

ORIGINAL ARTICLE

Diagnostic Accuracy of Ultrasonography in Pediatric Intussusception Taking Surgical Findings as Gold Standard

SADIA ASMAT BURKI¹, MUHAMMAD KASHIF ARSALAN², PALVESHA AMIN³, AMARA KHURSHEED⁴, SUMAIRA NAZ⁵, KHADIJAH AHMAD CHEEMA⁶

¹Consultant Pediatric Surgeon, PIMS hospital, Islamabad

²Pediatric Surgeon, Women and Children Hospital, Rajjar Charsada

³Anesthesiologist, Children Hospital and University of Child Health Sciences, Lahore

⁴Senior Registrar Paediatrics CMH/ SKBZH, Muzaffarabad

⁵Consultant Child Specialist, Paediatric Medicine, THQ Hospital and Trauma Centre, FatehPur Layyah

⁶Consultant Pediatric Surgery, Children Hospital and Institute of Child Health, Lahore

Corresponding author: Palvesha Amin, Email: palveshaamin@gmail.com, Cell: +923322389900

ABSTRACT

Objective: The objective of this study is to determine diagnostic accuracy of ultrasonography for diagnosis of Intussusception in children taking surgical findings as gold standard.

Study Design: Cross sectional study

Place and Duration of Study: The department of Pediatricsurgery, Children Hospital and Institute of Child Health, Lahore and PIMS Children Hospital, Islamabad during the time period from June 2019 to May 2021.

Methodology: 170 children fulfilling inclusion criteria were taken. After taking informed consent from parents or attendants of the children a detailed history was taken regarding their age, gender and address. All patients with symptoms and signs such as vomiting, abdominal pain and/or distension, rectal bleeding, pallor or lethargy were admitted. They were examined and investigated through ultrasound. The final diagnosis of Intussusception was confirmed on surgery by expert consultant with experience more than 5 years after postgraduation. Ultrasonographic images taken at the time of diagnosis were obtained.

Results: The mean age of children was 3.56 ± 3.29 years with 105(61.8%) male children and 65(38.2%) females. The Ultrasound results showed positive result in 97 (57.1%) children and negative in 73 (42.9%) children. The Surgical findings showed positive results in 107 (62.9%) and negative in 63 (37.1%) children. The sensitivity, specificity, Negative Predictive Value (NPV), and Positive Predictive Value (PPV) for ultrasound keeping surgical findings in diagnosis of intussusception were 85.05%, 90.48%, 93.81%, and 78.08% respectively, whereas, the overall diagnostic accuracy was 87.06%.

Conclusion: It is concluded that ultrasonography for diagnosis of Intussusception in children is very useful diagnostic modality. USG can help us for prompt and timely diagnosis and early surgical intervention can be done to minimize morbidity related to delayed diagnosis.

Keywords: Intussusception, Abdominal surgery, Imaging, Ultrasound, Accuracy

INTRODUCTION

The Latin words intus (inside) and suscipere (to succumb) are the root of the phrase "intussusception" (to receive). When a part of the intestine, referred to as the intussusceptum, invades the lumen of a neighbouring segment, referred to as the intussusciens, the invagination occurs in the direction of normal peristalsis or, on rare occasions, in a retrograde fashion.¹ Two walls make up the intussusceptum: an inner wall and an exterior wall.² The most prevalent cause of acute abdominal pain in children whose symptoms are difficult to diagnose is intussusception.³ An estimated 38 instances per 100,000 live births in the first year of life and 31 cases per 100,000 live births in the second year of life are associated with intussusception. Furthermore, 15% of women with suspected intussusception have intussusception found with ultrasonic diagnostic.⁴

It is fairly uncommon for the diagnosis of intussusception, an urgent medical issue, to be delayed, leading to obstruction of the bowel, venous congestion, eventual necrosis of the gut, and perforation.⁵

