Review Article

The role of ultrasound in diagnosis of acute appendicitis: A review article

Abstract:

Ultrasound (U/S) plays an essential role in the diagnosis and management of acute appendicitis, which improves patient outcomes. Recent technological advances have brought profound changes to diagnostic ultrasound imaging. Acute appendicitis is a frequent abdominal condition that affects many people at their lives acute appendicitis is a difficult diagnosis based on clinical and laboratory data.

Abnormal US findings during appendiceal scan indicate a greater chance of having recurrent appendicitis, US scan play an important role in the pre-surgical evaluation and planning of patients with appendicitis.

In this review, different US techniques and their applications in diagnosis of appendicitis and early and accurate diagnosis are discussed.

Key words: Ultrasound, Acute appendicitis, Abdominal Pain, Sign & symptom.

Introduction:

Acute appendicitis (AA) is a common abdominal illness that affects 7% of the population at some point [1]. Appendicitis is one of the most common causes of abdominal discomfort in adult patients who visit the emergency room. Each year, more than 250,000 cases of

appendicitis are diagnosed in the United States, and appendectomy is the most common urgent procedure performed worldwide [2, 3]. Acute appendicitis is a challenging diagnosis to make just on clinical and laboratory evidence since it might seem like a variety of urologic, gastrointestinal, or gynecologic problems [4].

When compared to non-perforating AA, appendiceal perforation is associated with increased morbidity and mortality. Acute but not gangrenous AA has a mortality risk of less than 0.1 percent, but gangrenous AA has a risk of 0.6 percent. Perforated AA, on the other hand, has a higher mortality rate of around 5%. Currently, mounting evidence suggests that perforation is not always the inevitable conclusion of appendiceal blockage, and that not only do not all patients with AA develop to perforation, but that resolution may be a regular occurrence as well [5].

In this way, any delay in making a decision can have negative consequences such as wound abscesses and perforation [6]. A non-peristaltic, incompressible tubular blind structure with a diameter of 6 mm or greater evident in the right iliac fossa is one of the ultrasonography diagnostic criteria for acute appendicitis. However, there are numerous auxiliary symptoms of acute appendicitis that might aid in the ultrasonography diagnosis of the condition [7].

Negative appendectomies may be a considerable burden on the health system due to diagnostic issues [8].

In terms of perforation rates, emergency department (ER) re-visits, and negative appendectomy rates, the use of ultrasound is accurate and safe. Using an appropriate clinical and/or staged approach with US/MRI may reduce the need for CT scans. In adults, MRI has at least the same sensitivity and specificity as CT and, despite greater costs, should be preferred over CT as a second-line imaging modality. [9].

Results and discussion:

Among the imaging techniques now in use in clinical practice is Ultrasound (US) which is a valuable useful diagnostic tool. It was first documented in 1986 by Puylaert, who characterized the "graded compression" approach as a way to see the inflamed appendix

better [10], A linear high-frequency transducer is positioned on the right lower quadrant using the graded compression approach, and pressure is applied progressively while imaging, displacing overlaying gas-filled bowel loops. Furthermore, as compared to the expenses of computed tomography (CT), this noninvasive approach is reproducible, avoids nonionizing radiation exposure, and may be less expensive.

Pre-operative diagnosis of acute appendicitis is difficult, especially in women of childbearing age [11]. Negative appendectomies, perforations, and hospital stays can all be greatly reduced with diagnostic help. Laparoscopy, scoring systems, ultrasonography, computed tomography, magnetic resonance imaging, and other tools are among them, which are all available in various settings and each have their own set of benefits and drawbacks [12]. As a result, any delay in diagnosis might result in complications such perforation and wound abscesses [6]. The fatality rate from acute appendicitis, on the other hand, is estimated to be around 0.25 percent across all age groups [13].

As a result, clinical judgment is still very important in the diagnosis of appendicitis. Women are more likely than males to have their appendicitis misdiagnosed. Diagnostic imaging has not been found to improve outcomes, hence limiting imaging to truly equivocal cases and employing it early in the diagnostic workup may improve outcomes. Ultrasonography is very user-dependent, and operator experience could have a role in appendicitis diagnosis accuracy. The Alvarado scale is a simple and inexpensive additional tool for confirming the diagnosis of acute appendicitis, particularly for junior surgeons [14].

