Study of Value of Abdominal Sonography in Diagnosis of GIT Disorders in children

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ABSTRACT

Background: Ultrasound is an ideal imaging modality in the pediatric population because it is a real-time, non-invasive, relatively low cost examination without ionizing radiation that requires no sedation.

Aim of the work: to evaluate the usefulness of abdominal ultrasonography (US) in diagnosis of GIT diseases in children.

patient and methods: The study was Prospective observational study carried out on 80 Egyptian children aged from 2 years to 18 years old 60 males and 20 females with symptoms related to GIT disorders who attended outpatient Clinic and ER of pediatrics department, Between1st March 2021 and 30th November 2021, all patient were subjected to history taking ,complete abdominal examination, abdominal aultrasound and other examination CT abdomen ,barium enema, X ray ,endoscopy ,and viral markers were done in some patients when indicated.

Result: Ultrasonographic examination revealed diagnosis of suspected acute hepatitis in 12 patients (15%), suspected acute pancreatitis in 3 patients (3.8%), suspected appendicitis in 7 patients (8.8%), Budd-Chiari syndrome in 2 patients (2.5%), colonic polyps in 3 patients (3.8%), IBD in 5 patients (6.3%), Inguinal hernia in 6 patients (7.5%), Intussesption in 8 patients (10%), peptic ulcer in 2 patients (2.5%), pyloric stenosis in 3 patients (3.8%), volvulus in 6 patients (7.5%), Hirsch sprung in 4 patient(5%), while it was normal in 19 patients (23.8%).

Conclusion: Ultrasound was proven to have a major role in diagnosis of bowel disorders in children; especially that it is considered a safe procedure that does not cause ionizing radiation exposure. Also, it helps rapid diagnosis without the need for prolonged special preparation.

Keywords: Ultrasound ،bowel diseases, pediatrics.

INTRODUCTION

Ultrasound is an ideal imaging modality in the pediatric population because it is a real-time, non-invasive, relatively low cost examination without ionizing radiation that requires no sedation. Several reviews have emphasized the utility of ultrasound in the evaluation of pediatric bowel pathology **(Arys et al., 2014)**.

In the last two decades, among the cross-sectional imaging techniques, US has had a growing role in the development and application of techniques for the diagnosis of GI diseases because it is cheap, non-invasive, and more comfortable for the patient, and it has sufficient diagnostic accuracy to provide the clinician with high temporal and spatial resolution image data **(Roccarina et al., 2013).**

Ultrasound of the bowel in children is typically a targeted examination, designed to answer a specific question, and common indications include evaluation for appendicitis, intussusception, and pyloric stenosis. Other focused examinations include evaluation of congenital abnormalities detected prenatally, confirmation of suspected hernia, and problem solving in the patient with necrotizing enterocolitis (NEC) **(Anupindi et al., 2016).**

patient and methods; The study was Prospective observational study carried out on 80 Egyptian children 60 males and 20 females with symptoms related to GIT disorders who attended on outpatient Clinic and ER of pediatrics department, Between1st March 2021 and 30th November 2021, all patient were subjected to history taking ,complete abdominal examination, abdominal aultrasound and other examination CT abdomen ,barium enema, X ray ,endoscopy ,and viral markers were done in some patients.

Ethical consideration:

The study was approved by internal review board of Faculty of Medicine, Al-Azhar University.

1. A written informed consent was obtained from patients or their legal guardians.

2. An approval by the local ethical committee was obtained before the study.

3. The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

4. All the data of the patients and results of the study are confidential, and the patients have the right to keep it.

5. The patient has the right to withdraw from the study at any time.

6. The researcher explained the aim of the study to each patient.

Sample size calculation:

The sample size was calculated using Epi-Info 7. The criteria used for sample size calculation were as follows: confidence limit of 95%, and precision of 80%. The calculated sample size was N=78 children. The sample size was increased to 80 to assume any drop out cases during follow up.

x = Z(c/100) ^2 r (100-r) n = N x/ ((N-1) E2 + x)

E = Sqrt [(N - n) x/n (N-1)]

Where N is the population size, r is the fraction of responses that you are interested in, and Z(c/100) is the critical value for the confidence level c.

