

Ultrasonographic Evaluation Of Gastrointestinal Tract Pathologies (A Study Of 64 Cases)

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ABSTRACT:

Background & Objectives: The purpose of our study is to evaluate the role of ultrasonography in diagnosing different bowel loop pathologies and to show that most of the common and some of the uncommon diseases of the intestine can be diagnosed on ultrasonography reliably without the need of further imaging studies. **Methods:** This study included 64 patients who presented with abdominal complaints like abdominal pain, abdominal lump, vomiting, fever, constipation and diarrhoea. **Results:** Most of the cases were initially diagnosed on ultrasound and was confirmed on CT. **Interpretation & conclusion:** In acute abdominal conditions, transabdominal ultrasound is a very sensitive investigative modality. Hence it can be used as an initial diagnostic tool. However, its value is limited in definitive diagnosis of acute abdominal conditions. It can also be used for further work up & follow up of bowel diseases. Ultrasound has gained acceptance, especially in inflammatory bowel disease because it can provide information regarding extent & activity of the disease. New sonographic techniques including colour Doppler combined with the application of intravenous contrast agents increase the accuracy in evaluating bowel wall vascularisation.

Key-words: Small bowel pathologies, appendicitis, intussusception

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INTRODUCTION

Ultrasonography has become widely accepted as an initial diagnostic tool for gastrointestinal pathologies. Ultrasonography has the advantage of being cheap, portable, flexible and user and patient-friendly, while at the same time providing the clinician with image data of high temporal and spatial resolution. Among all the cross-sectional imaging techniques, ultrasound is less invasive, more comfortable for the patient and has a significant diagnostic accuracy.¹ The flexibility offered by ultrasonography to the examiner makes it a better initial investigation modality in gastrointestinal lesions than computerized tomography and magnetic resonance imaging. The method

has limitations in obese individuals. Air in the intestine may also limit the diagnostic accuracy.

MATERIALS AND METHODS

This cross sectional study was approved by the institutional review board. Informed consent was obtained. All the patients presenting to SSG Hospital & Medical College, Vadodara, Gujarat, with acute and chronic non traumatic and non-gynaecological abdominal conditions in whom clinical diagnosis has been done already (male or female of any age) during the study period were included in the study. After the initial clinical evaluation at the emergency department for acute cases and in the wards for the stable patients with chronic abdominal conditions, they were submitted to

ultrasound examination. Philips IU 22 and Esaote my lab 40 plus machines were used and ultrasound was performed with both high frequency linear array and low frequency curvilinear array transducer. The examination was done in supine position and commenced in the epigastric region then in the right upper quadrant in the region of hepatic flexure of colon and ended in the lower quadrant in the region of sigmoid colon. Graded compression technique was used whenever necessary. Scanning at the point of maximum tenderness was found to be more useful in localizing certain abnormalities. This had decreased the duration of time required for examination. For scanning of stomach in suspected cases of gastric outlet obstruction and gastric malignancy, patients were given water to drink for the stomach to get distended, scan was done in the longitudinal, transverse and left sided sub costal oblique positions. After the ultrasound diagnosis was established, patients in the study group in whom surgery was indicated were taken for surgery. The per-operative findings were noted and compared with the ultrasound diagnosis. Some patients underwent CT for confirmation.

RESULTS AND OBSERVATIONS

USG is initial screening modality for the evaluation of suspected **acute appendicitis**. A 7.5 MHz ultrasound probe is applied with gradually increased pressure over the right iliac fossa. Appendix is seen as a blind ended tubular structure which is non-compressible, aperistaltic measuring >6mm in diameter, wall thickness >3mm with increased intramural vascularity on color Doppler. Appendicoliths were also seen in some cases causing an acoustic shadow. [Fig 1a, b] Fluid collection in the surrounding region was highly suggestive of an appendicular abscess or a ruptured appendix. One case of retrocaecal

appendix was missed on ultrasound and was diagnosed with the help of CT.