The use of abdominal ultrasonography (US), computed tomography (CT), and magnetic resonance imaging (MRI) in the diagnosis and exclusion of acute appendicitis has also been reported (AA). The sensitivity and specificity in diagnosing AA in the United States have been found to range from 71 to 92 percent and 83 percent, respectively, for normal contrast-enhanced CT 98 and 91 percent and MRI 97 and 93 percent, respectively [15].

A common and critical problem in general surgery is misdiagnosis of acute appendicitis. One of the novel diagnostic techniques that has been demonstrated to increase diagnostic accuracy and clinical outcomes is graded compression ultrasonography [16]. In a graded compression approach, a hand-held US transducer applies a consistent pressure in the right iliac fossa (RIF). Normal and gas-filled intestinal loops are either pushed out of view or squeezed between the front and posterior abdominal walls. As a result of the incompressibility of the inflamed appendix, it is best viewed. The inflamed appendix appears as a blind-ended tubular structure with a laminated wall that emerges from the caecum's base. It should be a peristaltic, noncompressible, and have a diameter of at least 6mm [16].

The risk of perforation increases by 5% every 12 hours in acute appendicitis, hence an appendectomy should be performed within 36 hours following a confirmed diagnosis of acute appendicitis [17]. As a result, any delay in diagnosis can result in complications like perforation and wound abscesses [18]. The fatality rate from acute appendicitis, on the other hand, is estimated to be around 0.25 percent across all age groups [19, 20].

Negative appendectomy rates range from 16 percent to 47 percent when a diagnosis is made only on the basis of the patient's history and a clinical examination. When medical imaging modalities are used in the diagnostic process, however, that percentage reduces to between 6% and 10% [21]. As a result, an accurate diagnosis is required to avoid any complications that may arise as a result of delayed surgical intervention.

Different tools were created to improve diagnostic accuracy, such as computer aided programs, different scoring systems, GIT contrast investigations, CT. Scan, Ultrasonography, MRI, and laparoscopic [22]. Ultrasonography is the simplest, most accessible, noninvasive, easy, and cost-effective of these methods [23]. The most common sonographic error occurs when the inflamed appendix can't be seen due to its position (i.e. when it's posteriorly placed behind the cecum) or when enough bowel compression can't be achieved due to excess body fat. However, because the differential diagnosis of pain in this region is not straightforward, proper diagnosis of acute right iliac fossa pain remains a difficult clinical challenge [24,25].

A negative appendicectomy is somewhat acceptable in the past to overcome the morbidity and mortality of perforation before surgery. However, many people have found this intolerable in recent years because the surgical technique itself may be a source of morbidity and mortality. Although appendicectomy has significantly reduced morbidity, it has also increased the rate of diagnostic mistake [26].

Negative appendicectomy is still common, with rates ranging from 15% to 30% worldwide [27]. According to the University of Malaya Medical Centre in Malaysia, the risk of negative appendicectomy is as high as 19.3% [26].

With a precise and timely diagnosis, the rate of negative appendicectomy can be minimized. Evaluation of clinical symptoms, scoring systems such as the Alvarado and RIPASA score, and imaging procedures such as ultrasonography and computed tomography (CT) scan are all relevant diagnostic modalities for acute appendicitis. The use of scoring systems can help predict acute appendicitis, but they lack sensitivity and specificity, and they don't tell you how far along the inflammatory process is [27].

Although a CT scan can reduce the rate of negative appendicectomy from 24% to 7.6% [28], such excellent instruments are costly and not widely available in many hospitals. Because of

its higher accuracy than U/S, standardized CT scan is the modality of choice for diagnosing appendicitis in the general population, according to the findings of various previous comparative studies. However, because it uses ionizing radiation and intravenous or gastrointestinal contrast material, it is a more intrusive diagnostic, making it unsuitable for use in children. On the other hand, U/S is straightforward, accessible, noninvasive, easy, and cost-effective. Furthermore, in the pediatric population, U/S can not only detect inflamed appendices but also assess disease severity [29]. Because of atypical presentations and a delay in seeking medical help, the clinical diagnosis of appendicitis in the elderly is much more challenging than in young and middle-aged persons, with a higher rate of perforation, surgical complications, and mortality [30].

As a result, imaging examination for suspected acute appendicitis in adults is becoming more common. Regardless of the radiologist's experience or the patient's body mass index (BMI), the diagnostic performances of sonography and CT for acute appendicitis or an alternative diagnosis were not significantly different in a prospective research, albeit sonography yielded more inconclusive exams [31].

