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Review Article

Diagnosis of Acute Appendicitis: Ultrasound as First-Line Imaging Modality

Waiz Chaudhary[1], Muhammad Adnan Ahsan[1], Muhammad Hashim[2*], Rana Muhammad Ather Azeem Shams[3], Muhammad Arslan Haider[2], Syeda Iman Zahra[2], Warda Zahid[2], Fizza Kazmi[2], Zainab Arshad[2] and Anosh Zainab[2]

[1]College of Allied Health Professionals, Government College University Faisalabad, Faisalabad, Pakistan
[2]University Institute of Radiological Sciences and Medical Imaging Technology, The University of Lahore, Lahore, Pakistan
[3]Department of Allied Health Sciences, Superior University, Lahore, Pakistan

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***Corresponding Author:**
Muhammad Hashim
University Institute of Radiological Sciences and Medical Imaging Technology, The University of Lahore, Lahore, Pakistan
hashimmuhammadch226@gmail.com

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ABSTRACT

The most prevalent abdominal emergency is acute appendicitis. Atypical manifestations may lead to diagnostic uncertainty and a delay in therapy, even if the clinical diagnosis may be simple in patients who exhibit conventional signs and symptoms. When laboratory results are presented, they often show a left shift and an increased leukocytosis. The chance of increased C-reactive protein measurement is high. Imaging modalities have become extremely important in the diagnostic work-up of patients with suspected acute appendicitis in order to maintain the low rate of negative appendectomy because the clinical diagnosis of acute appendicitis continues to pose a challenge to emergency physicians and surgeons. Ultrasound, computed tomography and magnetic resonance imaging modalities are used in diagnosis but we feel that all patients with suspected appendicitis should get an ultrasound. Because ultrasound has outstanding specificity, readily available, no ionizing radiation and cost is low.

INTRODUCTION

The Latin term appendix and the suffix -itis are the roots of the English word appendicitis, which denotes appendix inflammation. In the 1540s, the word "appendix" was used to denote an internal organ's prolonged extension. Metiever initially reported appendicitis in 1759, all at once, this was assumed that the appendix was not the cause of the illness; as a result, it was also known as peri-typhlitis, para-typhlitis, typhlitis, or extra-peritoneal abscess of the right iliac fossa. Appendicitis has been associated with fluid production by the appendix since the early twentieth century. By inserting a manometric recording device, an early investigation indicated that increased forces produced a drainage form that was linked with appendicitis, histopathological demonstrable hypercellularity, and other symptoms [1]. On the posteromedial wall of the cecum, 1.7 cm from the ileocecal valve, where colon's taenias meet, is a long tube known as the vermiform appendix. Mean sizes for males and women are approximately 91.2 mm and 80.3 mm. Mucosa, submucosa, muscularis externa and serosa are the components of the appendix wall [2]. One of the most prevalent illnesses treated by emergency surgery is acute appendicitis. In their everyday practice patients who have this illness are seen by surgeons along with doctors from a range of medical disciplines, such as internal medicine and pediatrics. When it has usual symptoms it's simple to

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identify and manage. Youngsters, old age individuals, and people having numerous unusual symptoms, however, the diagnosis can be not on time and treatment may also become difficult [3]. The primary complaint of individuals with severe acute appendicitis is abdominal discomfort. Only 50% of sufferers have the characteristic combination of colicky focal stomach pain, and pain transfer to the right iliac fossa and vomiting. Usually, the patient describes a periumbilical colicky discomfort that worsens over the course from the initial 24 hours, develops into a constant, severe pain, and tends to move to the right iliac fossa. Due to the midgut's visceral involvement, the first pain is a referred sensation, and the focal pain results from the parietal peritoneum's inclusion following the onset of the inflammatory process [4]. Someone who has acute appendicitis usually experience a low-grade fever. Every time the temperature rises above 38.3 degrees Celsius, perforation must be feared. If perforation does occur, the terminal ileum, caecum, and omentum will be in a position to block the inflammation, leading to periappendiceal phlegmon or an abscess. If there is a potential for a loose hole into the stomach cavity, peritonitis frequently occurs [4, 5]. The most common cause of gastrointestinal emergencies is appendicitis. Appendicitis has a 7% lifespan probability of developing and is often treated surgically. Approximately 11 incidences of this condition are reported in the general population for every 10,000 people annually. The peak incidence of appendicitis often occurs between the ages of ten and twenty, and the male to female ratio is 1.4:1. Men have a lifetime hazard of 8.6%, while women have a risk of 6.7% [1]. Ultrasound has excellent specificity but has limited sensitivity in evaluating patients with acute appendicitis. Until the invention of real-time ultrasonography with high resolution, this was impossible to consistently access appendicitis. Because of the transducers with high frequency provide improved or better resolution, it is now simpler to identify appendicular diseases. In situations of suspected simple acute appendicitis, graded compression sonography is very beneficial [6]. Computed tomography (CT) is a specific and sensitive technique for evaluating acute appendicitis, the requirement for thin sections, which typically demands a more concentrated inspection, raises the risk of missing abnormalities beyond the FOV (field of view). This is a costly procedure that frequently necessitates the use of contrast agents which can be given orally or IV line. Furthermore, computed tomography is not specific nor sensitive for detecting gynecology related illness, which is a common sign of acute appendicitis [7]. MRI show high exactness in the recognition of acute appendicitis. The purpose of this study is basically to describe different methods for the diagnosis of acute appendicitis to decrease the rate of negative appendectomy and ultrasound should be considered as primary imaging procedure in diagnosis of acute appendicitis because there is no risk of ionizing radiation to the patients and expenditure will be low.

