

Acute Appendicitis - Diagnostic Value of Direct and Indirect Ultrasonographic Signs - A Retrospective Study in Bangalore Rural

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ABSTRACT

BACKGROUND

Acute appendicitis is one of the commonest causes of pain abdomen. Appendicitis has a good prognosis but a delay in diagnosis may result in risk of perforation, peritonitis, abscess formation, sepsis, and even death.

METHODS

A retrospective study was conducted from December 2019 to April 2020 in MVJ Medical College and the pre-operative ultrasonographic images of all the patients who underwent surgery for suspected acute appendicitis were reviewed. A total of 50 such cases were found and included in the study. The direct signs were enlarged appendix, hyperaemia of wall of appendix, non-compressibility and appendicolith. The indirect signs were increased echogenicity and thickening of mesenteric fat in right iliac fossa (RIF), increased vascularity in RIF, thickening of caecal wall, RIF probe tenderness, free fluid in the RIF and mesenteric lymphadenopathy.

RESULTS

32 (64 %) were in the adult age group and 18 (36 %) patients were in the paediatric age group (below 18 years); the mean age was 38 years. 68 % (34) of the study population were males and 32 % (16) were females. At least one direct sign was present in 86 % of the cases, 2 and 3 direct signs were seen in 80 % and 56 % of the cases respectively. At least 1 indirect sign was noted in 97 % of the cases, 2 and 3 indirect signs were seen in 90 % and 70 % of the cases respectively. 2 cases had no indirect signs and all indirect signs were present in none of the cases studied. In the absence of direct signs, RIF probe tenderness (98 %) and increased echogenicity & thickness of mesenteric fat in RIF (86 %) were the most noted indirect signs in acute appendicitis.

CONCLUSIONS

There was a high incidence of indirect ultrasonography (USG) signs, of which the sign with maximum incidence was probe tenderness in 98 % of the cases, and increased mesenteric fat echogenicity in the RIF in 86 %. Among direct signs of acute appendicitis enlarged appendix (95 %) had the highest incidence followed by non-compressibility of appendix (90 %).

KEYWORDS

Acute Appendicitis, Ultrasound

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BACKGROUND

Vague pain in the abdomen is the most frequent symptom in OPD / causality at any hospital. It can be associated with fever, vomiting and diarrhoea but the utmost distressing symptom is the pain. Since pain threshold differs from person to person, the severity of the disease cannot not be evaluated considering only this symptom alone. The causes of the pain abdomen vary from benign to life threatening conditions. Diagnosing and treating these conditions on time is very important, as any delay can lead to grievous consequences like perforation, and may increase the morbidity and in some case mortality also. Hence, timely diagnosis is crucial and remains a challenging task.

Appendicitis is the most common cause of abdominal pain in patients at the emergency department. Diagnosing appendicitis in young male patient is mostly straight forward, but it becomes a problem in pre-menopausal women with similar symptoms and clinical history. It is primarily due to the reason that many gynaecological problems in women can present with pain abdomen mimicking acute appendicitis. The appendix was first described by Leonardo Da Vinci in western medicine. In 1541 Vesalius depicted appendix and listed it as the central cause of appendicitis which occurs due to a faecolith or an inspissated ball of stool which obstructs the appendiceal lumen.

The vermiform appendix is a true diverticulum arising from the base of the caecum at the ileo-caecal junction. The base of the appendix is always attached to caecum. However, the tip has various positions—retrocecal, subcaecal, paracaecal, preileal or postileal positions. Due to these variations in anatomy, the diagnosis of appendicitis is challenging as these lead to variations in imaging and symptomatology. A retrocecal appendix has been described in about 5 to 28 % of cases, making identification by USG technically tough due to artefacts from superimposing bowel gas / faeces.¹