A thicker wall, a noncompressible lumen, an outer appendiceal diameter more than 6 mm, the lack of gas in the lumen, appendicoliths, echogenic inflammatory periappendiceal fat change, and increased blood flow in the appendiceal wall are all US findings of appendicitis [23]

When compared to other diagnostic tests, US is less sensitive than CT; yet, because of its low negative predictive value for appendicitis, it may not be as effective in excluding appendicitis. More recently, an appendix color and power Doppler examination has proven to be a beneficial adjuvant in improving sensitivity by indicating increased flow in an inflamed appendix [33].

Adult patients with clinically suspected acute appendicitis require imaging; in fact, there is widespread agreement that early diagnosis improves the outcome of acute appendicitis. In the examination of patients referred with clinically suspected acute appendicitis, we still use graded-compression ultrasound [34].

US can be done at any time, regardless of how prepared a patient is. Nonetheless, due to varying diagnostic accuracy, individual skill is required not just to complete a good exam, but also to prioritize those equivocal situations that will need to be assessed by computed tomography [35].

Conclusions:

This review revealed that in distant settings, a diagnostic strategy based on clinical evaluations, routine US conducted by emergency physicians, and clinical re-evaluation of

patients with acute abdominal pain is appropriate for obtaining favorable results for appendicitis diagnosis and treatment. Although imaging with U/S has significantly lowered the negative appendectomy rates; the specificity and the positive predictive values were high supporting the use of US as a first-line test in the diagnosis of acute appendicitis.

Recommendations :

In patients with suspected acute appendicitis, we advocate using a customized personalized diagnostic method for stratifying risk and illness likelihood and establishing a suitable diagnostic modality, based on the patient's age, sex, and clinical signs and symptoms.

Informed consent statement: Not applicable.

References:

1. Omari, A.H.; Khammash, M.R.; Qasaimeh, G.R.; Shammari, A.K.; Yaseen, M.K.B.; Hammori, S.K. Acute appendicitis in the elderly: risk factors for perforation. World J. Emerg. Surg. 2014; 9(1): 6.

2. Reginelli A, Pezzullo MG, Scaglione M, Scialpi M, Brunese L, Grassi R: Gastrointestinal disorders in elderly patients. Radiol Clin North Am 2008, 46(4):755-71.

3. Macarini L, Stoppino LP, Centola A, Muscarella S, Fortunato F, Coppolino F, et al. Assessment of activity of Crohn's disease of the ileum and large bowel: proposal for a new multiparameter MR enterography score. Radiol Med 2013, 118(2):181-195.

4. Vriesman, A.C.V.B.; Puylaert, J.B.C.M. Mimics of Appendicitis: Alternative Nonsurgical Diagnoses with Sonography and CT. Am. J. Roentgenol. 2006, 186(4), 1103–1112.

5. Flum DR. Acute Appendicitis - Appendectomy or the "Antibiotics First" Strategy. N Engl J Med. 2015;372(1):1937–43.

6. Von Titte, S.N.; McCabe, C.J.; Ottinger, L.W. Delayed appendectomy for appendicitis: Causes and consequences. Am. J. Emerg. Med. 1996, 14(7), 620–622.

7. Quillin SP, Siegel MJ: Appendicitis: efficacy of color Doppler sonography. Radiology. 1994, 191(2):557-60.

8. Flum DR, Koepsell T. The clinical and economic correlates of misdiagnosed appendicitis: nationwide analysis. Arch Surg 2002; 137(7): 799-804.

9. Salomone D, Mauro P, Belinda D, Marco C,et al. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. Di Saverio et al. World Journal of Emergency Surgery. 2020:15(1):27-42.

10. Puylaert JB: Acute appendicitis: US evaluation using graded compression. Radiology, 1986, 158(2):355-360.

11. Hale DA, Jaques DP, Molloy M, Pearl RH, Schutt DC, d'Avis JC. Appendectomy: Improving care through quality improvement. Arch Surg. 1997; 132(2): 153-157

12. Gwynn LK. The diagnosis of acute appendicitis: clinical assessment versus computed tomography evaluation. J Emerg Med 2001; 21(2): 119-123.

13. Townsend, C.M., Jr.; Beauchamp, R.D.; Evers, B.M.; Mattox, K.L. (Eds.) Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice, 20th ed.; Elsevier: Philadelphia, PA, USA, 2016.