Inclusion criteria:

- All children aged from 2 years to 18 years old.
- All patients presented with GIT symptoms e.g pain ,vomiting , diarrhea ,bleeding per rectum and constipation.

Exclusion criteria:

- Children below 2 years and more than 18 years.
- Children are with chronic GIT diseases.

Full History taking:

All children included in the study were subjected to the following:

- Full and careful history was obtained from patients and their parents including Name, Age, Sex, Residence (Urban or Rural) ,symptoms of GIT disease e.g pain ,vomiting , diarrhea ,bleeding per rectum and constipation ,cardiac disease , renal disease and neurological disease.

Full Clinical Examination:

- general Examination : includes assessment of general condition, vital

signs (pulse, blood pressure, respiratory rate and temperature). Anthropometric parameters were obtained. Height and weight were measured, and body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters.

- Systemic examination: Abdominal, chest, heart and neurological examination were assessed with focus on manifestations of GIT diseases (such as jaundice, tenderness, organomegaly, ascites).

Laboratory evaluation: that were included CBC , Liver function tests (ALT, AST) , renal function tests (Creatinine) ,CRP ,serum amylase and lipase.

Imaging: Studied patients were submitted to screening by Abdominal Ultrasonography with the following procedures:

Technique of examination

- Child should be dressed in comfortable, loose-fitting clothing for an ultrasound exam. A clear water-based gel is applied to the area of the body being studied to help the transducer make secure contact with the body and eliminate air pockets between the transducer and the skin that can block the sound waves from passing into your body. The sonographer (ultrasound technologist) or radiologist then places the transducer on the skin in various locations, sweeping over the area of interest or angling the sound beam from a different location to see an area of concern. Doppler sonography is performed using the same transducer.
- Scans were obtained with the transducer placed transversely and longitudinally until the plane showed the maximum cross-sectional area of examination. For most ultrasound exams, doctor was positioned lying face-up on an examination table that can be tilted or moved. Patients may be turned to either side to improve the quality of the images.
- All the examinations were performed by a single operator using sonoscapeS11 ultrasound machine with a low frequency (2-6MHz) curved-array transducer to general

examination of all quadrants of abdomen for potential pathologic abnormalities like pathological distension, motility and para-intestinal structures such as abscesses. This was followed by examination using a high resolution linear-array transducer (4–12 MHz) for detailed examination of the bowel wall structure using a consistent technique and protocol: examination of the proximal to distal colon followed by complete examination of the small bowel. All the examinations were performed without any preceding preparation and without contrast material.

- All ultrasonographic examinations were performed by the same radiologist, who was blinded to the clinical and laboratory details of the patients.

1- The following parameters were involved in ultrasonographic evaluation:-

- Assessment of the liver for its size in both midline and mid-clavicular line, surface of the liver and echogenicity.
- Presence or absence of ascites and Portal vein patency.
- The spleen is measured obliquely in the axis of the largest length defined by the hilar vessels, Splenic size: were be expressed as average (absence of splenomegaly) or enlarged.
- Pancreas is usually assessed in a slightly oblique axial section of the median upper abdomen through the organ's longitudinal axis.
- The gallbladder and biliary tract were measured along the anterior wall between the lumen and the liver biliary for inflammation and/or biliary obstruction.
- Bowel wall structure, wall thickness, motility and para-intestinal structures.
- Measurement of the appendiceal diameter, the presence or absence of other variables such as appendiceal wall thickness, periappendiceal inflammation, free fluid, appendicolith, or hyperemia of the appendiceal wall.
- Other examination CT abdomen ,barium enema, X ray ,endoscopy ,and viral markers were done in some patients.

Endoscopic examination: upper and lower endoscopy when indicated.

Statistical analysis

Data collected were reviewed and coded. These numerical codes were fed to the computer where statistical analysis was done using the Statistic Package for Social Science Version 22 (SPSS 22).