Children with intussusception who arrive with abdominal pain have this complaint at all ages.⁶ The clinical appearance of intussusception might vary and include non-specific symptoms such as weeping episodes,

abdominal pain, vomiting and fatigue.⁶ There are just a few cases where "currant jelly" stool is seen, which is an early sign of ischemia in the digestive tract. regular ultrasonography has lately been advocated as the initial diagnosis method with great accuracy.² Morbidity rates increase with a delay in diagnosis. The success rate of enema reduction can be decreased by allowing for longer periods of intussusception. In children with intussusception, a high degree of suspicion is necessary to minimise the necessity for surgical intervention.³

The sensitivity and specificity of Ultrasonography were found to be 87% and 50%, respectively, in a recent study.⁷ Positive and negative predictive values were 95.2 and 25 percent, respectively, in a similar manner. Positive predictive values of abdominal ultrasound was 97.5 percent (466/478) sensitivity and 99 percent (106/107) specificity in detecting Intussusception in another trial, according to the findings.⁸

Ultrasonography is being used in this study to evaluate the diagnostic accuracy of surgical findings in children with intussusception as the gold standard in our paediatric population. No local study has been done so far for diagnosing intussusception on Ultrasonography using surgical findings as a gold standard, even though there is extensive literature available worldwide with a wide range

of specificity and sensitivity (50 percent - 99 percent) and inconsistent range of sensitivity (87 percent - 97.5 percent).⁸ For future patients with signs and symptoms of intussusception (such as the emergence of "currant jelly" stools, a marker for bowel ischemia), abdominal ultrasonography will be immediately performed for prompt diagnosis and early surgical intervention to minimise the morbidity associated with delayed diagnosis, if this study proves successful.

MATERIALS AND METHODS

This cross-sectional study was conducted at the department of Pediatricsurgery,Children Hospital and Institute of Child Health, Lahore and PIMS Children Hospital,Islamabad during the time period from June 2019 to May 2021. Total 170 patients aged ≤ 15 years of either gender with suspected Intussusception with symptoms andsignsincludingvomiting, abdominal pain and/or distension, rectal bleeding,pallor or lethargy (any 2 or more presenting within 48 hours) were included. Patients with recurrent and non-idiopathic Intussusception, and with previous abdominal surgery were excluded.

Following the receipt of informed consent from the children's parents or guardians, a full history was obtained, including the children's age, gender, and residence. Symptoms and indicators such as vomiting, stomach pain and/or distension, rectal bleeding, pallor ness lethargy were all considered serious enough to warrant admission for further evaluation. Patients had abdominal ultrasonography utilising an ultrasound scan that was performed with a curved probe 5MHZ transducer that was available at our facility. It was confirmed during surgery that the definitive diagnosis of Intussusception had been made by an expert consultant with more than 5 years of post-graduate experience. It was possible to collect ultrasonographic images taken at the time of diagnosis. The results of ultrasound and surgical discoveries were combined to create 2x2 tables to improve the accuracy of the diagnostic process.

SPSS version 20 was used to enter and evaluate all of the data that was obtained. For quantitative variables such as age, calculations were made. We expressed qualitative characteristics such as gender and diagnosis of Intussusception on USG and surgical findings as a frequency and percentage for the purposes of this study. For ultrasonography, the sensitivity, specificity, positive and negative predictive values, as well as diagnostic accuracy, were all computed using surgical results as the gold standard for comparison. The probability of occurrence will also be computed.

RESULTS

The mean age of children was 3.56±3.29 years with a range of 14.8 (0.2-15.0) years.Majority of children (148; 87.06%) were <8 years old, while 22 (12.94%) were 8-15 years old.**fig-1**

There were 105 (61.8%) male children and 65 (38.2%) were females. **Table-1**

The Ultrasound results showed positive result in 97(57.1%) children and negative in 73 (42.9%) children.The Surgical findings showed positive results in 107(62.9%) and negative in 63 (37.1%) children.91 cases

(true positive) had positive findings both on USG and on surgery and 57cases (true negative) had negative findings both on USG and on surgery. There were 6 false positive cases and 16 false negative cases. (Table 2)

The sensitivity, specificity, Negative Predictive Value (NPV), and Positive Predictive Value (PPV) for ultrasound keeping surgical findings in diagnosis of intussusception were 85.05%, 90.48%, 93.81%, and 78.08% respectively, whereas, the overall diagnostic accuracy was 87.06%.

