

Improving Sonographic Accuracy of Detecting Acute Appendicitis by Using Additional Criterion of Pinpoint Tenderness

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Abstract

Objective: The purpose of this study was to determine the improvement in sonographic diagnostic accuracy in patients with suspected acute appendicitis in a tertiary care hospital, utilizing commercially available 3.75 MHz curved array probe and adding a new criterion of pinpoint tenderness to the already known sonographic criteria of acute appendicitis. **Materials and methods:** 64 patients, 28 males and 36 females (mean patient age 22.4 years) attending the Emergency Department Of Lahore General Hospital, Lahore, from January 2008 to December 2008, were evaluated by the author sonographically after they had been labeled as cases of acute appendicitis by the referring experienced surgeon. The center of the probe was placed at the point of maximal tenderness and a diagnosis of acute appendicitis was confirmed if inflamed appendix or periappendiceal soft tissue inflammation was noted underneath this tender region. Clinical impression of acute appendicitis was refuted if neither enlarged appendix nor periappendiceal soft tissue hyperechogenicity/localized fluid collection were noted on sonography. **Results:** Sonography confirmed the diagnosis in 56 out of 64 patients whereas 2 patients, falsely reported to be normal on sonography, were found to be having acute appendicitis on surgery. False positive diagnosis was not made in any case. Sensitivity (96.5%) and specificity (100%) achieved in this study were higher than figures reported in current studies (sensitivity of 77-89% and specificity of 94-96%) where reliance has been made on known sonographic features of acute appendicitis without carefully evaluating the site of maximal tenderness. **Conclusion:** A careful search for inflamed appendix or other signs of acute appendicitis by ultrasound underneath point of maximal tenderness in right iliac fossa can significantly improve diagnostic accuracy and should be encouraged so that a sizeable portion of unnecessary appendectomies can be avoided.

Key words: Acute appendicitis, tenderness RLQ, sonography, tissue harmonic imaging

INTRODUCTION

The most common reason for abdominal operation in an emergency department setting is known to be acute appendicitis. Though it is considered to be a minor operation; post operative morbidity of 10-15% has been documented^{1,2} and a high incidence of unnecessary, uncalled for appendectomies has prompted the Radiologists to enter into the arena so that such mishaps can be avoided and false positive cases can be reduced to the minimum. Ultrasonography is considered to be

one of the most useful diagnostic modalities for making a definitive diagnosis though some studies have declined to accept its efficacy in this condition^{3,4}. Established criteria for making a diagnosis of the acute appendicitis include an enlarged appendix having diameter of more than 6 mm. which is non-compressible and usually is associated with localized fluid collection. In more severe cases periappendiceal soft tissues become inflamed due to transmural spread of inflammation. Although this criterion is considered to be quite sensitive, false positive diagnoses are still

commonly made and none of the sonographic criteria can support a definitive diagnosis when used alone⁵. The most reliable criterion of an outer to outer appendiceal wall diameter of more than 6 mm can at times be misleading too because upper limit of normal appendicular diameter in different studies has been upto 9 mm.

Therefore in an attempt to reduce the false positive cases to the minimum, the author included another clinical parameter of acute tenderness in the right iliac fossa for making a sonographic diagnosis of acute appendicitis. The transducer was placed at the point of maximum tenderness as pointed out by the patient and whenever an inflamed appendix, localized fluid collection or edematous soft tissue swelling in the form hyperechoic structure were detected underneath the scanned area, the author diagnosed the condition as acute appendicitis after adequately assessing the renal tract as well as pelvic cavity for any concomitant pathology. In this prospective study the author confirmed that ultrasonography is an excellent subordinate diagnostic tool to rule in or out acute appendicitis considering point of maximum tenderness.