The classical symptom is pain around the umbilicus with migration of pain to right lower quadrant of the abdomen. The other symptoms are nausea, vomiting and fever. Diarrhoea, indigestion, bowel irregularity, malaise are the atypical symptoms.² The symptoms also vary with location of the appendix. The most classical sign described for acute appendicitis is tenderness noted in the Mc Burney's point. Rovsing's sign is on palpation of the left lower quadrant, there is tenderness in the right lower quadrant. Psoas sign is seen in retrocecal appendix where on extension of right hip there is pain in the right lower quadrant.³ The laboratory finding most frequently present is mild leucocytosis and other marker is C-reactive protein (CRP) which is elevated in acute appendicitis. Alvarado score is the earliest and most frequently used clinical scoring system.⁴

A plain abdominal film has a limited value in the cases of pain abdomen, and is seldom useful, except in case of a renal calculi or a pneumoperitoneum. Diagnosis of acute appendicitis on plain film, depends mainly upon the occasional demonstration of an appendicolith. The diagnosis of acute appendicitis on barium studies is chiefly based on the demonstration of non-filling of the appendix.

Ultrasound is a non-invasive, economical and easily available technique without need for contrast. However, it has its own limitation of being operator dependent, highly depending on the skills and experience of the radiologist, the built of the patient and the different position of the appendix, which makes it hard for the radiologist to visualise the appendix. Since the ultrasound examination is interactive, scanning could be performed at the site where the patient has the maximum tenderness and thus allowing correlation of imaging findings with the symptoms of the patient.

On the other hand, computed tomography is considered to be very highly sensitive and specific for the diagnosis of acute appendicitis and also to rule out other causes of pain abdomen, but it is relatively expensive study which frequently requires oral and intravenous contrasts and an unwarranted exposure to the ionizing radiation.

The ultrasonographic landmark for appendix is the base of the caecum. The appendix is normally visualized as a small, ovoid, easily compressible, blind-ending, concentrically layered, mobile and a peristaltic tubular structure which arises from the caecum near the ileo-caecal junction. Absence of peristalsis and the lack of change in configuration over time differentiates the normal appendix from the small bowel loops. Appendix can be differentiated from the ascending colon based on its smaller size. In a normal appendix a thin central echogenic line which corresponds to the submucosa and surrounded by a hypoechoic outer zone which represents the muscularis mucosa is noted. The lumen of the appendix is collapsed.

Acute appendicitis was traditionally diagnosed clinically, imaging modalities like USG and CT have played a major role in complementing the diagnostic flow chart and in predicting the complications of acute appendicitis and also in reducing the rate of false negative appendicectomies.⁵ Acute appendicitis has a good prognosis; however, a delay in diagnosing can result in increased risk of perforation, abscess, peritonitis, sepsis, obstruction and even death. Studies have shown that appendix is not visualized on USG in a substantial proportion of patients which is due to difficulty in visualization of appendix because of its location like a retrocecal appendix, operator dependability or poor acoustic window.⁶ The lack of a visible appendix makes estimating diameter and other direct criteria impossible to assess, thus highlighting the probable use of more readily observable secondary sonographic signs of appendicitis.⁷

The aim of this study was to evaluate the diagnostic value of each of the direct and indirect signs of acute appendicitis on ultrasound.

METHODS

A retrospective study was conducted from December 2019 to April 2020 in MVJ Medical College and the pre-operative ultrasonographic (USG) images of all the patients who underwent surgery for suspected acute appendicitis were reviewed. The period of review was 15 days. A total of 50

such cases were found and included in the study. The direct signs which were evaluated include enlarged appendix, non-compressibility of appendix, hyperaemia of the wall of appendix and appendicolith. The indirect signs evaluated were thickening and increased echogenicity of mesenteric fat in right iliac fossa, thickening of cecal wall, probe tenderness in RIF (Right Iliac Fossa), free fluid in the RIF, increased vascularity in RIF and mesenteric lymphadenopathy.

Ultrasonography was performed using GE Voluson E6 machine. For initial survey of the abdomen and pelvis a low frequency curved array transducer probe was used and for focussed scanning of the RIF with graded compression⁸ and other techniques a high frequency linear transducer probe was used.