Descriptive data:

1. Quantitative data: were presented as mean and standard deviation (mean ± SD).

2. Qualitative data: were expressed as numbers and percentage.

- Comparing groups was done using:

a. Chi square-test (X^2): for comparison of qualitative data.

b. Student's "t"- test for comparison of quantitative data of 2 independent sample with normal distribution and homogeneity of variance

c. The coefficient interval was set to 95%. The level of significance was calculated according to the following probability (P) values:

- P-value <0.05 was considered significant.
- P-value <0.001 was considered as highly significant.
- P-value >0.05 was considered insignificance.

Results

Table (1): Demographic data in all studied patients of GIT diseases.

		Studied patients (N = 80)	
Age (years)	Mean ±SD	6.81± 2.8	
	Min – Max	2 – 15	
Sex	Male	60	75%
	Female	20	25%
Residence	Rural	42	52.5%
	Urban	38	47.5%
Consanguinity	Positive	47	52.2 %
	Negative	33	41.2%

This table shows the mean age of all studied patients was 6.81 (±2.8 SD) years with range (2-15), among the studied cases there were 60 (75%) males and 20 (25%) females in the studied patients and there were 42 patients (52.5%) from rural and 38 patients (47.5%) from urban in the studied patients and there were 47 patients (52.2 %) with positive consanguinity and 33 patients (41.2 %) with negative consanguinity in the studied patients.

Table (2): Clinical presentation in all studied patients of GIT diseases.

Studied patients (N = 80)		
	N	**%**
Abd.pain	60	75%
Vomiting	26	32.5%
Constipation	21	26.3%
Abdominal distention	21	26.3%
Jaundice	14	17.5%
Bleeding per rectum	13	16.3%
Diarrhea	13	16.3%
Dark urine	12	15%
Fever	12	15%
Red gelly stool	6	7.5%
inguinal swelling	5	6.3%

This table shows the most common complaint was presented abdominal pain (75%) followed by Vomiting (32.5%) , Constipation (26.3%) ,and Abdominal distention (26.3%)

Table (3): Laboratory data in all studied patients of GIT diseases.

(n = 80)	Minimum	Maximum	Mean	±SD
WBCs (x10^3/ul)	3	19.6	7.1	3.5
HB% (g/dl)	7.8	13.2	11.5	1.3
MCV(fl)	74	93	85.1	5.4
MCH(pg)	25.1	31.8	28.3	2.0
Platelets(x10^3/ul)	96	428	231.7	51.1
ALT (U/L)	15	1650	227.0	408.8
AST (U/L)	13	1710	274.0	398.3
S. Creat (mg/dl)	0.45	0.8	0.7	0.1
BUN (mg/dl)	5	18	11.8	3.7
CRP (mg/L)	5	55	15.0	8.0
Serum amylase(U/L)	30	973	534	89.2
Serum lipase(U/L)	10	1531	365	376.3

This table shows the description of laboratory data in all studied patients.

- **As regard WBCs,** the mean WBCs of all studied patients were 7.1 ± 3.5 (x10^3/ul) with minimum WBCs of 3 (x10^3/ul) and maximum WBCs of 19.6 (x10^3/ul).
- **As regard Hb%,** the mean Hb of all studied patients was 11.5 ± 1.3 g/dl with minimum Hb of 7.8 g/dl and maximum Hb of 13.2 g/dl.
- **As regard MCV,** the mean MCV of all studied patients was 85.1 ± 5.4 (fl) with minimum MCV of 74 (fl) and maximum MCV of 93 (fl).
- **As regard MCH,** the mean MCH of all studied patients was 28.3 ± 2 (pg) with minimum MCH of 25.1 (pg) and maximum MCH of 31.8 (pg).
- **As regard platelets,** the mean PLTs of all studied patients were 231.7 ± 51.1 (x10^3/ul) with minimum PLTs of 96 (x10^3/ul) and maximum PLTs of 428 (x10^3/ul).
- **As regard serum ALT,** the mean ALT of all studied patients was 227 ± 408.8 U/L with minimum ALT of 15 U/L and maximum ALT of 1650 U/L.
- **As regard serum AST,** the mean AST of all studied patients was 274 ± 398.3 U/L with minimum AST of 13 U/L and maximum AST of 1710 U/L.
- **As regard serum Creat,** the mean Creat of all studied patients was 0.7 ± 0.1 mg/dl with minimum Creat of 0.45 mg/dl and maximum Creat of 0.8 mg/dl.
- **As regard BUN,** the mean BUN of all studied patients was 11.8 ± 3.7 mg/dl with minimum BUN of 5 mg/dl and maximum BUN of 18 mg/dl.
- **As regard CRP,** the mean CRP of all studied patients was 15 ± 8 mg/L with minimum CRP of 5 mg/L and maximum CRP of 55 mg/L.