14. Fatma K. Althoubaity**,** FRCSI Suspected acute appendicitis in female patients Trends in diagnosis in emergency department in a University Hospital in Western region of Saudi Arabia Saudi Med J. 2006; Vol. 27 (11): 1667-1673

15. Gwynn LK. The diagnosis of acute appendicitis: clinical assessment versus computed tomography evaluation. J Emerg Med. 2001; 21(2):119–23.

16. Mohammad A , Ali M , Tariq S M , Irfan U K , et al. Role of Ultrasound in Acute Appendicitis. Journal of Ayub Medical College, Abbottabad (JAMC); 2007:19(3):72-9

17. Wagner, P.L.; Eachempati, S.R.; Soe, K.; Pieracci, F.M.; Shou, J.; Barie, P.S. Defining the current negative appendectomy rate: For whom is preoperative computed tomography making an impact? Surgery. 2008, 144(2), 276–282.

18. Von Titte, S.N.; McCabe, C.J.; Ottinger, L.W. Delayed appendectomy for appendicitis: Causes and consequences. Am. J. Emerg. Med. 1996, 14(7), 620–622.

19. Birnbaum, B.A.;Wilson, S.R. Appendicitis at the Millennium. Radiology 2000, 215(2), 337–348.

20. Townsend C.M., Jr Beauchamp, R.D.; Evers, B.M.; Mattox, K.L. (Eds.).2016. Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice, 20th ed.; Elsevier: Philadelphia, PA, USA.

21. Neumayer, L. Imaging in appendicitis: a review with special emphasis on the treatment of women. Obstet. Gynecol. 2003; 102(6), 1404–1409.

22. Douglas CD, Macpherson NE, Davidson PM, Gani JS. Randomized controlled trial of ultrasonography in the diagnosis of acute appendicitis, incorporating the Alvarado score.BMJ.2000;321(1):919-22.

23. Frank C, Bohner H, Yang Q, Ohmann C, Rohner HD. Ultrasonography for the diagnosis of acute appendicitis: results of a prospective multicenter trial. World J Surg. 1999;23(2):141-46.

24. Mumtaz K H , Zuhair Bashir Kamal , Laith Naif Hindosh, Wisam Abdullteef Hussein.The Role of Ultrasound in the Diagnosis of Acute Appendicitis: A Prospective Study ResearchGate.2014; 13(2):226-229.

25. Ahmad KA, Ideris N, Aziz SHSA. A cross-sectional study of neutrophil-to-lymphocyte ratio in diagnosing acute appendicitis in Hospital Melaka. Malays J Med Sci. 2019;26(6):55–66.

26. Lee HY, Jayalakshmi P, Noori SH. Acute appendicitis—the University Hospital experience. Med J Malaysia. 1993;48(1):17–27.

27. Beecher SM, Hogan J, O'Leary DP, McLaughli R. An appraisal of inflammatory marker in distinguishing acute uncomplicated and complicated appendicitis. Dig Surg. 2016;33(3):177–181.

28. Rafiq M S, Khan MM, Khan A, Ahmad B. Total leukocyte and neutrophil count as preventive tools in reducing negative appendectomies. Ulus Travma Acil Cerrahi Derg. 2015; 21(2):102–106.

29. Kaneko, K., & Tsuda, M. (2004). Ultrasound-based decision making in the treatment of acute appendicitis in children. Journal of pediatric surgery, 39(9), 1316-1320.

30. Storm-Dickerson TL, Horattas MC. What have we earned over the past 20 years about appendicitis in the elderly? Am J Surg. 2003; 185(3):198–201.

31. Keyzer C, Zalcman M, De Maertelaer V, et al. Comparison of US and unenhanced multi-detector row CT in patients suspected of having acute appendicitis. Radiology, 2005; 236(2):527–534.

32. Quillin SP, Siegel MJ: Appendicitis: efficacy of color Doppler sonography. Radiology 1994, 191(2):557-560.

33. Pinto F, Lencioni R, Falleni A, et al: Assessment of hyperemia in acute appendicitis: comparison between power Doppler and color Doppler sonography. Emerg Radiol. 1998, 5(1):92-96.

34. Cappabianca S, Reginelli A, Iacobellis F, Granata V, Urciuoli L, et al. Dynamic MRI defecography vs. entero-colpo-cysto-defecography in the evaluation of midline pelvic floor hernias in female pelvic floor disorders. Int J Colorectal Dis. 2011, 26(9):1191-6

35. Pinto A, Caranci F, Romano L, Carrafiello G, Fonio P, Brunese L: Learning from errors in radiology: a comprehensive review. Semin Ultrasound CT MRI .2012(1), 33:379-382.