When data was stratified for age gender, significant difference was observed in diagnostic accuracy among different age groups and gender. The children under age of< 8 years had higher sensitivity and specificity of US.while US had higher diagnostic accuracy in male when compared to female. **Table-3, 4**

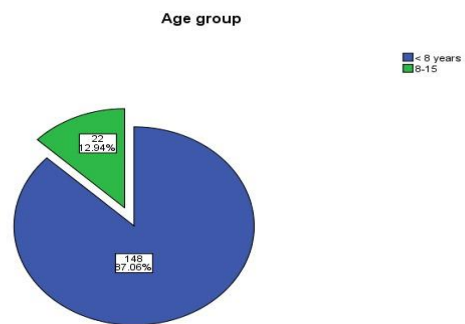


Figure 1: Age wise Distribution

Table 1: Gender-wise Distribution

Gender	Frequency(n)	Percent
Male	105	61.8
Female	65	38.2
Total	170	100.0

Table 2: Comparison of Diagnosis of Intussusception on Ultrasonography and Surgical

Ultrasonography		Surgical findings		Total
		Yes	No	
	Yes	91	6	97
	No	16	57	73
Total		107	63	170

Sensitivity	85.05%
Specificity	90.48%
Positive Predictive Value	93.81%
Negative Predictive Value	78.08%
Diagnostic Accuracy	87.06%
Likelihood ratio of a Positive Test	8.93
Likelihood ratio of negative test	0.165

Table 3: Comparison of Diagnosis of Intussusception on Ultrasonography and Surgical findings when stratified for age

Age group	Ultrasonography	Surgical findings	Pvalue		
			Yes	No	
< 8 years	Ultrasonography	Yes	81	0	0.002
		No	16	51	
8-15	Ultrasonography	Yes	10	6	0.012
		No	0	6	

Table 4: Comparison of Diagnosis of Intussusception on Ultrasonography and Surgical findings when stratified for gender

Sex		surgical findings		p-value	
		Yes	No		
Male	Ultrasonography	Yes	58	0	<0.001
		No	10	37	
Female	Ultrasonography	Yes	33	6	<0.001
		No	6	20	

DISCUSSION

The term "intussusception" refers to the telescoping of one portion of the digestive tract into an adjacent one. As the second leading cause of acute abdomen in children, it is a regular occurrence in this age range. Adults are substantially less likely to suffer from mechanical small intestinal blockage, with only 5% of occurrences involving adults. However, adult patients are more likely than children to receive a diagnosis that was not expected before imaging. As a result, in youngsters, there is frequently no underlying cause.⁹ The condition known as intussusception happens when a part of the digestive tract is squeezed into the next intestinal segment. Children between the ages of six months and two years are most susceptible to this illness. Intussusception is almost always idiopathic in children under the age of five. Most cases of intussusception in children are ileocolic, meaning that the ileum is pushed into the colon.¹⁰

Clinical signs might be perplexing in many circumstances. Of the children with clinical signs that suggest intussusception, only 30 percent to 68 percent have this condition confirmed.¹¹ Intussusception is notoriously difficult to diagnose because there are no standard indications and symptoms to look for. Only a third of the time does the traditional trio of vomiting, abdominal discomfort, and the passage of blood per rectum occur. As a result, this triad can't be relied on completely when making a diagnosis. Another interesting fact is that up to 16% of children who suffer from intussusception come with an unusual abnormal presentation.^{12,13} Using diagnostic tools that are as harmless as possible is a good idea to avoid potential harm to these children, to minimise any negative impacts on the actual diseases, and to minimize the suffering for children who are not shown to have intussusceptions.¹⁴

An ultrasonography-based diagnostic policy for intussusception has been established for more than 10 years, it has been claimed.¹⁵ With typical features such as target signals, doughnuts, and pseudokidney signs, ultrasonography is a dynamic test that can accurately diagnose Intussusception.¹⁶ When diagnosing and guiding a patient's enema reduction in patients with Intussusception, ultrasound has been the predominant diagnostic procedure, notably in Asia and Europe.¹⁷ Diagnostic procedures such as surgery are avoided when an intussusception diagnosis is ruled out using sonography.