Table (4): Abdominal ultrasonography diagnoses in all studied patients of GIT diseases.

		Studied patients (N = 80)	
U/S Diagnosis	Normal	19	23.8 %
	Suspected acute Hepatitis	12	15%
	Suspected acute pancreatitis	3	3.8%
	Suspected appendicitis	7	8.8%
	Budd–Chiari syndrome	2	2.5%
	Colonic polyps	3	3.8 %
	IBD	5	6.2%
	inguinal hernia	6	7.5%
	Intussesption	8	10%
	Peptic ulcer	2	2.5%
	pyloric stenosis	3	3.8 %
	Volvulus	6	7.5%
	Hirsch sprung	4	5%

This table shows the description of U/S diagnoses in all studied patients.

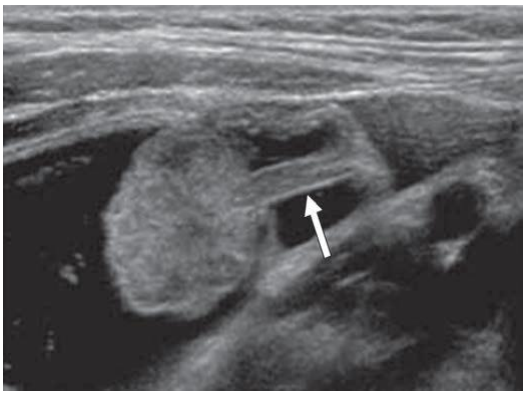

Fig. (1): Abdominal ultrasound of jejunal polyp with stalk (arrow), It Shows a small, well defined, isoechoic polypoidal lesion seen in the lumen of jejunal loop at the left upper abdomen with short pedicle attached to the wall.

Fig.(2):Abdominal ultrasound of intussusception, it shows a target sign of invagination (loop within loop appearance), it seen at the level of the middle lower abdomen.

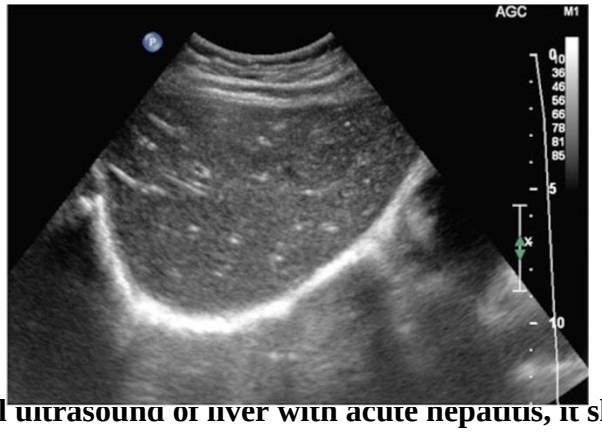

Fig.(3): Abdominal ultrasound of liver with acute hepatitis, it shows tiny echogenic foci throughout the liver giving picture of starry night appearance.

Table (5): Confirmed diagnoses in all studied patients of GIT diseases.

		Studied patients (N = 80)	
Confirmed diagnosis	Normal	14	17.5%
	Acute Hepatitis(Viral markers)	12	15%
	Acute pancreatitis(Serum amylase and lipase)	3	3.8 %
	Appendicitis(Examination Plus Ultrasound)	7	8.8 %
	Budd–Chiari syndrome(CT Abdomen)	2	2.5%
	Colonic polyps(lower endoscopy)	3	3.8 %
	Dysfunctional Constipation (Examination Plus Ultrasound)	3	3.8%
	IBD(lower endoscopy)	7	8.8 %
	Inguinal hernia(Examination Plus Ultrasound)	4	5%
	Intussesption (x-ray and examination)	8	10%
	Peptic ulcer(upper endoscopy)	5	6.2%
	pyloric stenosis(Examination Plus Ultrasound)	3	3.8 %
	Volvulus(x-ray and examination)	5	6.2%
	hirschsprung disease(Barium enema)	4	5%

This table shows the description of confirmed diagnoses in all studied patients.

