E-ISSN: 2616-3470
P-ISSN: 2616-3462

www.surgeryscience.com
2025; 9(1): 75-79
Received: 12-11-2024
Accepted: 17-12-2024

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Correlation study between anatomical site of inflamed appendix and clinical presentation

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DOI: https://doi.org/10.33545/surgery.2025.v9.i1.B.1142

Abstract
Background: The appendix is considered the most variable abdominal organ due to its multiple possible configurations. There is significant controversy surrounding the relationship between the anatomical positions of the appendix and the clinical presentations of appendicitis.
Aim of study: This study aimed to investigate the correlation between the anatomical site of the inflamed appendix and its clinical presentations.
Methods: A prospective observational study was conducted at the Department of General Surgery, Al-Yarmouk Teaching Hospital, Baghdad, over six months (July 1, 2020 - January 1, 2021). The study included 100 patients presenting with signs and symptoms of acute appendicitis at the outpatient clinic or emergency department. During surgery, the position of the appendix was identified prior to manipulating surrounding structures. The removed appendices were then sent for histopathological examination.
Results: The most common anatomical position of the appendix in this study was retrocecal (49%), followed by subserosal (21%). All patients with subserosal or post ileal appendix presented with diarrhea. Constipation was observed in 47.6% of patients with subserosal appendix, while anorexia was present in all patients with pelvic, pre ileal, and post ileal appendices. Shifting pain occurred in 85.7% of patients with subserosal appendix. Obturator sign was observed in 60% of patients with post ileal appendix.
Conclusion: Accurate diagnosis of appendicitis and the anatomical position of the appendix relies on a combination of clinical features, investigations, ultrasonography, and intraoperative findings rather than clinical presentations alone.

Keywords: Iraq, Appendicitis, clinical feature, anatomical site

Introduction
Acute Appendicitis (AA) is a common and urgent surgical condition characterized by inflammation of the vermiform appendix, typically presenting as an acute illness but occasionally manifesting as a chronic condition. Appendicitis primarily affects individuals aged 5 to 45 years, with a mean age of 28 years and a lifetime incidence of 8%. Males are slightly more predisposed than females, with rates of 8.6% and 6.7%, respectively. Annually, approximately 300,000 hospital visits in the USA result in appendectomy, with a median age of 22 years [1]. The incidence varies geographically, being higher in Western countries such as the USA (233/100,000) and UK (52/100,000) and lower in regions like South Africa (less than 9/100,000). Dietary habits, particularly low fiber intake, are suggested to contribute to regional differences in incidence [2, 3]. The pathogenesis of AA is multifactorial, involving mechanical, infectious, and genetic factors. Luminal obstruction by fecaliths, lymphoid hyperplasia, foreign bodies, or parasites leads to increased mucus secretion, luminal distension, and subsequent vascular compromise, resulting in inflammation and potential perforation [4, 5]. AA classically presents with symptoms such as poorly localized periumbilical pain that migrates to the right lower quadrant (RLQ), anorexia, nausea, vomiting, and, less commonly, diarrhea. Variations in clinical features are influenced by the appendix's anatomical position, complicating diagnosis [6]. Diagnosis of AA often relies on clinical evaluation, supported by laboratory tests and imaging modalities. While elevated white blood cell count and C-reactive protein (CRP) levels may suggest inflammation, these are not specific. Imaging, including ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI), is crucial in confirming the diagnosis, especially in atypical presentations [7, 8]. Scoring systems, such as the Alvarado score, are used to aid diagnosis and reduce negative appendectomy rates [9, 10].

Complications of untreated or delayed appendicitis include perforation, abscess formation, and systemic infections, which significantly increase morbidity and mortality. Prompt surgical intervention or antibiotics has dramatically improved outcomes, reducing mortality to near zero in uncomplicated cases. However, delayed diagnosis or treatment can lead to prolonged recovery or death, particularly in cases of rupture [11, 12]. Aim of study to investigate the correlation between the anatomical site of inflamed appendix and its clinical presentations.

Methods

This prospective observational study was conducted in the Department of General Surgery at Al-Yarmouk Teaching Hospital, Baghdad, over six months, from July 1, 2020, to January 1, 2021. The study included 100 patients presenting with signs and symptoms suggestive of acute appendicitis, such as lower abdominal or right iliac fossa pain.