MATERIALS AND METHODS

112 patients attending the Emergency Department of a large Metropolitan Teaching Tertiary Care Hospital were enrolled in this prospective study during a period from January 2008 to December 2008. Experienced Surgeons working in the same emergency settings were involved in the study who diagnosed condition as either acute appendicitis or another condition based upon their clinical acumen, labeled the case and got an ultrasound examination done by the author having sufficient and adequate experience of diagnosing such conditions. In this study only those 64 cases were evaluated who were diagnosed to be suffering from acute appendicitis based on clinical findings and surgeon's initial assessment.

Ultrasound impression of an enlarged non compressible appendix appearing as a blind ending loop and having outer wall to outer wall diameter of more than 6 mm, a wall thicker than 2 mm, presence of an appendicolith, appreciation of periappendiceal inflamed soft tissues or localized collection of

inflammatory fluid in the right iliac fossa were considered as key features for diagnosing acute appendicitis provided either all; a combination of two or more or any of these features was associated with exquisite tenderness over the same region (Figure 1).

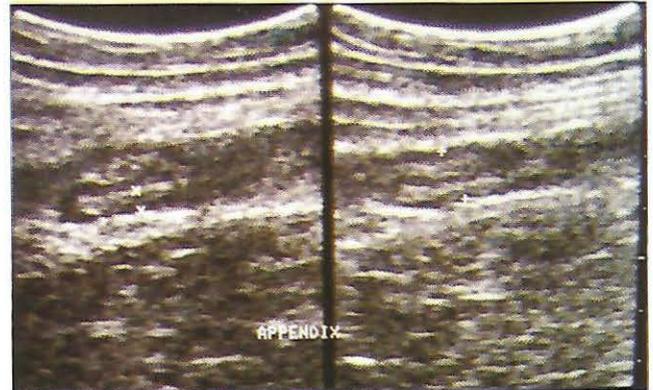


Fig. 1. Sonogram showing inflamed appendix in the right iliac fossa. Wall thickness of 4mm and a diameter of 9mm were associated with exquisite tenderness.

All of the Ultrasound examinations were performed using 3.75 MHz curved array transducer (Toshiba Famio 5, Tokyo Japan.) immediately after surgeon's initial clinical evaluation and impression. The author placed the centre of the ultrasound probe over the point of maximum tenderness, as pointed out by the patient, to find the underlying pathology and then pressed the probe gently over the pathological area to confirm that underlying abnormal area/appendix was the true cause of pain in the right iliac fossa. When the point of maximum tenderness was located on the inflamed appendix, a straight forward diagnosis of acute appendicitis was made and immediate surgery was recommended. In cases where point of maximum tenderness was not directly over the inflamed appendix but was rather over the abnormal hyperechoic periappendiceal structure (soft tissue inflammatory response associated with more severe appendicitis) the case was again diagnosed to be of acute appendicitis. The definitive diagnosis of the acute appendicitis was established surgically in all these cases. However in those cases where maximal tenderness in the right iliac fossa was neither associated with a visible enlarged non-compressible appendix nor with

periappendiceal soft tissue changes, the diagnosis of acute appendicitis made before ultrasound was refuted after failing to find possible retrocecal inflamed appendix. In such cases urinary tract obstruction/ inflammation or pelvic/ adnexal pathology was appreciated in a great majority of cases. Such cases were closely followed up and were discharged after recovery.

All those patients who refused surgery or left against medical advice were excluded from the study because of non availability of surgical findings.