Table (6): Correlation between abdominal ultrasonography diagnoses and confirmed diagnoses of GIT diseases.

	U/S Diagnosis		Confirmed diagnosis		χ^2	P
Normal	19	23.8%	14	17.5%	0.954	0.329
Acute Hepatitis	12	15%	12	15%	0.0	1.0
Acute pancreatitis	3	3.8 %	3	3.8 %	0.0	1.0
Appendicitis	7	8.8%	7	8.8%	0.0	1.0
Budd–Chiari syndrome	2	2.5%	2	2.5%	0.0	1.0
Colonic polyps	3	3.8 %	3	3.8 %	0.0	1.0
Dysfunctional Constipation	-	-	3	3.8%	4.103	0.043
IBD	5	6.3%	7	8.8%	0.360	0.548
Inguinal hernia	6	7.5%	4	5%	0.427	0.514
Intussesption	8	10%	8	10%	0.0	1.0
Peptic ulcer	2	2.5%	5	6.3%	1.345	0.247
pyloric stenosis	3	3.8 %	3	3.8 %	0.0	1.0
Volvulus	6	7.5%	5	6.2 %	0.098	0.755
hirschsprung disease	4	5%	4	5%	0.0	1.0

This table shows that there was no significant between the US diagnosis and confirmed examinations in diagnosis of GIT disease in children .

Table (7): Confirmatory test in all studied patients of GIT diseases.

		Diseases	Studied patients	
Confirmatory test	**Barium enema**	Hirshsprung disease	4	5%
	CT Abdomen	Budd_chiari syndrome	2	2.5%
	Endoscope with Histopathology	IBD,Colonic polyps ,peptic ulcer	15	18.75%
	Examination Plus Ultrasound	Dysfunctional constipation, CHPS, appendicitis and inguinal hernia	17	21.25%
	Serum amylase and lipase	Acute pancreatitis	3	3.75%
	x-ray and examination	Intussusception, volvulus	13	16.25%
	Viral markers	Hepatitis	12	15%

This table shows the description of confirmatory tests in all studied patients.

Table (8): Sensitivity and specifity for the use of abdominal ultrasonography in diagnosis of GIT diseases.

	Sensitivity%	Specificity%	PPV%	NPV%	Accuracy %
US	92.4	86.3	97	73.7	93.8

Table (9): Description of 4-8-12 weeks follow according to diseases.

Disease (Number of patients)	4 weaks Follow up	8 weaks Follow up	12 weaks Follow up
Acute Hepatitis (12)	Complete recovery on supportive treatment (75%)	Complete recovery on supportive treatment (100%)	_____
	Partial recovery on supportive treatment (25%)		
Acute appendicitis (7)	Appendectomy with complete recovery (100%)	complete recovery (100%)	_____
Acute pancreatitis (3)	Partial recovery on supportive treatment (66.6%)	Partial recovery on supportive treatment (33.3%)	Complete recovery on supportive treatment (100%)
	Complete recovery on supportive treatment (33.3%)	Complete recovery on supportive treatment (66.6%)	
Budd–Chiari syndrome (2)	Partial recovery on conservative treatment (100%)	Partial recovery on conservative treatment (100%)	Partial recovery on conservative treatment (100%)
Colonic polyps (3)	Colonoscopic polypectomy with complete recovery (100%)	complete recovery (100%)	_____
Dysfunctional Constipation (3)	Partial recovery on supportive treatment (33.3%)	Partial recovery on supportive treatment (66.6%)	Complete recovery on supportive treatment (100%)
IBD (7)	Partial Remesion on sulfasalazine (100%)	Remesion on sulfasalazine and corticosteroid (100%)	Remesion on sulfasalazine corticosteroid (100%)
Inguinal hernia (4)	Repaired with complete recovery (25%)	Repaired with complete recovery (75%)	Repaired with complete recovery (100%)

