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Chapter 7

The Epidemiology and Diagnosis of Acute Appendicitis: Review

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Abstract

Acute appendicitis is one of the most common causes of acute abdominal pain necessitating emergency surgical intervention worldwide. Despite more than a century of clinical and scientific investigation, appendicitis continues to pose significant diagnostic challenges because of its heterogeneous presentation, evolving epidemiological patterns, and overlap with numerous abdominal and pelvic conditions. This chapter synthesizes contemporary evidence on the epidemiology and diagnostic evaluation of acute appendicitis, with emphasis on global incidence trends and modern diagnostic strategies. Epidemiologically, acute appendicitis demonstrates marked geographic variation, historically affecting populations in high income countries more frequently, though recent data indicate rising incidence in low and middle income regions. Diagnostic approaches have evolved from relying solely on clinical examination to integrated algorithms that combine clinical scoring systems, laboratory biomarkers, and imaging modalities. Ultrasonography, computed tomography, and magnetic resonance imaging each play distinct roles, depending on the patient population and resource availability. safety, cost effectiveness, and reduced radiation exposure. Understanding the epidemiology and diagnosis of acute appendicitis remains essential for optimizing clinical outcomes, minimizing complications, and guiding future research priorities in this common surgical emergency.

Keywords: Acute Appendicitis, Biomarkers, Diagnosis, Epidemiology, Imaging, Ultrasonography, Computerized Tomography, and Magnetic Resonance Imaging.

Introduction

Acute appendicitis is characterized by inflammation of the appendix, which is the most common admission to the general surgical ward for abdominal pain. The incidence of acute appendicitis is about 90-100 cases per 100,000 population in developed countries. The incidence has remained relatively stable in most Western countries but has been increasing in developing countries. Acute appendicitis is commonly seen in patients in the second and third decades of life and is slightly more common in male than female patients (Moris, 2021). The clinical presentation of acute appendicitis is the presence of abdominal pain that radiates to the right iliac fossa, and it is associated with other symptoms like nausea, vomiting, abdominal distension, and fever. Abdominal examination will reveal guarding and rigidity over the right iliac fossa, with tenderness at McBurney's point (Krzyzak, 2020; Saidi, 2000).

The diagnosis of acute appendicitis involves clinical examination of patients, along with the use of biochemical markers, such as an elevated total white blood cell count and C-reactive protein (CRP). The clinical and biochemical parameters are incorporated into clinical scoring systems like the Alvarado, RIPASA, and AIR scoring systems to quantify patients into low, moderate, and high probability of acute appendicitis (Echevarria, 2023). Imaging modalities like ultrasonography and computerized tomography are performed for patients with an equivocal diagnosis of acute appendicitis. Ultrasonography has the advantage of its availability and no radiation exposure, but it is operator dependent and has a moderate sensitivity and specificity. Computerized tomography has a better sensitivity and specificity for diagnosing acute appendicitis, but it involves the use of ionizing radiation and is not readily available (Bhangu, 2015; Shogilev, 2014).

In this chapter, we will investigate the epidemiology of acute appendicitis. We will also look at the role of biochemical markers in diagnosing acute appendicitis and the imaging modalities like ultrasound, computerized tomography, and magnetic resonance imaging, and their role in diagnosing acute appendicitis. We conducted a literature review using PubMed, the Cochrane Database of Systematic Reviews, Google Scholar, and Semantic Scholar, searching for randomized controlled trials, non-randomized trials, observational and cohort studies, clinical reviews, systematic reviews, and meta-analyses published between 1990 and 2026. The following keywords were used: "acute appendicitis", "biomarkers", "diagnosis", "epidemiology ", "imaging", "ultrasonography", "Magnetic Resonance Imaging",

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and" computerized tomography". All articles were in English, and all articles were assessed by manual cross-referencing of the literature. Commentaries, case reports, and editorials were excluded from this review. Adult and pediatric patients were included in this review. Pregnant patients were not included in this review.

Discussion

The Epidemiology of Acute Appendicitis

The incidence of acute appendicitis in the Western population has seen a downward trend from a peak in the 1900s, and it has been steadily decreasing, whereas in most developing regions of the world, there has been a steady increase. A systematic review on the global incidence of acute appendicitis was conducted by Ferris et al. A total of 120 studies were included in this review, and the pooled incidence of acute appendicitis in North America was 100 cases per 100,000 population in the 21st century. The pooled incidence of acute appendicitis in Europe ranged from 105 to 150 cases per 100,000 population. The pooled incidence of acute appendicitis in developing countries in Asia, the Middle east and South America ranged between 150 and 210 cases per 100,000 population (Ferris, 2017).