RESULTS

64 patients, 28 males and 36 females were included in the study. Mean patient age was 22.4 years. Mean age of the males was 25.0 years (Range 12-35 years) and the mean age of females was 20.4 years (Range 10-32 years). Of all these 64 patients suspected to be cases of acute appendicitis based upon clinical findings, sonography had confirmed and positively supported the diagnosis in 56 patients and all of those cases proved to be truly positive upon surgery. Out of the remaining 8 patients, on ultrasonography, one male was diagnosed to be suffering from acute Right ureteric obstruction and the other showed right psoas abscess whereas pelvic inflammatory disease process was noted to be the cause of pain in right iliac fossa in four young females. These cases were not subjected to surgery and were followed up as inpatients. All these 6 cases were discharged after uneventful recovery. To our satisfaction, none of these patients had sonographic features characteristic of acute appendicitis and point of maximal tenderness was not associated with either inflamed appendix or periappendiceal soft tissue inflammation. Despite carefully evaluating point of maximal tenderness in right iliac fossa in the remaining 2 patients, sonography failed to find plausible explanation for acute pain. Surgeon's strong clinical suspicion led to surgery and retrocecal appendix was found to be the offender in these cases. One of these retrocecal appendices had nearly perforated at the time of surgery. In 58 patients with proven appendicitis upon surgery, appendiceal perforation had taken place in 03 patients; gangrenous appendicitis was detected in 12

patients whereas the remaining 43 patients had suppurative appendicitis.

Pinpoint tenderness on the appendix or nearby area under ultrasonography was detected in 56 out of 58 patients of surgically proven acute appendicitis. 2 patients not diagnosed as acute appendicitis on sonography but proved so on surgery had retrocecal appendices, a location which not only hindered visualization of appendix but also did not give rise to typical maximal tenderness in right iliac fossa. These two cases were labeled as non-specific acute right iliac fossa pain without any visible pathology in this area.

Logical conclusion from these findings is that sonographic accuracy of 96.5% (56 out of 58 patients) for detecting acute appendicitis was superior to that of clinical impression 90.6% (58 out of 64 patients) and this is more valid in female cases where pelvic inflammatory disease closely mimics pain of acute appendicitis and many a times deceives even the very experienced surgeon. In such cases ultrasound in experienced hands can clearly segregate these two entirely different conditions thus helping the surgeon avoid unnecessary surgery.

DISCUSSION

Transabdominal sonography has been performed as an imaging technique in patients with suspected appendicitis because sonography can rapidly help distinguish patients with appendicitis requiring CT or surgery from those with a normal appendix⁶. As ultrasonography is rapid, noninvasive, inexpensive, requires no patient preparation or contrast material administration, involves no ionizing radiation and excels in the depiction of acute gynaecologic and appendiceal conditions; it is recommended as the initial imaging study in children, in young women, and during pregnancy.

Appendicitis is the most common cause of acute abdominal pain that necessitates surgical intervention in an Emergency Department⁷ Clinical diagnosis is based primarily on symptoms and physical findings, however the diagnosis is often difficult and upto 50% of patients hospitalized for possible appendicitis do not actually have this disorder. Authors of large prospective studies report

a 22-30% removal rate of normal appendices at surgery⁸⁻¹¹. To reduce the frequency of unnecessary appendectomy, use of ultrasonography as a diagnostic tool for appendicitis has been widely evaluated¹²⁻¹⁴.

Documented deployment of Ultrasonography for the diagnosis of appendicitis started with the pioneering work of Puylaert who used primarily one criterion of enlarged appendix in order to make and/or support the diagnosis of acute appendicitis. Ultrasonography machines in general and their resolution in particular have markedly improved since then, therefore several additional criteria for appendicitis were established such as increased wall thickness of appendix, non-compressibility of inflamed appendix, shape of appendix (ovoid or linear structure), presence of localized fluid in right iliac fossa, demonstration of soft tissue hyperechogenicity in right lower quadrant due to inflamed pericecal/ perienteric fat and absence of gas in appendiceal lumen¹⁵⁻¹⁷. Recent introduction of tissue harmonic imaging (THI) can resolve problem in technically difficult patients by increasing depth of penetration and markedly improving image quality¹⁸.

A confident diagnosis of acute appendicitis can be made on the appearance of non-compressible appendix measuring 6 mm or more in antero-posterior diameter^{19, 20} (Figure 2). A diameter of 6 mm or more confirms acute appendicitis with a sensitivity of 100%; a specificity of 68%; positive and negative predictive values of 63% and 100% respectively and an accuracy of 79%¹⁶.