Intussesption (8)	Reduction with air enema (75%) Surgical reduction (25%)	Complete recovery (100%)	_____
pyloric stenosis (3)	Pyloromyotomy with complete recovery (100%)	complete recovery (100%)	_____
Peptic ulcer (5)	Partial recovery on PPI (100%)	Complete recovery on PPI (100%)	_____
Volvulus (5)	Surgical correction with complete recovery (100%)	complete recovery (100%)	_____
hirschsprung disease (4)	Surgical repair with complete recovery (100%)	complete recovery (100%)	_____

Discussion

Ultrasound is an ideal imaging modality in the pediatric population because it is a real-time, non-invasive, relatively low cost examination without ionizing radiation that requires no sedation. Several reviews have emphasized the utility of ultrasound in the evaluation of pediatric bowel pathology **(Arys et al., 2014)**.

This study include 80 patients, 60 males (75%) and 20 females (25%), The mean age of all studied patients was 6.81 ± 2.8 years, this results in agreement with the study by **(Refaat et al., 2021)** , who assessed sixty patients by conventional ultrasound linear transducer. (27) of them were female patients and (33) were males, which found abdominal diseases in children more common in males than females.

Regarding clinical presentation in our study. pain was presented in 60 patients (75%), vomiting was presented in 26 patients (32.5%), constipation was presented in 21 patients (26.3%), abdominal distension was presented in 21 patients (26.3%), jaundice was presented in 14 patients (17.5%), diarrhea was presented in 13 patients (16.5%),Fever was presented in 12 patients (15%), red gelly stool was presented in 6 patients (7.5%), dark urine was presented in 12 patients (15%), inguinal swelling was presented in 5 patients (6.3%), ascites was presented in 3 patients (3.8%) and bleeding per rectum was presented in 13 patients (16.3%).

This results were also in agreement with aprospective study of ultrasonographic examination in 146 paediatric patients presenting with acute onset abdominal pain. Common causes of acute abdominal emergencies in pediatric patients as noted on ultrasonography included nonspecific pain (28%), abdominal abscess (21%), acute appendicitis (7%) and intussusception (7%). The stated that ultrasonography evaluation of

children with acute abdominal pain, helps in making significant changes in the management plan of the patients, and also reveals various clinically unsuspected diseases **(Khalid et al., 2012).**

In the present study ultrasonographic examinations revealed patients were normal with abdominal non specific pain 19 (23.8%), suspected acute hepatitis in 12 patients (15%), suspected acute pancreatitis in 3 patients (3.8%), suspected appendicitis in 7 patients (8.8%), Budd-Chiari syndrome in 2 patients (2.5%), colonic polyps in 3 patients (3.8%), IBD in 5 patients (6.3%), Inguinal hernia in 6 patients (7.5%), Intussesption in 8 patients (10%), peptic ulcer in 2 patients (2.5%), pyloric stenosis in 3 patients (3.8%), volvulus in 6 patients (7.5%), Hirschsprung in 4 patient(5%), while it was normal in 19 patients (23.8%).

In consistent with our results, another study by **(Mwango et al., 2012).** Fifty-six children who presented with vomiting and suspected upper gastrointestinal disease. Age range was from six days to 12 years with mean age of one year five months. Of the 56 children, six were normal on sonography; 18 (32.1%) had intussusception, seven (12.5%) pyloric stenosis, four appendicitis, three jejunal/ileal atresia and two enteric duplication cysts.

This results were also in agreement with the study by (**Civitelli et al., 2014)** who evaluated the usefulness of colonic ultrasonography (US) in assessing the extent and activity of disease in pediatric ulcerative colitis (UC) and to compare US findings with clinical and endoscopic features. They examined 50 pediatric patients with a diagnosis of UC and suspected disease flare-up. The endoscopic extent of disease was independently confirmed in 47 patients by US that yielded a 90% concordance with endoscopy 95%.