Imaginological Diagnosis

Ultrasound

Puylaert was the first to develop real-time compression ultrasonography in 1986 [8]. On ultrasonography, the appendix looks like an elongated, lamellar, blind-ending structure. Appendix readings are taken on a maximum compression. Traditionally, appendicitis is diagnosed at the time the appendix is wider than 6 millimetres. The non-resilient, thick-walled appendix, on the other hand, will be visible because the compressing transducer keeps it in place.When the appendix has an uneven outline, it is diagnosed or when the detection of periappendiceal fluid accumulation found [4]. Recent studies showed that the normal anteroposterior appendix diameter ise 4.4 ± 0.9mm and transverse 5.1 ± 1.0 mm [9]. AL Ajerami studied 180 patients. Patients with appendicitis identified by ultrasonography throughout the research period [n = 180] had their appendix surgically removed. With just 4.4% [8/180] false positives, the rate of negative appendectomy was low. Female patients had a considerably greater erroneous diagnostic rate [false negatives + false positives] than male patients: 38.5% versus 6.2%. A large percentage of erroneously diagnosed patients [82.1%] had abnormal value of weight [obesity or overweight]. The overall specificity and sensitivity of ultrasound were 83.3% and 84.8%, respectively, using surgical outcome as the gold standard, correspondingly 93.3% and 66.7% for the negative and positive predictive scores. Males had higher specificity and sensitivity than females [95.7% and 88.2%, correlatively] [84.6% and 71.4%, respectively] [10]. Hahn *et al.*, [11] Puylaert *et al.*, [12] Skanne *et al.*, [13] Tarjan Z *et al.*, [14] Joshi *et al.*, [15] studies have sensitivity values ranges from 70-95% and specificity values from 90-98%.

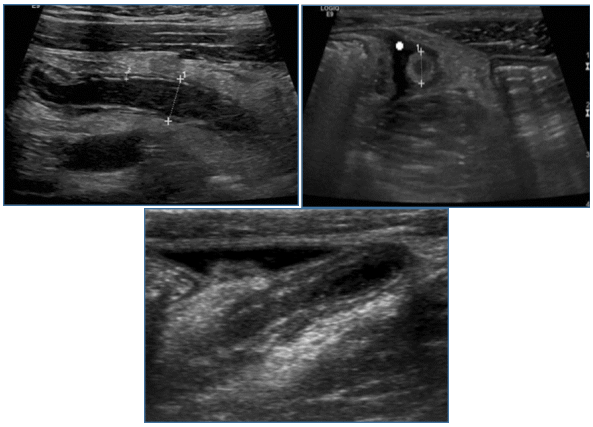

Figure 1: (A) shows longitudinal (B) shows transvere scan of acute appendicitis detected by US (C) shows abdomen ultrasonography

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displaying a thick-walled, dilated appendix

Computed Tomography (CT)

