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Radio Diagnosis

COMPARING THE ACCURACY OF CT AND ULTRASONOGRAPHY IN THE DIAGNOSIS OF ACUTE APPENDICITIS IN TERTIARY MEDICAL CENTRE OF SOUTH BIHAR

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ABSTRACT **Introduction:** Acute appendicitis is the one of the most common surgical emergencies, the incidence rate is almost 10% . Making an accurate diagnosis is of utmost importance to surgeons providing care, so preoperative imaging is now widely accepted by most surgeons and emergency medicine physicians in the workup of acute appendicitis. **Aim And Objective:** To calculate the sensitivity, specificity, positive predictive value and negative predictive value for both CT and USG having the histopathology findings as gold standard. **Material And Methods:** This is a prospective observational study planned to conduct at Narayan medical college and Hospital, Rohtas, Bihar on the 110 patients presented with signs and symptoms suggesting Acute Appendicitis. They will be selected from Emergency Department of Narayan medical college & Hospital. **Result:** On the diagnosis of AA, the sensitivity, specificity, positive and negative predictive value, and accuracy of US vs. CT were 85.5 percent vs. 87.8%, 66.7 percent vs. 75.0 percent, 98.5 percent vs. 97.7%, 15.4 percent vs. 33.3 percent, and 84.8 percent vs. 86.8%, respectively (Table 2). The researchers next included a subgroup of 24 patients who had both US and CT exams prior to surgery for ROC analysis to compare the diagnostic efficacy of the two imaging procedures. The area under the ROC (AUC) of US was 0.84, which was higher than that of CT (0.66), albeit the difference was not statistically significant , **Conclusion:** Both ultrasonography and CT examinations were highly effective in diagnosing acute appendicitis.

KEYWORDS : Computed tomography, Ultrasonography, Appendicitis, perforation

INTRODUCTION

Acute appendicitis is the one of the most common surgical emergencies, the incidence rate is almost 10% . Making an accurate diagnosis is of utmost importance to surgeons providing care, As a result, most surgeons and emergency medicine specialists now use preoperative imaging in the diagnosis of acute appendicitis. Imaging studies, such as ultrasound or computed tomography (CT), are performed in conjunction with clinical examination, which is the primary technique of diagnosis.[1]

However the diagnosis of AA is a constellation of history, physical examination coupled with laboratory investigations, supplemented by selective focused imaging. The role of diagnostic imaging; ultrasound (US), computed tomography (CT) is another major controversy.[2]

The rate of negative appendectomy used to be in the range of 20 to 28% before CT imaging and US became routinely used. This negative appendectomy score was reduced by the use of imaging and was shown to be in the order of 7 to 10% when assessing the impact of imaging on this type of diagnostic pathway with a slightly lower score for US (8%) compared to that of CT (7%).[3]

Therefore, making a correct diagnosis of acute appendicitis continues to be a challenge for radiologists, when presented with equivocal CT findings. The current management of equivocal CT findings of acute appendicitis is still controversial. It includes active observation, using alternate imaging modalities, diagnostic laparoscopy, or immediate appendectomy. However, a prompt, accurate diagnosis is important to avoid appendiceal perforation, which is associated with increased rates of morbidity and mortality.[4]

Because of its excellent sensitivity and specificity, CT is still regarded the gold standard technology for evaluating patients with suspected AA. While the accompanying radiation exposure is still a worry, particularly for youngsters, the elderly, and pregnant people, radiation shielding is critical.

Because of its radiation protection, wide availability, and cost-effectiveness, research on various aspects of US imaging in the diagnosis of AA has gotten a lot of attention in recent years. As a result, for patients with suspected AA or equivocal clinical presentations, US may be a good first imaging option.[5]

But the diagnostic findings in ultrasound include lack of compressibility, fecalith, loss of intestinal peristalsis, and increased appendix anteriorposterior diameter of more than 6 mm. The ultrasound study has positive and negative false results. The false positive results in ultrasound reports are detected in salpingitis, fecal impaction, overweight people and in cases where appendicitis is limited to the tip of the appendix, which large appendix is wrongly reported as ileum. Compressibility will be mistakenly reported normal if the appendix is ripped.[6]

CT can be used as a second-line imaging modality when an initial US is non diagnostic. A previous study found that the pathway of CT after an equivocal US is the most cost-effective pathway for the diagnosis of appendicitis. However, CT exposes patients to ionizing radiation, which is of special concern in pediatric and obstetric populations.[7]

With the above background we planned to have a study to compare USG and CT scan as imaging technique for acute appendicitis with following aims &objectives.