Inclusion and Exclusion Criteria

Patients aged 12 years or older with a clinical diagnosis of acute appendicitis were included. Diagnosis was based on clinical history, physical examination, and laboratory investigations. The Alvarado score was calculated to stratify patients into low, moderate, or high-risk categories, aiding in diagnosis. Patients with a score of 5 or more were considered for inclusion. Patients younger than 12 years or those whose diagnosis was not confirmed by histopathology were excluded.

Data Collection Tools

A structured questionnaire was used to collect demographic and clinical data, including age, gender, symptoms, examination findings, and investigation results such as complete blood count, renal function tests, and urinalysis. The questionnaire also recorded the appendix position observed during surgery.

Procedure

Open appendectomy was performed under general anesthesia via a single incision in the right lower abdomen. The appendix's position was identified during surgery, and the inflamed appendix was removed and sent for histopathological confirmation.

Ethical Considerations

Verbal consent was obtained from all participants before data collection, ensuring confidentiality by anonymizing patient data and storing it on a secure, password-protected device. Administrative approvals were obtained from the Council of Iraqi Board of Medical Specialization and the Department of General Surgery at Al-Yarmouk Teaching Hospital.

Statistical Analysis: Data were analyzed using SPSS version 25. Descriptive statistics were presented as means, standard deviations, ranges, frequencies, and percentages. Chi-square tests assessed the association between provisional diagnosis and specific parameters, with significance set at $p<0.05$.

Results

The distribution of study patients by age and gender and Anatomical Site is shown in Table 1. Study patients' age was ranging from 12-42 years with a mean of 23.28 years and a standard deviation (SD) of±7 years. The highest proportion of study patients was aged between 20-29 years (40%). Regarding gender, proportion of males was equal females (50% versus 50%) with a male to female ratio of 1:1. The distribution of study patients by anatomical site of appendix. We noticed that the highest proportion of study patients was presented with retrocecal site of appendix (49%) followed by subserosal site (21%).

Table 1: The distribution of study patients by age and gender and anatomical site

Attribute	Group	Percentage
Age Group (Years)	< 20	38%
	20-29	40%
	≥ 30	22%
Gender	Male	50%
	Female	50%
Anatomical Site	Retrocecal	49%
	Subserosal	21%
	Pelvic	12%
	Post ileal	10%
	Pre ileal	8%

Table 2 shows the distribution of study patients by signs and symptoms. In this study, the most common sign was tenderness as all the patients complained from tenderness. Also, nausea and rebound tenderness were very common (98% of study patients). The least common were constipation and diarrhea (26% and 20% respectively).

Table 2: Distribution of study patients by signs and symptoms

Sign and symptom	No (N=100)	Percentage (%)
Tenderness	100	100.0
Rebound tenderness	98	98.0
Nausea	98	98.0
Anorexia	88	88.0
Shifting pain	70	70.0
Vomiting	60	60.0
Psoas Sign	44	44.0
Obturator sign	34	34.0
Constipation	26	26.0
Diarrhea	20	20.0

Table 3: Distribution of anatomical site of appendix by signs and symptoms

Site and Sign / symptom	Retrocecal (%), N=49	Subserosal (%), N=21	Pelvic (%), N=12	Post ileal (%), N=10	Pre ileal (%), N=8
Tenderness	49 (100.0)	21 (100.0)	12 (100.0)	10 (100.0)	8 (100.0)
Rebound T.	49 (100.0)	21 (100.0)	10 (83.3)	10 (100.0)	8 (100.0)
Nausea	47 (95.9)	21 (100.0)	12 (100.0)	10 (100.0)	8 (100.0)
Anorexia	43 (87.8)	15 (71.4)	12 (100.0)	10 (100.0)	8 (100.0)
Shifting pain	38 (77.6)	18 (85.7)	6 (50.0)	4 (40.0)	6 (75.0)
Vomiting	28 (57.1)	16 (76.2)	6 (50.0)	4 (40.0)	6 (75.0)
Psoas Sign	22 (44.9)	12 (57.1)	2 (16.7)	6 (60.0)	2 (25.0)
Obturator sign	16 (32.7)	10 (47.6)	0 (0)	6 (60.0)	2 (25.0)
Constipation	12 (24.5)	10 (47.6)	0 (0)	2 (20.0)	2 (25.0)
Diarrhea	6 (12.2)	0 (0)	10 (83.3)	0 (0)	4 (50.0)

The distribution of anatomical site of appendix by signs and symptoms is shown in Table 3. All patients with retrocecal appendix had tenderness and rebound tenderness and 95.9% were presented with nausea. In subserosal appendix, all patients had tenderness, rebound tenderness and nausea; while 85% of them had shifting pain. In pelvic appendix, all patients had tenderness, nausea and anorexia; while rebound tenderness and diarrhea were presented in 83.3% of them. In pre and post ileal appendix, all patients had tenderness, rebound tenderness, nausea and anorexia.