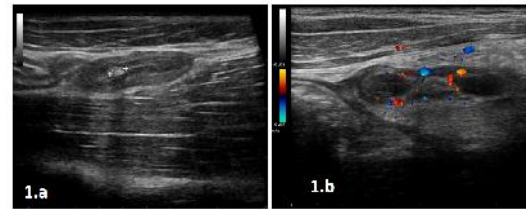


Figure 1. (a) Grey scale showing appendix, measuring 8.2mm in diameter with an appendicolith (b) Colour Doppler showing mural vascularity suggestive of inflamed appendix.

Meckel's diverticulitis was diagnosed on transabdominal sonography as a blind ended fluid filled tube seen to arise from the terminal ileum. It can be differentiated from appendix by its larger size and well defined wall with 3 definite layers. [Fig 2 a, b]

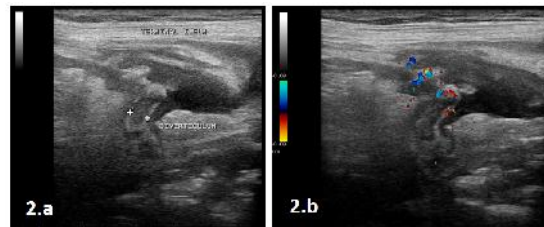


Figure 2: (a) Ultrasonography showing blind ended fluid filled outpouching arising from the terminal ileum. Note the diverticulum arising from the antimesenteric border s/o Meckel's diverticulum. (b) Colour Doppler image showing inflamed and oedematous Meckel's diverticulum in a young male patient with acute onset pain in right iliac fossa.

Cases of **Ileocecal tuberculosis** showed free or loculated free fluid in abdomen with internal septations and debris. Interloop ascites giving club sandwich pattern was also observed. [Fig 3a]. Discrete and matted lymph nodes were also seen few of them which appeared necrotic and calcified. [Fig 3 b, c]. There was uniform concentric thickening of bowel wall more prominent in the ileocecal region. [Fig 3d, e, f].

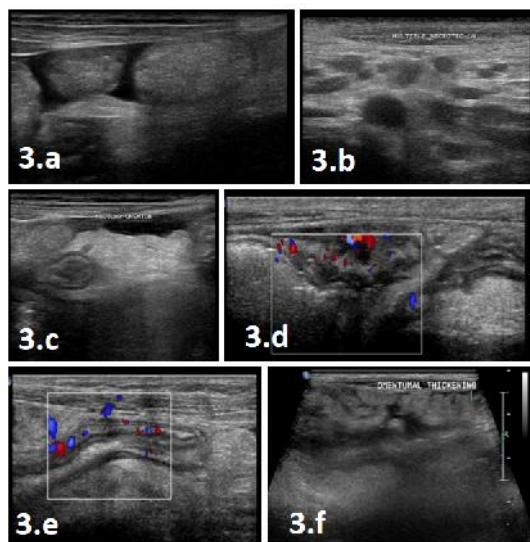


Figure 3: (a) A case of intestinal tuberculosis showing typical features: interloop free fluid (Club sandwich sign). (b) Multiple lymph nodes with loss of echogenic hilum. (c) Nodular omental thickening. (d) Another case showing inflammation of ileocecal junction. (e) Hypoechoic circumferential thickening of terminal ileum with mural vascularity. (f) Omental thickening. Features typical of intestinal tuberculosis.

Few cases of **Acute terminal ileitis** were seen in which the ultrasound showed hypoechoic edematous thickening of terminal ileum and caecum. In our study we had only one case of **Crohn's disease**. There was complete circumferential loss of the typical gut wall layers, which results in a thick hypoechoic rim with an echogenic centre giving the "target" sign. [Fig 4] Marked thickenings of the gut wall with a fixed hyperechoic narrowed lumen were noted which represents the strictures with proximal bowel dilatation. Ultrasound was more sensitive & specific than erect x ray in the diagnosis of acute intestinal obstruction. The bowel loops appeared dilated and showed hypoperistalsis. Few of the cases showed intraperitoneal free fluid. Cases of **Intestinal perforation** was primarily diagnosed on X-ray and confirmed on ultrasound. Few of the cases were primarily diagnosed with the help of transabdominal ultrasound. Free air is seen as echogenic spots or lines with

reverberation artefact seen in between the anterior surface of the left lobe of liver and abdominal wall. [Fig 5]