In our study The results showed that abdominal US had of sensitivity 92.4%, specificity 86.3%, PPV 97%, NPV 73.7% and accuracy 93.8%. This results were also in agreement with the study by **(Refaat et al., 2021)** who evaluated the Validity of US in prediction of different bowel diseases in pediatric as sensitivity of US is 85%, specificity is 100% and accuracy is 88.3% .

Results of current study showed that all patients with acute appendicitis were underwent appendectomy with complete recovery in 4 weeks. All patients with acute hepatitis A were recovered completely without complications through 4-8 weeks. In patients presented with intussusception, reduction were achieved by air enema and surgically with complete recovery without complications.

In a study of 200 patients, laparotomy based on clinical criteria alone for acute appendicitis, showed 22.5% negative

appendicectomy, while laparotomy based on both clinical and US findings showed 4.7% negative appendicectomy. This study proved that routine US examination by graded compression does improve diagnostic accuracy and reduce adverse outcome **(Mardan et al., 2007).**

In accordance with our results**,** reviewed the medical records of 350 patients (age 0–16 years) admitted to the Infectious Diseases Hospital, Kuwait, with hepatitis A infection, to describe the epidemiology, clinical features and outcome of hepatitis A virus (HAV) infection in children. They noted that none of the patients had permanent sequelae or complications **(Husain et al, 2006).**

Conclusion

- Ultrasound was proven to have a major role in diagnosis of bowel diseases in children; especially that it is considered a safe procedure that does not cause ionizing radiation exposure. Also, it helps rapid diagnosis without the need for prolonged special preparation.
- Abdominal US had sensitivity of 92.4%, specificity of 86.3%, PPV of 97%, NPV of 73.7 % and accuracy of 93.8% in diagnosis of GIT diseases.
- Our results suggest a possible role of abdominal ultrasound in diagnosis of GIT diseases.

Recommendations

Ultrasound can diagnose several diseases that cause GIT disorders and can differentiate among various medical and surgical problems in pediatric patients helping to an earlier diagnosis.

REFERENCES

Anupindi SA, Halverson M, Khwaja A, Jeckovic M, Wang X, Bellah RD. (2016): Common and uncommon applications of bowel ultrasound with pathologic correlation in children. AJR Am J Roentgenol;202:946–959.

Arys B, Mandelstam S, Rao P, Kernick S, Kumbla S. (2014) : Sonography of the pediatric gastrointestinal system. Ultrasound Q;30:101–117.

Civitelli, F., Di Nardo, G., Oliva, S., Nuti, F., Ferrari, F., Dilillo, A& Aloi, M. (2014): Ultrasonography of the colon in pediatric ulcerative colitis: a prospective, blind, comparative study with colonoscopy. The Journal of pediatrics;165(1), 78-84.

Husain, E., Al-Tawfiq, J. A., & Husain, K. (2007): Epidemiology and outcome of severe hepatitis A infection in children in Kuwait. Medical Principles and Practice;15(4), 266-269.

Khalid M, Redhu N, Nazir B, Khalid S, Chana RS, Jha A. (2012): Diagnostic value of ultrasonography in evaluation and management of acute abdominal conditions in the paediatric age group. Afr J Paediatr Surg;9:198-201.

Mardan, M. A., Mufti, T. S., Khattak, I. U, et al. (2007): The role of ultrasound in acute appendicitis. J. Ayub Med. Coll. Abbot; **19:** 75 - 79.

Mwango, G. N., Salim, S. I., Wambugu, M. N., & Aywak, A. A. (2012): Role of abdominal ultrasound imaging in evaluation of children with suspected upper gastrointestinal disease. East African Medical Journal; 89(8), 250-257.

Refaat M M., Ahmed E. Shalaan, Doaa A. Mokhtar.(2021): Ultrasound Role in Assessment of Bowel Diseases in Pediatrics. BMFJ;38 (Radiology); 128-136.

Roccarina D, Garcovich M, Ainora ME, Caracciolo G, Ponziani F, Gasbarrini A, Zocco MA.(2013): Diagnosis of bowel diseases: The role of imaging and ultrasonography. World J Gastroenterol; 19(14): 2144-2153.