The presence of edematous thickening of the cecal wall, pericecal lymphadenopathy, right lower quadrant abscess or ascites is suggestive of, but not specific for, appendicitis. Although the criteria for the diagnosis of appendicitis are focused on the appendix itself, inflammatory change in perienteric fat is often the first and most obvious finding at ultrasound examination. Inflamed fat appears as hyperechoic periappendiceal soft tissue with indistinct margins²¹.

Although these criteria for recognition of appendicitis are important, they are found to be having relatively limited sensitivity and specificity primarily because none of these takes into account clinical manifestations of acute appendicitis. In this

study therefore the author added simple criterion of pinpoint tenderness to the already known sonographic criteria for making diagnosis of acute appendicitis. Because local inflammatory process in and around acutely inflamed appendix leads to overlying perietal peritoneal inflammation, the pain is fairly well localized to the right iliac fossa. This is in contrast to visceral peritoneal inflammation which is vaguely localized, usually migratory in nature and is common for a variety of intraperitoneal inflammatory conditions²². Because inflammation causes pain and tenderness, it is logical to conclude that detection of the exquisite tenderness in a small area could be the key to the detection of underlying inflammatory organ. If this tenderness is confined to the right iliac fossa and on sonography an enlarged swollen non compressible appendix with or without local fluid collection or regional soft tissue inflammation is detected, a very confident diagnosis of acute appendicitis can be made.



Fig. 2. Grossly enlarged, edematous and ballooned appendix measured 11mm in diameter and was tender on even slight pressure by the ultrasound probe.

There was no false positive case in this study and all patients who met the sonographic criteria suggestive of acute appendicitis proved so on surgery. An accuracy of 96.5% achieved in this study exceeds that acquired in an earlier study (76%) by the same author in the same settings (under publication). The only difference between these study designs was inclusion of point tenderness. Surgeon's accuracy was 90.5 % for the detection of appendicitis and sonography helped the

surgeon avoid at least 6 unnecessary surgeries out of 64 patients (9%). The author believes that even if these 9% unnecessary surgeries would have been performed, they still would have been within documented removal rates of normal appendices of 22-30%⁸⁻¹¹. The higher sensitivity (96.5%) achieved in this study also exceeds the overall sensitivity of 86% described by Terasawa et. al who analysed all available literature relating to sonographic and CT depiction of acute appendicitis from 1966 to Dec 2003²³.

Although the relationship of the base of the appendix to the cecum essentially is constant, the remainder of the appendix is free, which accounts for its variable location in the abdominal cavity. The appendix may lie in a retrocecal, subcecal, retroileal, preileal, or pelvic site. This variability in location may greatly influence the clinical presentation in patients with appendicitis^{8, 9}. This difficulty was encountered in this study as well where 2 patients with retrocecal appendix were wrongly interpreted as non-appendicitis cases but had to be operated because of surgeon's strong suspicion of acute appendicitis.

CONCLUSION

The study conducted in an Emergency Department of a large Tertiary Care Metropolitan Teaching Hospital clearly shows that if the clinical parameter of acute pain and tenderness in right iliac fossa is also taken into account while performing sonography in clinically suspected cases of acute appendicitis, diagnostic accuracy can be further increased and a good number of unnecessary appendectomies can be avoided. Consideration of this parameter alone can improve diagnostic accuracy by about 20% (from 76% to 96%) for the same operator, a significant improvement when considering cost effectiveness and morbidity associated with operation. However appendices in uncommon locations still pose diagnostic problems and this fact needs to be considered while evaluating Right iliac Fossa pain. False diagnosis of acute appendicitis is more frequent in females because pain arising from pelvic pathologies closely mimics appendicular pain. Therefore, if time permits, pre-operative sonography with adequately distended

bladder should be carried out in all female patients. Even very experienced surgeons may be deceived therefore they may be required to get their clinical impression of acute appendicitis ruled in before proceeding to surgery.

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