In Table 4, we noticed that there was no statistical significant association (P=0.251) between anatomical site of appendix and vomiting.

Table 4: Association between anatomical site of appendix and vomiting

Anatomical site of appendix	Vomiting		Total (%) N=100	P-Value
	Yes (%), N=60	No (%), N=40		
Retrocecal	28 (57.1)	21 (42.9)	49 (49.0)	0.251
Subserosal	16 (76.2)	5 (23.8)	21 (21.0)	
Pelvic	6 (50.0)	6 (50.0)	12 (12.0)	
Post ileal	4 (40.0)	6 (60.0)	10 (10.0)	
Pre ileal	6 (75.0)	2 (25.0)	8 (8.0)	

As shown in Table 5, 83.3% of patients with pelvic appendix were complained from diarrhea while all patients with subserosal or post ileal appendix had diarrhea with a significant association between anatomical site of appendix and diarrhea.

Table 5: Association between anatomical site of appendix and diarrhea

Anatomical site of appendix	Diarrhea		Total (%), N=100	P-Value
	Yes (%), N=20	No (%), N=80		
Retrocecal	6 (12.2)	43 (87.8)	49 (49.0)	0.001
Subserosal	0 (0)	21 (100.0)	21 (21.0)	
Pelvic	10 (83.3)	2 (16.7)	12 (12.0)	
Post ileal	0 (0)	10 (100.0)	10 (10.0)	
Pre ileal	4 (50.0)	4 (50.0)	8 (8.0)	

In this study, 47.6% of patients with subserosal appendix had constipation; while no patients with subserosal appendix had constipation and this association was significant (P=0.048) as shown in Table 6.

Table 6: Association between anatomical site of appendix and constipation

Anatomical site of appendix	Constipation		Total (%), N=100	P-Value
	Yes (%), N=26	No (%), N=74		
Retrocecal	12 (24.5)	37 (75.5)	49 (49.0)	0.048
Subserosal	10 (47.6)	11 (52.4)	21 (21.0)	
Pelvic	0 (0)	12 (100.0)	12 (12.0)	
Post ileal	2 (20.0)	8 (80.0)	10 (10.0)	
Pre ileal	2 (25.0)	6 (75.0)	8 (8.0)	

Anorexia was presented in all patients with pelvic, pre and post ileal appendix and in 71.4% of subserosal appendix and this association was significant (P=0.049) as in Table 7.

Table 7: Association between anatomical site of appendix and anorexia

Anatomical site of appendix	Anorexia		Total (%), N=100	P-Value
	Yes (%), N=88	No (%), N=12		
Retrocecal	43 (87.8)	6 (12.2)	49 (49.0)	0.049
Subserosal	15 (71.4)	6 (28.6)	21 (21.0)	
Pelvic	12 (100.0)	0 (0)	12 (12.0)	
Post ileal	10 (100.0)	0 (0)	10 (10.0)	
Pre ileal	8 (100.0)	0 (0)	8 (8.0)	

In this study, 85.7% of patients with subserosal appendix had shifting pain; while 40% of patients with post ileal appendix had shifting pain and this association was significant (P=0.03) as shown in Table 8.

Table 8: Association between anatomical site of appendix and shifting pain

Anatomical site of appendix	Shifting pain		Total (%), N=100	P-Value
	Yes (%), N=72	No (%), N=28		
Retrocecal	38 (77.6)	11 (22.4)	49 (49.0)	0.03
Subserosal	18 (85.7)	3 (14.3)	21 (21.0)	
Pelvic	6 (50.0)	6 (50.0)	12 (12.0)	
Post ileal	4 (40.0)	6 (60.0)	10 (10.0)	
Pre ileal	6 (75.0)	2 (25.0)	8 (8.0)	

In Table 9, we noticed that there was no statistical significant association (P=0.119) between anatomical site of appendix and psoas sign.