Few studies have been done in our community to determine the most accurate diagnostic tool for Intussusception, which is the most prevalent cause of acute intestinal blockage among infants and young children. For the diagnosis of Intussusception and the guidance of air or

hydrostatic enema reduction, ultrasound is increasingly being used. In industrialised countries, however, the accuracy of ultrasonography outside of tertiary care settings has not been tested, notably in Asia where the incidence of Intussusception based on sonographic diagnosis has been reported to be the highest in the globe.⁸

640 newborns (412 male, 228 female) with suspected acute intussusception were studied in a clinical trial. 533 individuals were diagnosed with Intussusception (83 percent). 533 patients, 93% of them boys, were diagnosed with the condition of Intussusception at an average age of 9.3 months (range 3–24 months) (65 percent).⁸

With a range of 0.2-15.0 years, we observed that the average age of children was 3.563.29 years in our study. There were 148 children (87.06 percent) under the age of 8, and there were 22 (8.94 percent) between the ages of 8 and 15. There were 105 boys and 65 girls, or 61.8 percent and 38.2 percent, respectively. The male-to-female ratio was higher in this survey than in the previous one. On the other hand, the age distribution in this study was lower than in the previous one.

Ultrasonography's sensitivity was 97.5 percent, its specificity was 99 percent, and its NPV was 90 percent, according to the researchers.⁸

Our findings were pretty much in line with these results. There were 97 (57.1%) good outcomes and 73 (42.9%) negative results from the Ultrasound results in our study. 107 children (62.9 percent) had positive surgical outcomes, while 63 (37.1 percent) had bad ones. The sensitivity, specificity, NPV and PPV of ultrasound in the diagnosis of intussusception were 85.05 percent, 90.48 percent, 93.81 percent and 78.08 percent, respectively, while the total diagnostic accuracy was 87.06 percent. In the meantime, Usang U.E. et al. have found the sensitivity and specificity were 87% and 50%, respectively, and the positive and negative predictive values were 95.2% and 25%, which are extremely comparable to our results except for the NPV alone. The total accuracy of the US was 84%.⁷

To assess the efficacy of ultrasound in boosting diagnostic confidence in patients with suspected intussusceptions, Usang U.E. carried out this study to determine the accuracy of ultrasound diagnosis and operation findings in cases of suspected intussusception in children. During the eight-year study period, researchers saw 41 individuals who had intussusception. Participants ranged in age from 3 months to 7 years, with a median of 6 months and a range of 5.57 months. More than two-thirds of the children were under the age of two, with a total of 21 newborns and four older children. Intussusception was most common between the ages of 3 and 7 months.⁷

Ultrasound (US) has been shown to be a useful diagnostic tool in children who have a clinically suspected acute intussusception. There were no cases that were discovered to be intussusceptible during the enema investigation that were negative in the US (negative predictive value = 100%). The sensitivity of the United States was 100%, and the specificity was 88%.¹⁸

US has a sensitivity and specificity of 97.9 percent and 97.8 percent, respectively, when it comes to identifying intussusception. The ultrasonography has an 86.6 percent positive and a 99.7 percent negative predictive value.⁴

Another study on 65 individuals with a mean age of 1.7 years (ranging from 2 weeks to 5 years) found that USG had a sensitivity of 100%, a specificity of 93%, and a negative predictive value of 100%.¹⁹

Ultrasound may accurately and reliably diagnose intussusceptions in children, according to these investigations, which are in agreement with our findings.

CONCLUSION

Through the findings of our study, diagnostic accuracy of ultrasonography for diagnosis of Intussusception in children taking surgical findings as gold standard is high and can be used in future for diagnosis of Intussusception. USG can help us for prompt and timely diagnosis and early surgical intervention can be done to minimize morbidity related to delayed diagnosis.