The global burden of acute appendicitis was assessed by Yang et al, who noted that the incidence of acute appendicitis has been steadily increasing, with the largest increase seen in South Asia, the Caribbean, and the Andean Latin America. This study showed the steady increase in the incidence of acute appendicitis from 1990 to 2019 (Yang, 2022). Lin et al looked at the epidemiology of acute appendicitis in Taiwan, and in this 12-year study, the incidence of acute appendicitis was 107.6 per 100,000 population, with male patients and those in the 15 to 30-year age group being the most affected common group who had acute appendicitis (Lin, 2015). A retrospective study was conducted by Oguntola et al on the epidemiology and outcomes of acute appendicitis in south-western Nigeria. The incidence of acute appendicitis had been increasing with a similar distribution in both males and females, and patients in the second and third decades of life were the most common age of presentation (Oguntola, 2010). The epidemiology of acute appendicitis in South Korea was assessed by Lee et al. This retrospective study was conducted from 2005 to 2007, and the incidence of acute appendicitis was 227 per 100,000 population (Lee, 2010).

The role of blood investigations in the diagnosis of acute appendicitis

The white cell counts and C.Reactive protein (CRP) are the two inflammatory markers that are used to aid in the diagnosis of acute appendicitis. These inflammatory markers will demonstrate leukocytosis and elevated CRP levels, and when combined with clinical examination, it increases the probability of diagnosis of acute appendicitis. These inflammatory markers are, however, weak at diagnosing acute appendicitis on their own (Bom, 2021). Maghsoudi et al had conducted a cross-sectional study on the evaluation of full blood count parameters in the diagnosis of acute appendicitis. A total of 200 patients were included in this study, and none of the parameters were sensitive enough to diagnose acute appendicitis on their own (Maghsoudi, 2021). Yang et al had conducted a retrospective study on the laboratory test in the diagnosis of acute appendicitis. A total of 897 patients were included in this study, and the sensitivities of white cell count, neutrophil percentage, and CRP were 88.5%, 87.2%, and 76.5%, respectively, while the specificities were 31.9%, 33.1%, and 26.1%, respectively (Yang H. R., 2006). Further retrospective studies by Peksoz et al and Al-Abed et al also concluded that these inflammatory markers were not sensitive to diagnose acute appendicitis on their own (Peksöz, 2021; Al-Abed, 2015).

Andersson conducted a meta-analysis on the clinical and laboratory diagnosis of acute appendicitis. A total of 24 studies were included in this analysis, and an elevation of all inflammatory markers (leukocytosis, granulocyte count, and C-reactive protein(CRP), with corresponding abdominal signs were associated with a higher discriminating power to diagnose acute appendicitis, and the individual use of inflammatory markers was associated with a low discriminating power to diagnose acute appendicitis (E., 2004). A systematic review and meta-analysis on the diagnostic accuracy of procalcitonin, C-reactive protein, and white cell count for suspected acute appendicitis was conducted by Yu et al. A total of 7 studies with 1047 patients were included in this study, and the sensitivity and specificity of procalcitonin was 33% and 89%, respectively, and for C-reactive protein were 57% and 87% respectively, and for total white cell count were 62% and 75% respectively. C.Reactive Protein (CRP) and total white cell count had the highest accuracy for the diagnosis of acute appendicitis (Yu, 2013). A systematic review and meta-analysis on the diagnostic accuracy of inflammatory markers for acute appendicitis in the pediatric patient was conducted by Fawkner-Corbett et al. A total of 67 studies with 34,839 patients were included in this study. Leukocytosis($>$10,000) had a sensitivity of 0.85(95% CI 0.80-0.89), and the combined leukocytosis and raised C.Reactive Protein(CRP)($>$10mg/dl), was associated with a sensitivity of 0.97(95%C.I-0.93-0.97). CRP was the most specific test with a specificity of 0.87(95% CI 0.80-0.91) (Fawkner-Corbett, 2022).