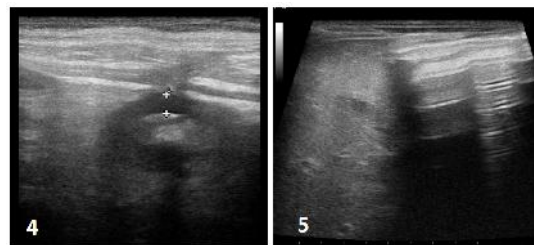


Figure 4: A case of Crohn's disease of small bowel. Note the symmetrical bowel wall thickening (pseudokidney sign) with preserved stratification. Same patient showing increased intramural vascularity involving jejunal loops and mild dilatation of proximal loops were noted. (not shown) Figure 5: Image showing reverberation artefact as echogenic bands over left lobe of liver s/o free intraperitoneal gas.

Intussusception on transverse section shows "doughnut sign" with alternating hyperechogenicity and hypoechogenicity. [Fig 6a] The leading point of intussusception was also correctly diagnosed on ultrasound. [Fig 6 b, c]

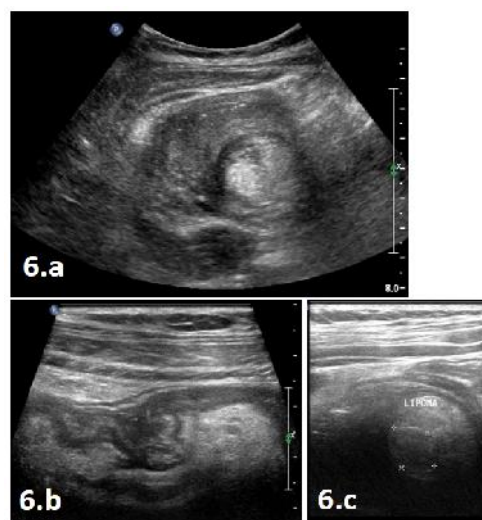


Figure 6: (a) Transverse scan showing Doughnut Sign. (b) Longitudinal section showing bowel within bowel with central echogenic mesentery in a case of colo-colic intussusception. (c) Note lipoma as the lead point in colo-colic intussusception.

Jejunal polyposis can be diagnosed on ultrasound which was later confirmed by CT. The polyps vary in size

and may be sessile and pedunculated. [Fig 7a, b, c, d] Large lesions characteristically have a lobulated surface.

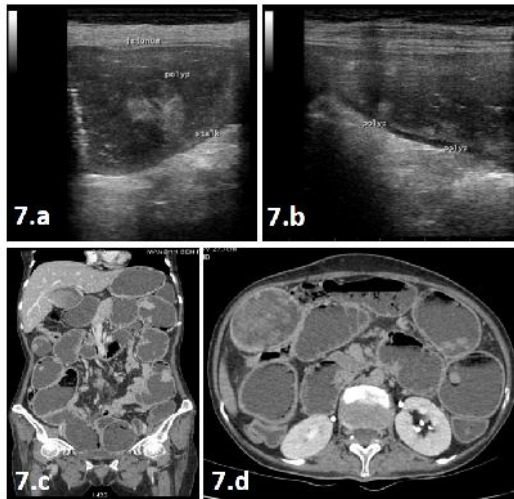


Figure 7: (a, b) Showing multiple polyps in jejunum. (c, d) Axial and coronal CT image of the same patient showing multiple polyps in jejunum and gall bladder in the same patient.

Gastric wall thickening with loss of wall stratification and intramural vascularity favoured **gastric malignancy**. CECT abdomen showed nodular, thickened and heterogeneously enhancing wall of gastric antrum. [Fig 8a, b]. However early mucosal lesions without reasonable tumor bulk was difficult to detect on ultrasound. Such cases with clinical suspicion and a negative ultrasound was referred for endoscopy.