REFERENCES

1. Lideo L, Roberto M. Predictors and Ultrasonographic Diagnosis of Intussusception in Children: INTECH Open Access Publisher; 2012. 23-46p.
2. Chang Y, Hsia S, Chao H. Emergency medicine physicians performed ultrasound for pediatric intussusceptions. *Biomed J* 2013;36(4):175-8.
3. Riera A, Hsiao AL, Langan ML, Goodman TR, Chen L. Diagnosis of intussusception by physician novice sonographers in the emergency department. *Ann Emerg Med* 2012;60(3):264-8.
4. Hryhorczuk AL, Strouse PJ. Validation of US as a first-line diagnostic test for assessment of pediatric ileocolic intussusception. *Pediatr Radiol* 2009;39(10):1075-9.
5. Applegate KE. Clinically suspected intussusception in children: evidence-based review and self-assessment module. *Am J Roentgenol* 2012;185(3):S175-S83.
6. Mandeville K, Chien M, Willyerd FA, Mandell G, Hostetler MA, Bulloch B. Intussusception: clinical presentations and imaging characteristics. *Pediatr Emerg Care* 2012;28(9):842-4.
7. Usang UE, Inah GB, Inyang AW, Ekabua AT. Intussusception in children: Comparison between ultrasound diagnosis and operation findings in a tropical developing country. *Afr J Paeds Surg* 2013;10(2):87.
8. Justice FA, de Campo M, Liem NT, Son TN, Ninh TP, Bines JE. Accuracy of ultrasonography for the diagnosis of intussusception in infants in Vietnam. *Pediatr Radiol* 2007;37(2):195-9.
9. Byrne A, Goeghegan T, Govender P, Lyburn I, Colhoun E, Torreggiani W. The imaging of intussusception. *Clinic Radiol* 2005;60(1):39-46.
10. Del-Pozo G, Albillos JC, Tejedor D, Calero R, Rasero M, dela-Calle U, et al. Intussusception in children: current concepts in diagnosis and enema reduction. *Radiographics* 1999;19(2):299-319.
11. Sargent M, Babyn P, Alton D. Plain abdominal radiography in suspected intussusception: A reassessment. *Pediatr Radiol* 1994;24(1):17-20.
12. Ugwu B, Legbo J, Dakum N, Yiltok S, Mbah N, Uba F. Childhood intussusception: a 9-year review. *Annals of Tropical Paediatrics: Int Child Health* 2000;20(2):131-5.
13. Shekhawat N, Prabhakar G, Sinha D, Goyal R, Gupta A, Sharma R, et al. Nonischemic intussusception in childhood. *J Pediatr Surg* 1992;27(11):1433-5.
14. Bisset 3rd G, Kirks DR. Intussusception in infants and children: diagnosis and therapy. *Radiol* 1988;168(1):141-5.
15. Shanbhogue RL, Hussain SM, Meradji M, Robben SG, Vernooij JE, Molenaar JC. Ultrasonography is accurate enough for the diagnosis of intussusception. *J Pediatr Surg* 1994;29(2):324-8.
16. Daneman A, Alton DJ. Intussusception. Issues and controversies related to diagnosis and reduction. *Radiol Clin North Am* 1996;34(4):743.
17. del-Pozo G, Albillos JC, Tejedor D. Intussusception: US findings with pathologic correlation--the crescent-in-doughnut sign. *Radiology* 1996;199(3):688-92.
18. Verschelden P, Filiatrault D, Garel L, Grignon A, Perreault G, Boisvert J, et al. Intussusception in children: reliability of US in diagnosis--a prospective study. *Radiology* 1992;184(3):741-4.
19. Bhisitkul DM, Listernick R, Shkolnik A, Donaldson JS, Henricks BD, Feinstein KA, et al. Clinical application of ultrasonography in the diagnosis of intussusception. *J Pediatr* 1992;121(2):182-6.