AIM AND OBJECTIVE

1. To calculate the sensitivity, specificity, positive predictive value and negative predictive value for both CT and USG having the histopathology findings as gold standard.

2. To find the diagnostic accuracy of both the imaging technique in diagnosing acute appendicitis

METHODOLOGY

This is a prospective observational study planned to conduct at Narayan medical college and Hospital, Rohtas, Bihar on the 110 patients presented with signs and symptoms suggesting Acute Appendicitis. They will be selected from Emergency Department of Narayan medical college & Hospital. If the history, physical examination findings and laboratory test results raised the suspicion of acute appendicitis, patients will be asked to participate in this study. The patients will be admitted to the hospital either for observation or for surgery. Patients who needed to undergo urgent surgery will be excluded. In these cases, no imaging will be performed.

Exclusion criteria was pregnancy and patients with high creatinine

level. The radiologic procedures and logistics of the study was explained to the patients, and informed consent was obtained from each patient or from a parents in cases of children. Institutional ethical permission was taken before start of study. Patients was undergo US and CT examinations before undergoing surgery or during the first 24 hr of observation. The decision of whether to operate or not was based on the clinical parameters and laboratory findings. The operation strategy, i.e. laparoscopy or laparotomy, Was determined and documented before US and CT was performed.

Using 4-10 MHz linear array and 2-5 MHz curved array transducers, graded-compression US was done in a step-by-step technique to optimise imaging of the appendix (Voluson E6, GE Medical Systems, Germany). Obese patients were treated using curved array transducers, which will allow for deeper penetration.

Direct US Signs Of Acute Appendicitis:

- Dilation and non-compressibility of the appendix, its diameter > 6 mm, single wall thickness ≥ 3 mm.
- Target sign: Hypoechoic fluid-filled lumen, hyperechoic mucosa/ submucosa, hypoechoic muscularis layer.
- Appendicolith: Hyperechoic with posterior shadowing.
- Color Doppler and contrast-enhanced US: Hypervascularity in early stages of AA.

Indirect US Signs Of Acute Appendicitis:

- Free fluid surrounding appendix.
- Local abscess formation.
- Increased echogenicity of local mesenteric fat.
- Enlarged local mesenteric lymph nodes
- Thickening of the peritoneum.
- Signs of secondary small bowel obstruction.
- Appendicular mass formed by dilated oedematous intestinal loops with thick oedematous mesentery.

All of the patients had CT scans performed according to a single, uniform protocol designed for patients referred from the Emergency Department with acute abdominal pain. Patients were positioned supine and scanned with a 160 slice multidetector scanner from the diaphragm to the symphysis pubis (Aquilion PRIME; Toshiba Medical System, America). In order to make an alternate diagnosis of urinary stone, non-contrast pictures were included in the protocol. 120 kVp, reference effective 160 mAs with automatic dosage modulation, detector collimation of 64 x 0.6 mm, rotation duration of 0.5 seconds, and pitch of 1.2 were the scanning settings. CT scans were reconstructed with a 5-mm transverse plane slice thickness and a 4-mm coronal plane slice thickness, with no overlap. A single-phase contrast enhanced scan was performed on all of the patients and was taken 65 seconds after the IV contrast agent was started. An 18-gauge needle was used to inject 100–120 mL (2 mL/kg of body weight) of non-ionic iodinated contrast agent (iohexol, Omnipaque 350; Nycomed Amersham, Princeton, NJ, USA) into the antecubital vein at a rate of 3 mL/sec, followed by a 20-mL saline flush, using an Automatic power injector. Contrast substance was given orally or recally.

CT findings were interpreted as positive for acute appendicitis in this study, with an enlarged appendix (6 mm in outer diameter), appendiceal wall thickening (3mm), appendiceal wall hyper enhancement, periappendiceal fat stranding, periappendiceal abscess, which usually indicated perforated appendicitis and is associated with extraluminal air, ileocecal inflammation, and localised peritonitis in a patient Right lower quadrant inflammation, appendicoliths lymphadenopathy, and appendicular mass, which presents as a complicated right iliac mass composed of edematous caecal wall and loops of dilated small intestine with thickened mesentery, are all ancillary indications of appendicitis.

If the appendix is visible with intraluminal air, the CT findings are regarded as negative. An appendix with an outside diameter of less than 6 mm is likewise considered normal. The findings will be interpreted as negative if an appendix is not visible and ancillary indications are present or absent.