The role of imaging modalities in the diagnosis of acute appendicitis

The common imaging modalities in the diagnosis of acute appendicitis include ultrasonography, computerized tomography, and magnetic resonance imaging. They are used to aid in the diagnosis of acute appendicitis in cases where the diagnosis is equivocal, after clinical and laboratory examination. Ultrasonography is the most common imaging modality that is used in acute appendicitis; it is readily available, low-cost, and does not involve the use of radiation. The disadvantages of ultrasonography are that it is operator-dependent, and if the appendix is not visualized, then the test is inconclusive. Computerized tomography is the next imaging modality that is used to diagnose acute appendicitis. It has a good sensitivity in diagnosing acute appendicitis, but it involves the use of ionizing contrast, which is contraindicated in pregnant patients and in pediatric patients. Magnetic resonance imaging is the third imaging modality that is used to diagnose acute appendicitis. It has a higher sensitivity and specificity when compared with computerized tomography, and it does not use ionizing radiation, but it takes longer to perform, requires expertise to interpret the images, is expensive, and artifacts will disrupt the images and make reporting difficult (Parks, 2011; Debnath, 2017; Karul, 2014; E. A. , 2002).

The World Society of Emergency Surgeons (WSES), in their guidelines for the management of acute appendicitis, has recommended ultrasonography of the abdomen for both adults and pediatric patients with suspected acute appendicitis. A low-dose contrasted computerized tomography is then recommended for patients with suspected acute appendicitis, where the ultrasonography is negative (Di Saverio, 2020). The European Association of Emergency Surgeons(EAES) has recommended that ultrasonography of the abdomen be the initial imaging modality in patients with suspected appendicitis, and low-dose computerized tomography without oral contrast is the imaging modality of

choice if the ultrasonography is normal in patients with suspected appendicitis (Gorter, 2016).

Ultrasonography of the abdomen is the initial imaging modality of choice to diagnose acute appendicitis. The appearance of the inflamed appendix and the presence of free fluid in the right iliac fossa can be demonstrated. The presence of appendicolith, especially in pediatric patients, can also be demonstrated (B, 2016; Tong, 2023). A meta-analysis on the diagnostic ability of bedside ultrasonography in the diagnosis of acute appendicitis was conducted by Shen et al. A total of 27 studies with 7403 patients were included in this study. The sensitivity and specificity of ultrasonography was 90%(95%CI,82%-95%) and 95%(95%CI,98%-98%). The positive likelihood and negative likelihood ratios were 17.7(95%CI,8.3-37.7) and 0.11(95%CI,0.06-019) (Shen, 2019). A meta-analysis on the diagnostic ability of ultrasonography in the diagnosis of acute appendicitis was conducted by Yu et al. A total of 22 studies with 2643 patients were included in this study, and the sensitivity and specificity of ultrasonography in the diagnosis of acute appendicitis were 86.7%(95%CI,85.4-88) and 90%(95%CI,88.9-91.2), respectively (Yu S. H., 2005). A systematic review and meta-analysis on the accuracy of point-of-care ultrasound in the diagnosis of acute appendicitis was conducted by Fields et al. A total of 21 studies with 6636 patients were included in this study. The sensitivity and specificity of point-of-care ultrasound was 91%(95%C.I.83%-96%) and 97% (95% C.I.91%-99%). The positive and negative predictive values were 91% and 94%, respectively (Matthew Fields, 2017).

Computerized tomography (CT) is the next imaging modality performed for patients with suspected appendicitis, typically using intravenous or oral contrast. It can also be performed without the use of contrast. Computerized tomography has a high sensitivity and specificity, and it can detect inflammation of the appendix. The presence of an appendicolith and inflammatory changes over the cecum. It can also detect complications like perforation, abscess, and mass formation (Pinto Leite, 2005). A Cochrane review on computerized tomography in acute appendicitis was conducted by Rud et al. A total of 68 studies with 10,280 patients were included in this study, and the sensitivity and specificity of computerized tomography in the diagnosis of acute appendicitis were 0.95(95%CI,0.93-0.96) and 0.94(95%CI,0.92-0.95). The probability of acute appendicitis following a positive computerized tomography was 0.92(95%CI,0.90-0.94), and the probability of appendicitis following a negative computerized tomography was 0.04(95%CI,0.03-0.05) (Rud, 2019). A meta-analysis on the impact of computerized tomography on the diagnosis of acute appendicitis was conducted by Krajewski et al. A total of 28 studies with 9330 patients were included in this study, and the negative appendectomy rate 8.7% with Computerized tomography against 16.7% without its use (Krajewski, 2011).