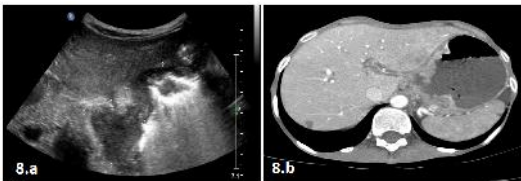


Figure 8: (a) Transverse scanning of the upper abdomen of the patient. Nodular and irregular thickening of the gastric antrum measuring 2cm in thickness with loss of wall stratification (arrows); Note also gastric antrum indenting the left lobe of liver in a 45year old patient with chronic abdominal pain and weight loss. With colour Doppler increased mural vascularity was noted in the gastric antrum. (not shown). (b)

Same patient CECT image shows nodular, thickened, heterogeneously enhancing wall of gastric antrum.

Small bowel carcinoid tumours are slow growing tumours but are nevertheless capable of metastasis. They appear as hypoechoic, homogenous, predominantly intraluminal masses with smooth intraluminal contours. The tumour is attached to the wall with a broad base, leading to interruption of the submucosa and thickening of the muscularis propria. CT is used for demonstrating the intestine, mesentery, lymph nodes and liver in a single examination and for staging the neoplasm as well as follow up after surgery or chemotherapy. Liver metastases from jejunal and ileal carcinoids are generally hypervascular. [Fig 9a, b, c] There was a single case of primary **small bowel lymphoma**. Criteria to diagnose primary bowel lymphoma include: lack of liver or spleen involvement, no evidence of any lymph nodal mass except the involvement of the draining lymph nodes, normal WBC count.

Ileum is the most common site of involvement by lymphoma. Sonography classically shows transmural circumferential profoundly hypoechoic wall thickening with loss of normal stratification. This sign is nonspecific and is seen in most other diseases. [Fig 10a, b]. Sonographic findings associated with **colonic carcinoma** include localized colonic wall thickening with heterogeneous low echogenicity, irregular contour and loss of gut signature. [Fig 11 a, b, c]. However, negative findings during sonographic examination do not rule out the diagnosis of colonic carcinoma because small masses and overlying bowel gas can lead to false-negative results.

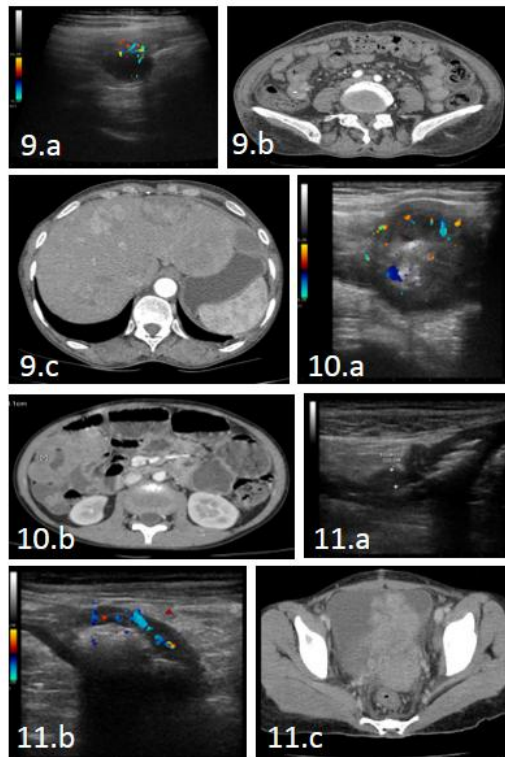


Figure 9:(a) Ultrasonographic images showing hypoechoic mass lesion in RIF which shows increased vascularity on colour Doppler. (b, c) CECT image of the same patient showing intensely enhancing mass (post contrast HU of 92) lesion in terminal ileum and multiple hypervascular metastasis in liver. Features suggestive of carcinoid tumor.

Figure 10 (a) A case of ileal lymphoma showing segmental circumferential symmetrical marked hypoechoic bowel wall thickening involving ileum with loss of gut signature and increased intramural vascularity. There were associated enlarged mesenteric lymph nodes (not shown). (b) Axial CECT image of the same patient showing mild homogenous enhancement (HU 51) of thickened bowel wall involving ileal loops. Note the loss of stratification of bowel wall. There was no evidence of any lesions in liver and spleen. A case of primary lymphoma of small bowel.