An independent surgeon was notified if an ultrasound or CT revealed abnormalities other than appendicitis that could have clinical implications. The independent surgeon will determine whether the radiologic diagnosis has any bearing on the surgical approach and whether the surgery should be cancelled or the type of operation changed, such as split-muscle incision laparotomy or laparoscopy.

The diagnosis of acute appendicitis was made during surgery based on macroscopic evidence. All removed appendices were histologically examined using paraffin sections.

RESULTS

Image features of US compared to CT on acute appendicitis. US image features of AA included enlarged appendix (7- 18 mm) (61 cases), thickened appendix (2.3-10 mm) (47 cases), effusion in appendiceal lumen (32 cases), appendicolith (17 cases), periappendicealhy perecho (9 cases), hyperecho around ileocecus and the base of appendix (1 case), inter-intestinal effusion (16 cases), ileocecus edema (6 cases), ileocecus expansion (1 case), appendiceal abscess (3 cases), and invisible appendix (11 cases) (Figure 1, 2).

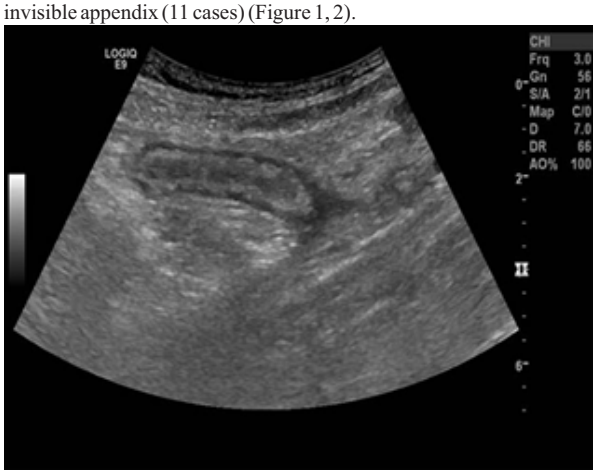

Figure 1: Ultrasound image of acute appendicitis (low-frequency probe) enlarged appendix, thickened appendix wall, rough edge of each layer of the appendix, hyperecho around the appendix, and no obvious fluid sonolucent area was detected

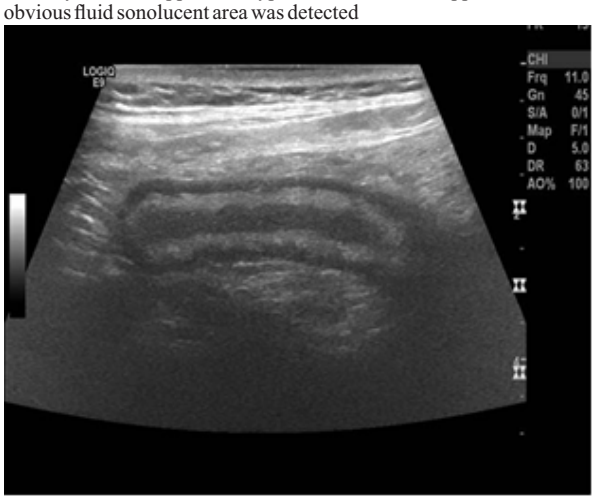

Figure 2. Ultrasound image of acute appendicitis (high frequency probe) en- larged appendix, thickened appendix wall, rough edge of each layer of the appendix, hyperecho around the appendix, and no obvious fluid sonolucent area was detected.

Figure 3. Cross-section CT image of acute appendicitis enlarged

appendix, thickened appendix wall, around the see leakage, effusion and blurred fatty space around appendix and ileocecus, shown as the high density strip.

CT image features of AA included enlarged appendix (44 cases), thickened appendix (15 cases), gas in appendiceal lumen (2 cases), appendicolith (15 cases), peripheral exu- dation or blurred fatty space (40 cases), adjacent peritoneal thickening (2 cases), lymph- adenectasis around ileocecus (13 cases), ileocecus edema and thickening (3 cases), exudation around ileocecus (2 cases), appendiceal perforation (1 case), appendiceal abscess (1 case). Enhanced CT scan was performed in 4 cases, and the images features included mucosal enhancement in lleum and appendix (2 cases), appendix wall rein- forcement (1 case), appendiceal abscess (1 case) (Figure 3, 4).

Fig 4: Diagnostic Results Of US Compared To CT

Among 101 pathology-proven AA patients (including 4 patients diagnosed with appen- diceal abscess). As shown in Table 1, 66 cases were diagnosed with AA using US imaging, including 3 cases with appendiceal abscess, and other 12 cases of AA were missed, because the appendix was invisible due to the interference of intestinal gas. Additionally, 42 were diagnosed with AA using CT imaging, including 1 with appendiceal abscess, and other 7 cases of AA were missed, because the appendix was normal or slightly enlarged. Of 7 non AA patients, 1 case was diagnosed with distal ileitis under US imaging, and other 2 cases of chronic appendicitis were missed. 1 case was diagnosed with appendix benign tumor.

