Emergency Based Ultrasound of Clinically Suspected Acute Appendicitis with Low Frequency Curvilinear Transducer and its Association with Surgical Outcome

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ABSTRACT

Aim: To determine the diagnostic accuracy of low frequency curvilinear transducer as an ancillary emergency tool for clinical suspects of acute appendicitis and its association with surgical outcome.
Material & methods: This cross sectional study was conducted at Omer hospital between September 2008 and December 2010. We included 89 cases (38 male, 51 female; age range 12–70 years, mean age 37 years) of clinically suspected acute appendicitis. Clinical categorization was based on Alvarado scoring. Transabdominal ultrasound was performed using curvilinear low frequency 3.5-MHz transducer with graded compression technique, followed by linear high frequency transducer of 7.5MHz. All cases underwent appendectomy. Specimen inflammatory grading was done by histopathology.
Results: Out of 89 patients, 71 cases presented with typical and 18 with atypical clinical symptoms and signs of acute appendicitis. On sonography, appendix was visualized in 73 cases (82%) using low frequency transducer in comparison to 78 cases (87.6%) by high frequency transducer. Sensitivity and specificity of preoperative sonographic scan was about 68.0% and 88.0% respectively. Association of sonographic and histopathological diagnostic evidences was also found statistically significant (p=0.000).
Conclusion: Negative appendectomy rate can be substantially reduced by a careful ultrasound examination using low frequency transducer, which proves ancillary to clinical evaluation.
Key words: Acute appendicitis, sonography, transducer, sensitivity, specificity

INTRODUCTION

Acute appendicitis is one of the most commonly encountered clinical entities in accidents and emergency department that requires surgical intervention. Patients with typical clinical signs and symptoms of acute appendicitis undergo immediate surgery[1]. Beside significant improvement in imaging technology, radiological imaging is usually reserved for atypical or confusing cases. Even with advent of spiral computed tomography (CT) and Color Doppler, gray scale ultrasound (US) is still a preliminary imaging modality in patients with suspected appendicitis. US can rapidly help distinguish patients with appendicitis requiring CT or straight away surgery[2].

In recent years, visualization of normal appendix has been emphasized[3]. The ability to make a differential diagnosis is important for both clinicians as well as emergency radiologists because a number of disorders can mimic the clinical signs of acute appendicitis, including gallbladder disease, acute pyelonephritis, urinary tract stone disease, infectious/inflammatory conditions of the cecum/ascending colon, and abnormal diseases such as complicated ovarian cysts, hemorrhage, and torsion. The availability of sophisticated imaging modalities including CT and Color Doppler is an issue yet to be resolved in many of the emergency departments of tertiary care hospitals in our country[4]. However, gray scale US is exclusively available in most of the settings with only single low frequency curvilinear transducer. Considering this fact, we aimed to determine the diagnostic accuracy of low frequency curvilinear transducer as an emergency tool for the suspected cases of acute appendicitis and its correlation with surgical outcome.

MATERIAL AND METHODS

This cross sectional study was conducted at Omer hospital between September 2008 and December 2010. We included 89 cases (38 male, 51 female; age range 12–70 years, mean age 37 years) that were suspected for acute appendicitis clinically in Emergency Department. Patients were categorized as either typical or atypical for acutely inflamed appendix using Alvarado scoring. Transabdominal ultrasound was performed by a single radiologist using Toshiba Nemio XG ultrasound equipment with curvilinear low frequency 3.5-MHz transducer. Technique included graded compression with uniform pressure by the transducer over right lower quadrant to displace normal and gas-filled bowel loops from the field of view or to compress between musculature of abdominal walls [5]. Abnormal or obstructed appendix remained non-compressible and was optimally imaged. The gentle maintained pressure allowed lengthy evaluation of particular region of interest even in the most uncomfortable and reluctant patients who had peritoneal irritation.

A

B

Fig. 1: (a). Curvillinear transducer demonstrating acutely inflamed appendix as an 7mm aperistaltic and non-compressible blind-ended tubular structure (star) with a laminated wall (yellow arrow heads). (b). Similar findings demonstrated by high frequency linear transducer.

Transverse, sagittal and oblique planes were imaged from tip of liver proceeding to the pelvic brim. Inflammatory changes in perienteric fat and appendix was carefully observed. After initial scanning, linear high frequency transducer of 7.5MHz was used for comparison and demonstrating more detailed sonographic features.

Inflamed appendix was documented as an aperistaltic and non-compressible blind-ended, tubular structure with a laminated wall and a threshold diameter of 6mm. Appendicolith appeared as bright, echogenic foci with dense posterior acoustic shadowing. With perforated appendix, distended lumen was

no longer be visualized, however, periceacal fluid along with inflammatory changes in the perienteric fat were obvious. Phlegmonous change manifested as hypoechoic zones with poor margins within the inflamed fat that blended imperceptibly with the fatty tissues. Sympathetic thickening of the adjacent terminal ileum and ascending colon was also demonstrated in few cases. All cases underwent surgical resection of appendix and specimen was sent for histopathology for grading the inflammatory changes.

For statistical analysis, frequencies and percentages of categorical variables were measured and comparison was made. Moreover, sensitivity, specificity, positive predictive values and negative predictive values were also computed. Association of histopathological diagnosis with sonography was measured by Fisher's exact test at 5% level of significance.

RESULTS

Out of 89 patients, there were 83 cases who presented with typical clinical symptoms and signs suggestive of acute appendicitis. However, 24 patients presented atypically (table-1). We found that more patients were falling in 2nd to 4th decade of age. Females were predominant in the atypical clinical presentation.

Table-1: Distribution of age and gender according to the clinical presentation in the sample population.