A meta-analysis comparing low-dose and standard dose computerized tomography in the diagnosis of acute appendicitis was conducted by Yun et al. A total of 9 studies with 2957 patients were included in this study, and the sensitivity and specificity of low-dose computerized tomography were 96.25%(95%CI,91.88%-98.31%) and 93.22%(95%CI,88.75%-96%), while the sensitivity and specificity for standard dose computerized tomography were 96.40% (95%CI,93.55%-98.02%) and 92.17%(95%CI,88.24%-94.86%). This study showed that there were no significant differences between low-dose and standard-dose computerized tomography in the diagnosis of acute appendicitis (Yun, 2017). A systematic review and meta-analysis on the diagnostic accuracy of non-contrasted computerized tomography in the diagnosis of acute appendicitis was conducted by Oh et al. A total of 11 studies with 1996 patients were included in this study, and the sensitivity and specificity of non-contrasted computerized tomography were 0.93(95%CI,0.91-0.95) and 0.97(95%CI,0.95-0.97), respectively (SK., 2025).

Magnetic resonance imaging has slowly been gaining popularity in the diagnosis of acute appendicitis. It has a sensitivity and specificity that are like computerized tomography, and it has the advantage of no ionizing radiation usage. It can be used for pediatric and pregnant patients, but it has the disadvantage of being costly, time-consuming, and requiring special training to report the images (Mervak, MRI of acute appendicitis. Journal of magnetic resonance imaging , 2019).A systematic review and meta-analysis on the diagnostic ability of magnetic resonance imaging (MRI) for the diagnosis of acute appendicitis was conducted by Duke et al. A total of 30 studies with 2665 patients were included in this study, and the sensitivity and specificity of magnetic resonance imaging were 96%(95%CI,95%-97%) and 96%(95%CI,95%-97%), respectively (Duke, 2016).

A meta-analysis on the diagnostic performance of magnetic resonance imaging (MRI) in acute appendicitis was conducted by Barger et al. A total of 8 studies with 363 patients were included in this study, and the sensitivity and specificity of magnetic resonance imaging were 97%(95%CI-92%-99%) and 95%(95%CI,94%-99%), respectively (Barger, 2010). A Cochrane review on magnetic resonance imaging(MRI) in the diagnosis of acute appendicitis was conducted by D'Souza et al. A total of 58 studies with 7462 patients were included in this study, and the sensitivity and specificity of magnetic resonance imaging in the diagnosis of acute appendicitis were 0.95(95%CI,0.94-0.97) and 0.96(95%CI,0.95-0.97), respectively (D'Souza, 2021).

Study	Study Type	Year	Imaging Modality	Sensitivity (%)	Specificity (%)
Yu S.H.	Systematic review & meta-analysis	2025	Ultrasonography	86.7%	90%
Krajewski	Systematic review & meta-analysis	2011	Ultrasonography	88%	94%
			Computerized Tomography	96%	95%
Barger	Meta-analysis	2010	Ultrasonography	85%	92%
			Computerized Tomography	97%	96%
Fields	Systematic review & meta-analysis	2017	Ultrasonography	57%	95%
			Computerized Tomography	96%	97%
Duke	Systematic review & meta-analysis	2016	Ultrasonography	92%	94%
			Computerized Tomography	98%	99%
			Magnetic Resonance Imaging	96%	98%
Rud	Cochrane review	2019	Computerized Tomography	95%	94%
Shen	Meta-analysis	2019	Ultrasonography	82%	88%
			Computerized Tomography	96%	96%
			Magnetic Resonance Imaging	95%	97%
D'Souza	Cochrane review	2021	Magnetic Resonance Imaging	97%	98%

Table showing the sensitivity and specificity of ultrasonography, computerized tomography, and magnetic resonance imaging in the diagnosis of acute appendicitis.

Conclusion

Acute appendicitis is a common condition encountered by general surgeons. Although its incidence in Western countries has stabilized, it has been gradually increasing in most developing countries in Asia and the Middle East. The diagnosis of acute appendicitis involves the use of clinical examination with inflammatory markers like full blood count and C.Reactive Protein. Imaging modalities like ultrasound are the first imaging modalities that are performed, due to their availability, reduced cost, and absence of radiation. Computerized tomography is performed for patients who have equivocal features on ultrasound, and the diagnosis of acute appendicitis is not ruled out. Magnetic resonance imaging is a new imaging modality that has been introduced to diagnose acute appendicitis in pediatric and pregnant patients. Conflict of interest-There is no conflict of interest.

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