Stroman *et al.*, [16] examined 107 patients with a history of possible acute appendicitis.. A total of 107 individuals, 44 men and 63 females (41% and 59%) with an average age of 33 years ranging from 13 to 89 years, scan was performed using Routine contrast-enhanced computed tomography (CECT) to assess probable appendicitis. 11 false-positive readings and three false-negative readings were present in 107 CECTs done, resulting in a specificity of 85 percent, sensitivity of 92 percent, negative predictive value (NPV) of 95%, positive predictive value (PPV) of 75 %, and an average accuracy rate of 90%. CECT demonstrated considerably greater sensitivity and accuracy (30% against 92% and 68% versus 88%), respectively, than ultrasonography in 43 patients. In terms of clinical therapy, appendectomy was performed on 100% (36/36) of patients with appendicitis and 4.2% (3/71) of patients without appendicitis. As a result, 7.6% (3/39) of appendectomy procedures were found to be negative. A statistical analysis from 31 investigations which comprised 4341 indiviuals which include both adults and children, the overall specificity and sensitivity in children was 95% and 94% for CT scan and 94 and 88% for ultrasound for acute appendicitis diagnosis, respectively. In adults for acute appendicitis diagnosis, combined specificity and sensitivity for ultrasound tests were 93% and 83%, respectively, and 94%, respectively, for CT scans [17]. In CT findings if appendicitis is probably not present or ambigous appendix is present then patients were advised to seek ultrasound re-evaluation. Sim *et al.*, [18] studied that patients with equivocal findings in CT should go for ultrasound re-evaluation.They studied 869 patients, 71 (8.2%) of the 869 individuals exhibited equivocal appendicitis results, whereas 63 (7.2%) were categorised as probably not appendicitis. The CT results combined with Ultrasound re-evaluation group's sensitivity and specificity (100% and 98.1%, respectively) outperformed the CT alone group's (93% and 99%; equivocal group considered as negative appendicitis, 100% and 89.9%; as positive, respectively). After including ultrasound re-evaluation the average rate of negative appendectomy was dropped from 3.4 to 2.3%. Ultrasound re-evaluation could enhance diagnosis accuracy and reduce the proportion of negative appendectomies in individuals with equivocal CT results of acute appendicitis.

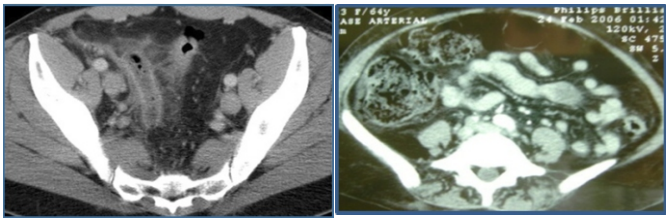

Figure 2: (A) shows contrast-enhanced computed tomographgy with inflammed appendix (B) shows CT scan with acute appendicitis

Magnetic Resonance Imaging (MRI)

MRI is becoming more popular as a problem-solving tool or when US results are equivocal, especially in populations where radiation protection is a concern [17]. Israel et al., [19] studied the sensitivity and specifity of MRI and ultrasound in suspected acute appendicitis during pregnancy. 33 pregnant patients were examined under US and MRI and their results were compared. 5 of the 33 individuals had appendicitis that had been diagnosed pathologically. 4 of the 5 patients with appendicitis had their appendicitis identified correctly on MRI, while 1 was deemed uncertain (appendix not seen). One was accurately identified, 1 was misdiagnosed as normal, and three were read as uncertain in the United States (appendix not seen). An MRI revealed a normal appendix in 13 individuals, none of whom had appendicitis. At US, a normal appendix was found in 3 patients, 1 of whom had appendicitis. The sensitivity, specificity, positive predictive value PPV, and negative predictive value NPV for diagnosing appendicitis when the appendix was seen at MRI were all 100%. When the appendix was seen by ultrasound, the sensitivity, specificity, PPV, and NPV for diagnosing appendicitis were 50%, 100% and 100%, 60% respectively. Diagnosing suspected acute appendicitis in children without ionizing radiation,ultrasonography can be used first followed by MRI in some cases is feasible and can be compared to CT, in terms length of stay in hospital and negative appendectomy rate.