Age Group (Yrs)	**Clinical Presentation**			
	Male	**Female**	**Male**	**Female**
≤10	2	3	1	-
11-20	9	14	2	5
21-30	13	17	3	4
31-40	6	4	1	1
>40	1	2	-	1
Total	31	40	7	11

On transabdominal sonography, appendix was visualized in 73 cases (82%) using low frequency curvilinear transducer. We compared this transducer with high frequency linear transducer. On comparison, there was only a slight increase in the visualization of appendix, i.e. 78 cases (87.6%).

Table-2: Sensitivity and specificity measures for visualization of appendix using low and high frequency transducers (n=89)

Appendiceal Imaging		**Linear high frequency 7.5 MHz**	
		Visualized	**Non-visualized**
Curvilinear low frequency 3.5 MHz	Visualized	73	0
	Non-Visualized	5	11

In table-2, sensitivity and specificity of curvilinear low frequency transducer was compared with that of linear high frequency (taken as gold standard) which elucidate that sensitivity of low frequency is about 94.0% while specificity is 100%. Hence, curvilinear low frequency can also give almost same efficient visualization of appendix as in case of high frequency transducer.

The visualized appendix through curvilinear low frequency transducer was then categorized in either appendix with normal morphology, acutely inflamed appendix or perforated appendix. Most of the clinically suspected patients were falling in acutely inflamed category (table-3).

Table-3: Sonographic categorization of appendix by low frequency transducer in typical and atypical cases.

Clinical presentation	**Sonographic features of appendiceal imaging with low frequency curvillinear transducer**			
	Appendix not visualized	Normal morphology of appendix	Inflamed appendix	Perforated appendix
Typical (n=71)	10	11	46	4
Atypical (n=18)	6	3	8	1

There were about 17 cases that turned out to be negative for any histological evidence of inflammation, suggestive of 19.1% negative appendectomy rate. In table-4, results of preoperative sonographic diagnosis have been compared with histopathological evidences of appendicitis (gold standard). Results showed that sensitivity and specificity of sonographic diagnosis with respect to Gold standard is 68.0%, 88.0% respectively indicating that there are about 68.0% chances of correctly classify true positive appendices using ultrasound with respect to histopathology evidences. Similarly, exact detection of true negative cases is about 88.0%. Moreover, by applying the Fisher's Exact test, it was found that there is significant association of sonography and histopathology ways of detection (p=0.000). Hence, sonographic diagnosis can also be a useful ancillary tool in the detection of inflamed appendix considering the sensitivity and specificity greater than 50.0%. Table-4: Hitopathology of surgically ressected appendices and sonographic preoperative association.

Histopathology of surgically resected appendices		**Preoperative sonographic diagnosis**	
		-ve scan (n=25)	*+ve scan (n=25)*
Gold Standard	-ve for inflammation	17	8
	+ve for inflammation	8	64

DISCUSSION

High-frequency linear transducers are still in wide use today in appendicitis imaging[6]. We found, however, that in a large number of patients, curvilinear low frequency transducer worked equally well when compared with linear transducer. Wide availability as well as larger field of view and greater penetration are the main advantages which makes the use of curvilinear transducer more frequently for radiologists and sonologists. The particular benefit in obese patients is another aspect in which it is difficult to scan adequately with a superficial penetrating linear transducer. We believe that the critical factor is an appropriate choice of transducer for appendiceal imaging[7].

Prompt diagnosis of acute appendicitis is essential to minimize morbidity, which remains substantial if perforation occurs. Current surgical management essentially recommends a balance between negative laparotomy and rate of perforation at the time of surgery. Recent advances emphasize more and more these days to define role of medical imaging in appendicitis besides clinical and laboratory parameters correlation[8]. Sonographic under-diagnosis of acute appendicitis is common if inflammation is localized to only the tip of the appendix leading to an erroneous impression that the appendix is normal. Other problems may be. Related to a position of the appendix that makes it more difficult to appreciate, in particular when it is in the true pelvis and when it is retrocecal[9]. Furthermore, perforation of the appendix may lead to decompression of the appendiceal lumen, such that the appendix, per se, is no longer seen. Over-diagnosis of appendicitis with US is mainly due to misinterpretation of the terminal ileum as the appendix which, in contrast to the appendix, shows frequent peristaltic activity and does not attach to the base of the cecum and is not blind-ended[10].

With the advent of spiral CT and color Doppler US, the activity of inflammation can be accurately detected within the appendix and peri-appendiceal soft tissues. The contribution is most evident in the case of the equivocal gray-scale US examination [11]. The choice of imaging largely depends on institutional preference and on available expertise, although patient age, sex, and body habitus are important influencing factors. US is still a preliminary choice in most of the centers as it is rapid, noninvasive, cost-effective, and requires no patient preparation or contrast material administration[12]. Because US involves no ionizing radiation and excels

in the depiction of acute gynecologic conditions, it is the recommended initial imaging study in children, young women and during pregnancy. CT is complementary to US and is recommended whenever US results are suboptimal, indeterminate, or normal in patients with acute abdominal pain[13].

CONCLUSION

Negative appendectomy rate can be substantially reduced by a careful ultrasound examination with low frequency linear transducer. Ultrasound has a potential role of appendiceal imaging to enhance the diagnostic accuracy and augment clinical evaluation to label right lower quadrant pain as an acute appendicitis, particularly in equivocal cases. Whether it should be performed in all patients suspected to have acute appendicitis or should it be reserved for atypical clinical presentations is still a debate for clinicians prior surgical decision making. We recommended preoperative sonographic scan as a cost-effective ancillary tool to clinical evaluation in all suspects of acute appendicitis.

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