Figure 11: (a) Showing eccentric irregular hypoechoic bowel wall thickening involving sigmoid colon in a 48year old patient with chronic abdominal pain and weight loss. (b) Colour Doppler demonstrating increased mural vascularity. (c) CECT image showing sigmoid colon with heterogeneously enhancing asymmetrically thickened and irregular bowel wall.

Ultrasound is currently the imaging modality of choice that reliably establishes the diagnosis of **Infantile hypertrophic pyloric stenosis**. Pyloric muscle thickness of 3 mm or greater, pyloric canal length of 17 mm or greater and the absence of the passage of a peristaltic wave through the pylorus, during the period of scanning is the diagnostic ultrasound criteria. In many cases, an elongated pylorus that lies adjacent to and just below the gallbladder provides the initial clue to the diagnosis. [Fig 12 a, b] Failure of obliteration of the embryonic vitellointestinal duct leads to various congenital anomalies like–Meckel's diverticulum, vitelline cord, enteric cyst, umbilical sinus, enteric fistula or haemorrhagic umbilical mass. Of all the anomalies of the VID, complete patency of the duct is the rarest. Patient may present the anomaly itself or due to complications. In our case the patient presented with intermittent umbilical discharge. [Fig 13 a, b] **Intussusception in children** gave the same sonographic appearance as in adults. But the leading point was enlarged mesenteric lymph nodes unlike in adults wherein the lead point is any mass lesion most commonly a lipoma polyp or carcinoma. Ultrasonography of abdomen is a quick, safe, easily available, non-invasive and relatively inexpensive modality for suspected **Intestinal ascariasis**. The ascaris worms are seen as thick echogenic strip with central anechoic tube representing its gut. A “doughnut” or “target” sign and “bull’s eye” appearances were noted on transverse scan. [Fig 14 a, b].

A total of 64 cases were included in the study. Out of these 40 were males and 24 were females. (M: F ratio=1.6:1). Most common age group is between 21 to 30 years (30%). Most common site of involvement is small intestine (47%).

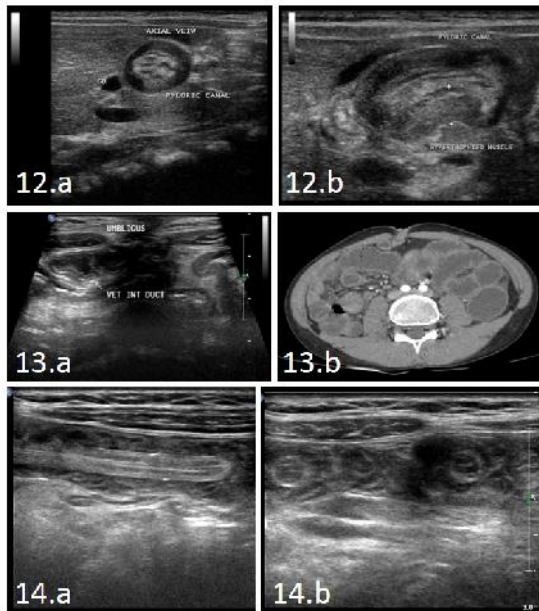


Figure 12: (a) Transverse view through epigastric region showing hypertrophied muscular layer in the pyloric canal in 1 month old infant. (b) Longitudinal view elongated and narrowed pyloric canal measuring 2.6 cm in length and hypertrophied hypoechoic muscular layer measuring 5.9mm in thickness. Figure 13 (a) A 13-year-old boy who presented with an umbilical discharge and pain at umbilical region. Ultrasonographic images reveal a fistulous tract connecting small intestine (ileum) to the umbilicus. (b) CECT axial images of the same boy show completely patent vetilointestinal duct. Figure 14: (a) A longitudinal scan showing a thick echogenic structure with a central anechoic tube (representing ascaris worm) within the intestine of a 10-year-old boy with h/o abdominal pain and vomiting. (b) Transverse scan showing target sign.

Out of 64 cases with abdominal complaints, 22 cases of appendix were found. Thus the most common condition detected by ultrasound in our study is acute appendicitis (35%). There was only a single case of appendicitis in which diagnosis was missed on ultrasound and turned out to be inflamed appendix on CT. Intussusception, tumours and tuberculosis were next common and together constituted 42 % cases of our study. Small bowel pathologies were detected in 30

cases. 15 cases showed involvement of both large and small bowels.

