness of ultrasound in reducing radiation hazards. Our study's results align with a previous cohort study on the efficacy of ultrasound for managing suspected malrotation, which reported 100% specificity and sensitivity of ultrasound(14). The majority of the participants in our study were neonates, and ultrasound was performed at the bedside, which diminished the risk of hypothermia and ionizing radiation associated with radiography. A previous study suggested that ultrasonography is a safe diagnostic method with high accuracy and can be used in clinical practice(15). Nevertheless, there are reasons, such as the limited ability of physicians to interpret the results and operator dependency, due to which this procedure is not widely accepted. However, real-time recording of ultrasound images and delineating duodenal anatomy using water as a contrast medium makes ultrasound findings reliable.

Conclusion

It is concluded that ultrasound is a safe and productive investigation for diagnosing intestinal malrotation and is feasible to adopt in clinical practice.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.

It is approved by the department concerned. (IRB/LGHMS/order number 19 dated 12-10-22)

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared an absence of conflict of interest.

Authors Contribution

NADIA HANIF (Associate Professor)

Final Approval of version

SMEERA SIDDIQUE (Assistant Professor)

Revisiting Critically

AMBER GORAYA (Associate Professor) & **SAHIRA AARAJ** (Associate Professor)

Data Analysis

WAJEEHA AKBAR (SR) & **SAMARA SIDDIQUE** (Assistant Professor)

Drafting & Concept & Design of Study

References

1. Abu-Elmagd K, Mazariegos G, Armanyous S, Parekh N, ElSherif A, Khanna A, et al. Five hundred patients with gut malrotation: thirty years of experience with the introduction of a new surgical procedure. *Annals of Surgery*. 2021;274(4):581-96.
2. Derbew HM, Otero HJ. Imaging of Malrotation and Midgut Volvulus. *Evidence-Based Imaging in Pediatrics: Clinical Decision Support for Optimized Imaging in Pediatric Care*: Springer; 2023. p. 1-12.
3. Park SG, Hwang JH. A Case of Midgut Volvulus with Gastric Perforation and Periventricular Leukomalacia in a Term Infant. *Neonatal medicine*. 2021;28(1):53-8.
4. Girolamo M, Emanuela G, Yu WMC, Anna M, Marta P, Grazia CM, et al. Diagnostic accuracy of upper gastrointestinal series in children with suspected intestinal malrotation. *Updates in Surgery*. 2024;76(1):201-8.
5. Taylor GA. Sonographic diagnosis of malrotation: it isn't very easy—counterpoint. *Pediatric Radiology*. 2022;52(4):723-5.
6. Youssfi M, Goncalves LF. Ultrasound for malrotation and volvulus—point. *Pediatric Radiology*. 2022;52(4):716-22.
7. Zani A, Pierro A. Malrotation. *Pediatric Surgery: General Principles and Newborn Surgery*. 2020:897-904.
8. Li X, Huang T, Zhou M, Zhang C. Prenatal diagnosis of midgut volvulus using two-dimensional and three-dimensional ultrasound. *American Journal of Translational Research*. 2022;14(3):1859.
9. Nguyen HN, Navarro OM, Bloom DA, Feinstein KA, Guillerman RP, Munden MM, et al. Ultrasound for midgut malrotation and midgut volvulus: AJR expert panel narrative review. *American Journal of Roentgenology*. 2022;218(6):931-9.
10. Nsia RE, Nyemb PMM, Kane RW, Ndiaye A, Gaye M. About one case of common mesentery: embryological study, morphological profile and interest of the doppler ultrasound.
11. Nguyen HN, Sammer MB, Bales B, Cano MC, Trout AT, Dillman JR, et al. Time-driven activity-based cost comparison of three imaging pathways for suspected midgut volvulus in children. *Journal of the American College of Radiology*. 2020;17(12):1563-70.
12. Menghwani H, Piplani R, Yhosu E, Jagdish B, Sree BS. Delayed presentation of malrotation: Case series and literature review. *Journal of Indian Association of Pediatric Surgeons*. 2023;28(4):271-7.
13. Ayaz E. Ultrasound of the Pediatric Gastrointestinal Emergencies. *Ultrasound Imaging-Current Topics*: IntechOpen; 2021.
14. Cho H-H, Lee SM, You SK. Gastrointestinal emergencies in neonates: what we should know. *Taehan Yongsang Uihakhoe chi*. 2020;81(4):770-93.
15. Saliakellis E, Turcotte M-C, Faure C, Thapar N. Pediatric Intestinal Pseudo-Obstruction. *Pediatric*

Neurogastroenterology: Gastrointestinal Motility Disorders and Disorders of Gut-Brain Interaction in Children: Springer; 2023. p. 333-53.



Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. © The Author(s) 2024