Table 1. Diagnostic Results Of US Compared To CT On Acute Appendicitis (n)

		Pathological results	
		Acute appendicitis	**Non acute appendicitis**
US	+	**66**	**1**
	-	**12**	**2**
CT	+	**42**	**1**
	-	**7**	**3**

Table 2. Diagnostic Efficacy Of US Compared To CT On Acute Appendicitis (%)

	US	**CT**
Sensitivity	85.5	87.8
Specificity	66.7	75.0
Positive predictive value	98.5	97.7
Negative predictive value	15.4	33.3
Accuracy	84.8	86.8

Table 3. AUC Of US Compared To CT On The Diagnosis Of Acute Appendicitis

	AUC	**X^2**	**P Value**
USG	0.8409	0.49	0.48
CT	0.659		

Table 4. Display Rate Of Direct Signs Of Acute Appendicitis On US Compared To CT

	Enlarged appendix	**Thickened appendix**
	(%)	(%)
US	82.6	63.6
CT	93.8	31.8
P value	0.077	0.001

Table 5. The Detective Rates Of Ultrasound Compared To CT On Different Types Of Acute Appendicitis

	US (%)	**CT (%)**	**P value**
Simple appendicitis	81.8	60.0	0.38
Purulent appendicitis	86.0	92.6	0.47
Gangrenous appendicitis	90.9	100	0.48

The sensitivity, specificity, positive and negative predictive value, and accuracy of US vs. CT in the diagnosis of AA were 85.5 percent vs. 87.8%, 66.7 percent vs. 75.0 percent, 98.5 percent vs. 97.7%, 15.4 percent vs. 33.3 percent, and 84.8 percent vs. 86.8%, respectively (Table 2). The researchers next used ROC analysis to assess the diagnostic efficacy of the two imaging methods in a subgroup of 24 patients who had both US and CT tests prior to surgery. US had a larger area under the ROC (AUC) of 0.84 than CT (0.66), albeit the difference was not statistically significant (Figure 5, Table 3).

For an enlarged appendix, ultrasound had a display rate of 63.5 percent, which was substantially higher than CT (31.9 percent) (P=0.001). The ultrasonography and CT display rates for an enlarged appendix were 82.4 percent and 93.6 percent, respectively, with no statistically significant difference (P=0.077).

The detective rates of US versus CT on different pathological kinds of acute appendicitis on different pathological kinds of acute appendicitis. Following that, the detective rates of US and CT were compared for several clinical kinds of acute appendicitis, such as simple appendicitis, purulent appendicitis, and gangrenous appendicitis. Table 5 reveals that the detective rates for these three types of acute appendicitis were 81.8 percent, 86.0 percent, and 90.9 percent for US and 60.0 percent, 92.6 percent, and 100 percent for CT, with no significant difference between the two imaging modalities.

DISCUSSION

The appendix is a tube that connects the small and large intestines to the cecum and is blind-ended. It's located around the point where the small and large intestines meet. Despite the fact that the appendix's base is fairly consistent, its shape and size vary widely from person to person, and the appendix's tip can be found anywhere in the pelvis, outside the peritoneum, or behind the cecum. Identifying the appendix on an ultrasound image is frequently difficult due to the obstruction of intestinal gas. The appendix can be plainly identified on the CT image, which is surrounded by mesenteric fat. Ultrasound picture resolution has continuously improved in recent years as a result of advances in ultrasonic technology, particularly the use of digital ultrasound, high-frequency probes, and natural tissue har- monic imaging technologies. The display rate of the appendix has been reported to be as high as 97.7% in the United States, which is comparable to the spiral Ct[8].

When acute appendicitis develops, the appendix wall becomes inflamed and thickened, and imaging examinations reveal an expanded appendix in diameter and a thicker appendix wall. In our investigation, whether employing ultrasonography or CT, the rate of exhibition of an aberrant appendix in patients was high. Ultrasound, in particular, had a much higher rate of thickening appendix detection than CT (P=0.001). Our data revealed a significant rate of appendix display, which was consistent with earlier studies[8]. Furthermore, our research found that US performed better than CT imaging for the first time in displaying an enlarged appendix, which had never been observed before. This could be because the US can clearly show the structure of the appendix wall as well as the internal echo. While a CT scan cannot adequately depict the body's anatomy.