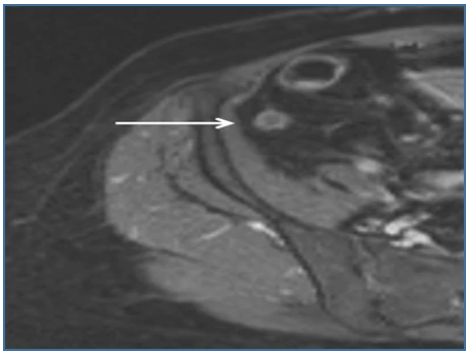

Figure 3: Contrast enhanced MRI of acute appendicitis

DISCUSSION

The clinical evaluation of a patient with suspected

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appendicitis is still difficult because nonsurgical conditions that resemble appendicitis make matters worse [20]. To prevent the repercussions of a missed or belated diagnosis, the clinical choice to operate in ambiguous situations leads to the elimination of 20% of normal appendices. That was viewed as the best possible compromise between the two variables negative appendicitis and rate of perforation and they inversely connected according to the previous beliefs [6]. The clinical diagnosis is made with around 80% accuracy, which leads to a negative appendectomy rate of about 20%. Since it was prioritized to execute an early procedure, this diagnostic accuracy defect has historically been allowed. The objective of quality control was perforated appendicitis rather than low appendectomy rates. For a number of reasons, this approach has lost favor. The costs and morbidity of a failed appendectomy are significant [19]. Low negative appendectomy rates can be achieved by incorporating novel diagnostic modalities into clinical decision-making without raising perforation rates. Clinical assessment alone is insufficient to effectively manage patients with who have the risk of acute appendicitis. The patients suffering with acute abdominal pain, a diagnostic route using routine US, CT, and MRI yielded outstanding outcomes in the identification and treatment of appendicitis. Despite the fact that CT and MRI showed greater diagnosis accuracy, we feel that all patients with suspected appendicitis should get an ultrasound [8]. Until the invention of real-time ultrasonography with high resolution, this was impossible to consistently access appendicitis. However, appendicular disorders are now simpler to diagnose. In situations of suspected simple acute appendicitis, graded compression sonography is very beneficial [5]. Computed tomography (CT) is a specific and sensitive technique for evaluating acute appendicitis, the requirement for thin sections, which typically demands a more concentrated inspection, raises the risk of missing abnormalities beyond the FOV (field of view). This is a costly test that frequently necessitates the use of contrast agents. Aside from that, CT is not specific or sensitive for diagnosing gynecology related illness, which is common symptom of acute appendicitis. In some ways, CT is better than ultrasonography since its results are much more precise and intestinal gas has no impact on them. Unlike ultrasonography, CT scan is able to show the elongated appendix but is unable to describe the wall's anatomy. As a result, depending on the mural alterations, ultrasonography is preferable to CT for determining the severity of appendicitis [9]. If we talk about MRI imaging, although it reduces the use of ionizing radiation, it has various drawbacks, including a large cost, extensive study durations, and restricted availability on an emergency basis. According to some writers, MR imaging is only used in pregnant women whose ultrasound results are unclear. Although MRI imaging has not been associated with any negative effects during human pregnancy, but the safety of it has yet to be demonstrated clearly. Acoustic stimulation has the ability to injure the fetus, despite tissue heating from radiofrequency pulses. So, MRI is avoided during the first trimester [8].

CONCLUSIONS

For nearly a century, researchers have been studying appendicitis. Clinical evaluation and Imaging results are used to make a diagnosis. Clinical assessment alone is insufficient to effectively manage patients with suspected acute appendicitis. For patients with acute abdominal pain, a diagnostic route using routine US, CT, and MRI yielded outstanding outcomes in the identification and treatment of appendicitis. Despite the fact that CT and MRI showed greater diagnosis accuracy, we feel that all patients with suspected appendicitis should get an ultrasound. Because ultrasound is readily available, no ionizing radiation and cost is low.

Conflicts of Interest

The authors declare no conflict of interest.

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REFERENCES

[1] Krzyzak M and Mulrooney SM. Acute Appendicitis Review: Background, Epidemiology, Diagnosis, and Treatment. Cureus. 2020 Jun; 12(6):e8562. doi: 10.7759/cureus.8562

[2] Kraemer M, Franke C, Ohmann C, Yang Q. Acute appendicitis in late adulthood: incidence, presentation, and outcome. Results of a prospective multicenter acute abdominal pain study and a review of the literature. Langenbecks Archives of Surgery. 2000 Nov; 385(7):470-81. doi: 10.1007/s004230000165

[3] Di Saverio S, Podda M, De Simone B, Ceresoli M, Augustin G, Gori A, et al. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. World Journal of Emergency Surgery. 2020 Apr; 15(1):27. doi: 10.1186/s13017-020-00306-3