Inclusion Criteria

- All patients who underwent surgery for suspected acute appendicitis with a pre-operative ultrasonography of the abdomen and pelvis in our institution.

Exclusion Criteria

- Patients who were managed conservatively.
- Patients who refused surgery or ultrasound.
- Patients who were given alternate diagnosis on ultrasound.

Patients in whom all the above listed directed and indirect signs of acute appendicitis were not documented / looked for.

Statistical Analysis

For descriptive statistics & correlation study, statistical package for social sciences (SPSS) version 17.0 was used. Microsoft Word & Excel were used to generate graphs, tables etc.

RESULTS

50 patients who underwent surgery for acute appendicitis and were referred to our department and underwent ultrasound imaging of the abdomen and pelvis were included in our study. The age of the patients ranged from 5 years to 75 years. 32 (64 %) were in the adult age group and 18 (36 %) patients were in the paediatric age group (below 18 years); the mean age was 38 years. 68 % (34) of the study population were males and 32 % (16) were females.

At least one direct sign was present in 86 % of the cases, 2 and 3 direct signs were seen in 80 % and 56 % of the cases respectively. At least 1 indirect sign was noted in 97 % of the cases, 2 and 3 indirect signs were seen in 90 % and 70 % of the cases respectively. 2 case had no indirect signs and all indirect signs were present in none of the cases studied. In the absence of direct signs, RIF probe tenderness (98 %) and increased echogenicity & thickness of mesenteric fat in RIF (86 %) were the most noted indirect signs in acute appendicitis.

Direct Sign	Percentage
Enlarged appendix	95
Non compressibility	90
Hyperaemic wall of appendix	70
Appendicolith	30
None	10

Table 1. Incidence of Direct Sign in Acute Appendicitis

Indirect Signs	Percentage
RIF probe tenderness	98
Increased echogenicity and thickening of mesenteric fat in RIF	86
Increased vascularity in RIF	60
Free fluid in RIF	40
Mesenteric lymph node	30
Caecal wall thickening	10
None	4

Table 2. Incidence of Indirect Sign in Acute Appendicitis

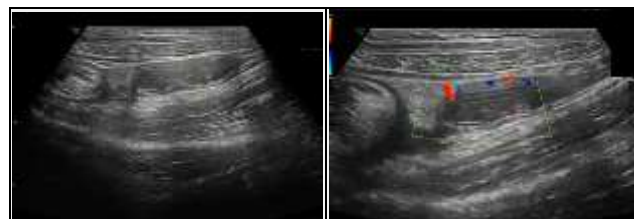


Image 1. USG Images Showing Enlarged Appendix (>6 mm in Diameter) with Hyperaemic Walls of Appendix

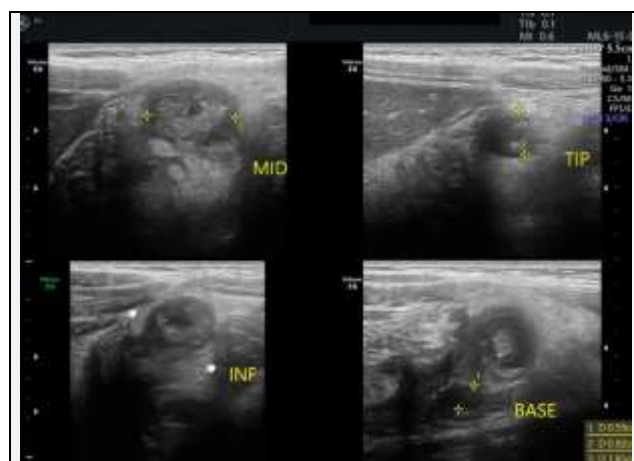


Image 2. USG Image Showing Non Compressible, Enlarged Appendix in a Patient with RIF Probe Tenderness with Increased Echogenicity and Thickening of Mesenteric Fat in RIF (INF)