CT scan exhibited a sensitivity of 94 percent and a specificity of 95 percent in detecting acute appendicitis, whereas US had an overall sensitivity of 86 percent and a specificity of 81 percent [9]. Furthermore, in the diagnosis of acute appendicitis, a CT scan has been shown to be more accurate than an ultrasound, meaning that CT performed better than the US in this regard[10]. Furthermore, Jang KM's study team discovered that when CT cannot make a definitive decision, US can be used as an assisted examination to improve diagnostic accuracy[11]. According to the current study, ultrasound and computed tomography had good sensitivity (85.5 percent and 87.8 percent, respectively) and specificity (66.7 percent and 75 percent, respectively, in diagnosing acute appendicitis. The accuracy of the two modalities was 84.8 percent and 86.8 percent, respectively, suggesting that the two imaging

modalities had equivalent diagnostic value in acute appendicitis.

A total of 101 patients were evaluated using a combination of ultrasound and computed tomography in our study. The accuracy of the diagnosis in the 101 cases ranged from 95.8% to 100%. Five cases of an unnoticed appendix on US imaging were followed up with CT imaging, and four of them were diagnosed with acute appendicitis, one of which had a little enlarged appendix. Furthermore, two people had a normal appendix on CT imaging but needed help with US imaging. In the United States, an acute appendicitis with thickened appendix wall was diagnosed (3 mm). A ROC curve examination of the 101 patients revealed that the AUC of US was 0.84, which was higher than that of CT (0.66), but the difference was not statistically significant. We advocate a combined imaging evaluation to increase diagnostic accuracy when a single imaging method fails to provide a clear diagnosis, especially in patients with classic symptoms.

In our study, the United States and Connecticut both had a high detective incidence of gangrenous appendicitis (90.9 percent and 100 percent respectively). As gangrenous appendicitis advances, appendix perforation can occur, resulting in increased purulent effusion around the appendix, increased omentum aggregation, and the development of localised or diffuse peritonitis. In this investigation, one case of gangrenous appendicitis with perforation was discovered on CT imaging. The appendix was not visible on the US images in this case; instead, only intestinal dilatation in the lower right abdomen due to the formation of a diffuse peritonitis and paralytic ileus was visible, hence the gangrenous appendicitis was overlooked by the US imaging. When the appendix perforates or gets inflamed, the mesenterium, or bigger omentum, is moved to the right abdomen and coils around the appendix, forming an abscess. At this stage, both US and CT scans are unable to distinguish the shape of the appendix, indicating only masses in the lower right abdomen. The surrounding tissues are typically hazy, with lumps that have irregular forms or fecalith. In our investigation, ultrasonography and CT both detected the periappendiceal abscess 100% of the time. On distinct pathological types of acute appendicitis, the diagnostic effectiveness of two imaging modalities was very equal across the board.

One of the advantages of CT is that the image has a good quality and is less affected by intestinal gas. The image is unaffected by the patient's pain and is independent of the operator. The appendix lesions, as well as the depths of the abdomen in the location of the abscess and the organs that surround it, can be seen clearly on a CT scan. On an enhanced CT scan, the bigger appendix, as well as the enlarged lymph nodes around it, can be observed [12]. The following are some of the disadvantages of CT: it takes a long time, there is a risk of radiation, and the appearance of the appendix is influenced by the surrounding mesenteric fat. In young people with less abdominal fat, slimmer women, and the elderly, displaying the appendix with good resolution is challenging, making it difficult to judge inflamma- tory modifications around the appendix. This study included six people who had false negative appendicitis, three of whom were missed on CT imaging due to a lack of mesenteric fat, which affects the appearance of the appendix and the inflammatory changes it causes. Enhanced CT scan and reconstruction technology can not only show the location and pathophysiological changes of the appendix from different angles, but it can also rule out other organ diseases like ileocecal occupation, peritoneal gas effusion caused by digestive tract perforation, and peritoneal exudation. Several studies have found that low-dose CT can improve diagnostic efficiency while lowering radiation exposure [12].

CONCLUSIONS

Both ultrasonography and CT examinations were highly effective in diagnosing acute appendicitis. Ultrasound evaluation is a safe, cost-effective, and convenient imaging option for individuals with suspected acute appendicitis, particularly children, the elderly, pregnant women, and those with a thin body. CT can be employed as an additional imaging modality to increase diagnosis accuracy in individuals with highly suspected acute appendicitis when the US examination fails to reach a conclusive conclusion.

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