TABLE 1: Demographic Profile

Age group (yr)	No. of cases (n)			%
	Male	Female	Total	
0-1	3	2	5	8%
2-10	2	2	4	6%
11-20	5	1	6	9%
21-30	12	7	19	30%
31-40	8	5	13	20%
41-50	5	4	9	14%
51-60	2	1	3	5%
61-70	3	2	5	8%
Total	40	24	64	100%

TABLE 2: Case distribution

Case	%
Appendicitis	35%
Intussusception	19%
Tumours	14%
Tuberculosis	9%
Paediatric diseases	8%
Obstruction	6%
Nonspecific enteritis	3%
Diverticulitis	2%
Jejunal polyps	2%
Perforation	2%
Inflammatory bowel disease	2%
Total	100%

TABLE 3: Sites affected

Region affected	%
Stomach	9%
Small intestine	47%
Large intestine	20%
Both small and large intestines	24%
Total	100%

DISCUSSION

USG is initial screening modality for the evaluation of suspected acute appendicitis and its complications. Sensitivity, specificity of USG in

diagnosing acute appendicitis is 80-93%, 94%-100% respectively.² Appendix is seen as a blind ended tubular structure which is non-compressible, aperistaltic measuring >6mm in diameter.³ The presence of hyperemia in appendiceal wall & adjacent mesoappendix is a sensitive indicator of inflammation & can be well demonstrated on color Doppler. False positive results are seen in resolving appendicitis, dilated fallopian tubes, inflammatory bowel disease, and inspissated stools mimicking appendicolith. False negative results are seen in appendicitis involving tip, retrocecal appendicitis, gangrenous or perforated or appendix (become compressible) and gas filled appendix. 50 % of cases of meckel's diverticulitis presents in the first 2 years of life. Complications of Meckel's diverticulum develop in approximately 2.5% of the cases and include inflammation, perforation, intussusception, volvulus and rarely neoplasia.⁴ Sonographically, Meckel's diverticulum may be identified as a fluid-filled over distended tube connected to the umbilicus.⁵ This tubular structure can be differentiated from an inflamed appendix as it does not arise from the caecum and has a diameter of up to 40 mm and a well-defined wall of small bowel with 3 definite layers. Meckel's diverticulum opens into the anti-mesenteric side of the small intestine in contrast to the duplications of small bowel which arise on the mesenteric side of the small intestine.⁶

Ultrasound can also diagnose abdominal Koch's involving ileocecal region with all the associated features of tuberculosis. Intra-abdominal fluid may be free or loculated. "Club sandwich" or "sliced bread" sign is due to localized fluid between radially oriented bowel loops, due to local exudation from the inflamed bowel (interloop ascitis).⁷ Lymphadenopathy may be discrete or

conglomerated (matted) with caseation and calcification. Uniform and concentric bowel wall thickening is seen as opposed to the eccentric thickening at the mesenteric border found in Crohn's disease and the variegated appearance of malignancy. Only a single case of crohn's disease was diagnosed in our study by ultrasound giving classic sonographic appearance of the "target" sign on transverse images.⁸ In cases of acute intestinal obstruction, a bowel diameter of >24mm & collapsed distal bowel loops carries a sensitivity, specificity & accuracy of 95%, 82% & 81% respectively. Some studies have reported ultrasound to be more sensitive than plain X-ray radiography for the diagnosis of pneumoperitoneum.⁹ In our study, initial x-ray was non-diagnostic, and perforation was diagnosed with ultrasound. Demonstration of free air as echogenic spots or lines with posterior ring down artefact, enhancement of peritoneal stripe, echogenic free intraperitoneal free fluid and shifting phenomenon (rolling the patient to left lateral position allow free air to rise to the highest position of right hypochondrium) are the features of intestinal perforation.¹⁰

Ultrasound accurately diagnosed all cases of intussusceptions in adults & in children & we found from our study that the most common cause of intussusception in children is mesenteric lymphadenopathy & in adults it is usually a mass lesion (lipoma, polyp etc.). On transverse sections it reveals a swirled pattern of alternating hyperechogenicity and hypoechogenicity, giving the "doughnut" or "bull's eye" sign.^{11,12} On longitudinal sections, alternating loops of bowel and a loop-within-loop have a sandwich-like appearance (pseudo-kidney sign). 50% patients with polyposis present before the age of 20 years, in particular because of obstruction and intussusceptions.¹³ The

jejunum and ileum most frequently involved followed by duodenum, colon and stomach. The polyps vary in size and may be sessile and pedunculated.