Image 3. USG Image Showing an Appendicolith in a Patient Diagnosed with Acute Appendicitis

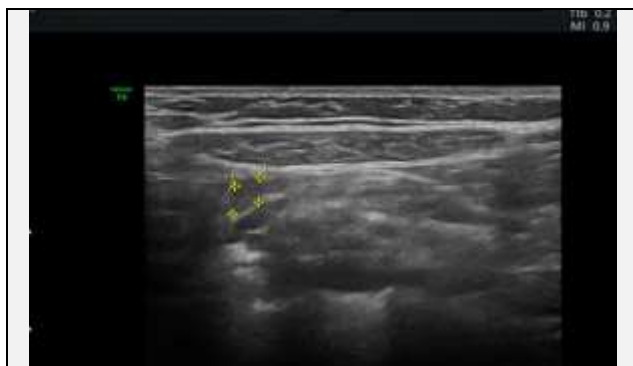


Image 4. USG Image Showing Enlarged Mesenteric Lymph Nodes

DISCUSSION

Even though acute appendicitis is one of the frequent causes of pain abdomen, there is lot of diagnostic dilemma due to the inherent anatomic variation in location of the appendix causing diverse clinical presentations and signs which overlap with many other diseases and few of which do not need a surgical intervention. So, imaging plays a crucial role in the management of acute appendicitis. Though CT is proven to be more sensitive and specific, USG has its own advantages of being more easily available, has no risk of radiation and cheaper. The major limitation of USG is in the equivocal scans when appendix is not visualised. The aim of this study was mainly to assess the diagnostic value of each of the indirect and direct ultrasonographic signs of acute appendicitis.

Kessler et al. found that the indirect sign with maximum diagnostic accuracy is inflammatory fat change (negative predictive value / NPV of 91 % and positive predictive value / PPV of 76 %). The frequency of inflammatory fat change noted in his study was 91.2 %, free fluid was 50.8 %, lymphadenopathy was 31.5 % and caecal wall thickening was 24.5 %. These findings were consistent to the values in our study⁹ in which we found inflammatory fat change to have a negative predictive value of 89 % and positive predictive value of 75 %. Furthermore, N. Kouamé et al. also found that the most specific secondary sign in acute appendicitis is RIF mesenteric fat hypertrophy (96.7 %) and the sign with the maximum net present value (NPV) is RIF probe tenderness (83.3 %).¹⁰ These findings were also consistent to the values in our study.

Kessler et al. reported that the direct sign with maximum accuracy is diameter of appendix more than or equal to 6 mm (NPV & PPV of 98 %). The incidence of appendicular diameter more than or equal to 6 mm was 94.7 %, that of non-compressibility of appendix was 92.9 % and hyperaemia of appendicular wall was 49.1 %. These findings were similar to the values obtained in our study in which we found diameter of appendix more than or equal to 6 mm to have a NPV & PPV of 95 %. The limitation of this study was small sample size and acute appendicitis being an emergency condition with significant pain, in many cases all the signs were not adequately looked for and reported. Hence, these cases were excluded from the study.

CONCLUSIONS

There was a high incidence of indirect USG signs and the indirect sign with maximum incidence were probe tenderness in 98 % and increased mesenteric fat echogenicity in the RIF in 86 %. Other useful secondary signs in acute appendicitis in decreasing order of frequency include increased vascularity in RIF, free fluid in RIF, mesenteric lymph node and caecal wall thickening. Among the direct signs of acute appendicitis, enlarged appendix (95 %) had the highest incidence followed by non-compressibility of appendix (90 %), hyperaemic wall of appendix and appendicolith in decreasing frequency. At least one direct sign was present in 86 % of the cases, 2 and 3 direct signs were seen in 80 % and 56 % of the cases respectively. At least 1 indirect sign was noted in 97 % of the cases, 2 and 3 indirect signs were seen in 90 % and 70 % of the cases respectively.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.

Financial or other competing interests: None.

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