[4] Petroianu A. Diagnosis of acute appendicitis. International Journal of Surgery. 2012 Jan; 10(3):115-9. doi: 10.1016/j.ijsu.2012.02.006

[5] Rybkin AV and Thoeni RF. Current concepts in imaging of appendicitis. Radiology Clinics of North

DOI: https://doi.org/10.54393/pjhs.v3i05.220

America. 2007 May; 45(3):411-22. doi: 10.1016/j.rcl.2007.04.003
[6] Mardan MA, Mufti TS, Khattak IU, Chilkunda N, Alshayeb AA, Mohammad AM, et al. Role of ultrasound in acute appendicitis. Journal of Ayub Medical College Abbottabad. 2007 Sep; 19(3):72-9
[7] Abu-Yousef MM. Ultrasonography of the right lower quadrant. Ultrasound Q. 2001 Dec; 17(4):211-25. doi: 10.1097/00013644-200112000-00003
[8] Puylaert JB. Acute appendicitis: US evaluation using graded compression. Radiology. 1986 Feb; 158(2):355-60. doi: 10.1148/radiology.158.2.2934762
[9] Coyne SM, Zhang B, Trout AT. Does appendiceal diameter change with age? A sonographic study. AJR American Journal of Roentgenology. 2014 Nov; 203(5):1120-6. doi: 10.2214/AJR.13.12205
[10] Al-Ajerami Y. Sensitivity and specificity of ultrasound in the diagnosis of acute appendicitis. East Mediterranean Health Journal. 2012 Jan; 18(1):66-9. doi: 10.26719/2012.18.1.66
[11] Hahn HB, Hoepner FU, Kalle T, Macdonald EB, Prantl F, Spitzer IM, et al. Sonography of acute appendicitis in children: 7 years experience. Pediatric Radiology. 1998 Mar; 28(3):147-51. doi: 10.1007/s002470050316
[12] Puylaert JB, Rutgers PH, Lalisang RI, de Vries BC, van der Werf SD, Dörr JP, et al. A prospective study of ultrasonography in the diagnosis of appendicitis. The New England Journal of Medicine. 1987 Sep; 317(11):666-9. doi: 10.1056/NEJM198709103171103
[13] Skaane P, Amland PF, Nordshus T, Solheim K. Ultrasonography in patients with suspected acute appendicitis: a prospective study. The British Journal of Radiology. 1990 Oct; 63(754):787-93. doi: 10.1259/0007-1285-63-754-787
[14] Sidler S, Heim D, Negri M, Stricker U. The value of ultrasound diagnosis in "acute appendicitis" patient admission. Swiss Surgery. 2003; 9(6):297-306. doi: 10.1024/1023-9332.9.6.297
[15] Debnath J, Ram S, Balani S, Chakraborty I, Gupta PD, Bindal RK, et al. Ultrasonography in Patients with Suspected Acute Appendicitis. Medical Journal Armed Forces India. 2005 Jul; 61(3):249-52. doi: 10.1016/S0377-1237(05)80166-2
[16] Stroman DL, Bayouth CV, Kuhn JA, Westmoreland M, Jones RC, Fisher TL, et al. The role of computed tomography in the diagnosis of acute appendicitis. The American Journal of Surgery. 1999 Dec; 178(6):485-9. doi: 10.1016/s0002-9610(99)00223-8
[17] Mostbeck G, Adam EJ, Nielsen MB, Claudon M, Clevert D, Nicolau C, et al. How to diagnose acute appendicitis: ultrasound first. Insights Imaging. 2016 Apr; 7(2):255-63. doi: 10.1007/s13244-016-0469-6
[18] Sim JY, Kim HJ, Yeon JW, Suh BS, Kim KH, Ha YR, et al. Added value of ultrasound re-evaluation for patients with equivocal CT findings of acute appendicitis: a preliminary study. European Radiology. 2013 Jul; 23(7):1882-90. doi: 10.1007/s00330-013-2769-2
[19] Israel GM, Malguria N, McCarthy S, Copel J, Weinreb J. MRI vs. ultrasound for suspected appendicitis during pregnancy. Journal of Magnetic Resonance Imaging. 2008 Aug; 28(2):428-33. doi: 10.1002/jmri.21456
[20] Van Breda Vriesman AC, Puylaert JB. Mimics of appendicitis: alternative nonsurgical diagnoses with sonography and CT. AJR American Journal of Roentgenology. 2006 Apr; 186(4):1103-12. doi: 10.2214/AJR.05.0085