Gastric wall thickening with loss of wall stratification has been shown to be a sign of gastric malignancy.¹⁴ The sonographic thickness of normal gastric body and antral wall measures up to 5mm in a non-distended state.¹⁵ Wall thickening of a lesser extent (5-8mm) favours benign causes, such as chronic gastritis and gastric ulcer.¹⁶ In our case of gastric carcinoma there was irregular antral wall thickening measuring 20 mm favouring malignancy. Usually, small bowel carcinoids appear as hypoechoic, homogenous, predominantly intraluminal masses with smooth intraluminal contours. The tumour is attached to the wall with a broad base.¹⁷ CT is used for demonstrating the intestine, mesentery, lymph nodes and hypervascular metastasis in liver. One case of ileal lymphoma with features such as long segmental marked hypoechoic bowel wall thickening with loss of gut signature & increased mural vascularity & enlarged regional lymph nodes^{18,19,20} was provisionally diagnosed on ultrasound and later confirmed on CT. Sonographic findings associated with colonic carcinoma are heterogeneous colonic wall thickening with irregular contour and loss of gut signature.^{21,22,23} From our study we comprehend that ultrasound cannot be used as a reliable modality for confirming the diagnosis of gastrointestinal malignancy. Limitation lies in the detection of early mucosal lesions that have not yet reached the stage of frank submucosal invasion and formed a reasonable tumour bulk. Hence, patients with a negative ultrasound finding but with relevant symptoms should not be deferred for endoscopy. Bowel wall thickening with intramural raised vascularity is a non-specific sign and may also be seen in

inflammatory conditions. Hence further work up and confirmation by CT and histopathology is necessary. Because of these limitations, abdominal sonography cannot be an effective screening technique in colon cancer.

Ultrasound is currently the imaging modality of choice in Infantile hypertrophic pyloric stenosis. Pyloric muscle thickness of 3 mm or greater, pyloric canal length of 17 mm or greater and the absence of the passage of a peristaltic wave through the pylorus, during the period of scanning is the diagnostic ultrasound criteria. On transverse section, it resembles a 'doughnut' or a 'bull's-eye' or a 'target' with the echogenic pyloric canal in the centre surrounded by the hypertrophied pyloric muscle. Prolapse of the redundant mucosa into the antrum creates an 'antral nipple sign'.²⁴ Persistent vitellointestinal duct results from failure of obliteration of the embryonic vitellointestinal duct which leads to various congenital anomalies like – Meckel's diverticulum, vitelline cord, enteric cyst, umbilical sinus, enteric fistula or hemorrhagic umbilical mass.^{25,26} Patient may present the anomaly itself or due to complications like intestinal obstruction due to volvulus, intussusception or adhesion. Our patient who presented with intermittent umbilical discharge was correctly diagnosed on ultrasound and later confirmed on CT. Ultrasound is a quick, safe, easily available, non-invasive and relatively inexpensive modality for suspected intestinal ascariasis. Diagnosis was easier in patients with dilated fluid filled bowel loops secondary to obstruction.

CONCLUSION

From our study it can be concluded that, in acute abdominal conditions, ultrasound is a more sensitive investigation and is non-invasive. Hence it can be used as an initial diagnostic tool. However, its

value is limited in definitive diagnosis of acute abdominal conditions. Transabdominal ultrasound may be regarded as the first imaging procedure in the diagnostic work up & follow up of bowel diseases. Ultrasound has gained acceptance, especially in inflammatory bowel disease because it can provide information regarding extent & activity of the disease. New Sonographic techniques including application of colour Doppler combined with the application of intravenous contrast agents increase the accuracy in evaluating bowel wall vascularisation.

Conflict of Interest: None.

Source of Funding: Nil.

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