Table 9: Association between anatomical site of appendix and Psoas sign

Anatomical site of appendix	Psoas sign		Total (%), N=100	P-Value
	Yes (%), N=44	No (%), N=56		
Retrocecal	22 (44.9)	27 (55.1)	49 (49.0)	0.119
Subserosal	12 (57.1)	9 (42.9)	21 (21.0)	
Pelvic	2 (16.7)	10 (83.3)	12 (12.0)	
Post ileal	6 (60.0)	4 (40.0)	10 (10.0)	
Pre ileal	2 (25.0)	6 (75.0)	8 (8.0)	

Obturator sign was presented in 60% of patients with post ileal appendix with a significant association between anatomical site of appendix and obturator sign (P=0.024) as in Table 10.

Table 10: Association between anatomical site of appendix and obturator sign

Anatomical site of appendix	Obturator sign		Total (%), N=100	P-Value
	Yes (%), N=34	No (%), N=66		
Retrocecal	16 (32.7)	33 (67.3)	49 (49.0)	0.024
Subserosal	10 (47.6)	11 (52.4)	21 (21.0)	
Pelvic	0 (0)	12 (100.0)	12 (12.0)	
Post ileal	6 (60.0)	4 (40.0)	10 (10.0)	
Pre ileal	2 (25.0)	6 (75.0)	8 (8.0)	

Discussion

This study's findings align with several studies conducted locally and internationally, though differences in results are noted due to variations in sample sizes and methodologies. In Iraq, a 2016 study reported an average age of 47.16±12.15 years [4], similar to another study in Northern Iraq published in 2009, which found a mean age of 47.4±11 years [5]. A higher average age was observed in a 2015 USA study, reporting a mean age of 59±13.07 years [6]. The current study found the highest proportion of patients (46.5%) in the ≥ 50 years' age group, consistent with the 2015 USA study, where 28.5% of cases were observed in patients aged 50-60 years [6]. In contrast, the 2016 Iraq study reported that 68.2% of patients were below 50 years [4]. A 2001 study in southern Sweden indicated a statistically significant trend toward mutation-positive cases in younger age groups (P=0.0027) [13]. Marital status also influences outcomes. A 2017 California study found that 42.7% of 145,564 cases were unmarried at diagnosis and reported higher mortality among unmarried patients compared to married ones, with variations by ethnicity and tumor subtype [14]. Similarly, a 2015 USA study concluded that single patients had increased mortality (P=0.006) compared to married patients, with no significant difference between married and divorced/separated/widowed patients (P=0.468) [5]. These findings differ from the current study, likely due to the larger sample sizes in the USA studies. Smoking and alcohol consumption have been explored in several studies. A 2000 USA study indicated an elevated risk for women who began smoking between ages 10 and 14 [15]. In contrast, a 2009 study concluded there was no increased risk with current smoking, though past smoking posed a potential risk [16]. Similarly, a 2004 study found no association between lifetime smoking and increased risk [17]. Regarding alcohol, a 2007 USA study found that moderate or high alcohol intake was associated with a 30-50% increased breast cancer risk compared to non-drinkers [18]. Conversely, a 2010 Canadian study reported no increased risk with alcohol among women with BRCA1 or BRCA2 mutations and suggested wine consumption might modestly reduce risk [19]. A 2001 USA study also observed that increased alcohol frequency might raise risk only in women with a family history [20]. Family history plays a critical role in risk assessment. A 2012 USA study showed 81.8% of patients had no family history [21]. Similarly, a 2014 nationwide cohort study found that only 13% of women diagnosed had a first-degree female relative, but those with such a history had nearly double the risk compared to those without [22]. A 2001 study reported that 26% of patients with one or more first-degree relatives were BRCA1 or BRCA2 mutation carriers, compared to 3.9% of patients without this history (p<0.001) [13]. In summary, the study findings align with several previous studies while highlighting differences influenced by sample size and population characteristics. Factors such as age, marital status, smoking, alcohol consumption, and family history significantly impact outcomes, reinforcing the complexity of assessing risks and outcomes in diverse populations.

Conclusion

The accurate diagnosis of position of appendix & appendicitis is a combination of multiple modalities rather than clinical features (investigation, ultrasonography, and intraoperative findings).

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How to Cite This Article
Madęeh MW, Khateeb MAL. Correlation study between anatomical site of inflamed appendix and clinical presentation. International Journal of Surgery Science. 2025;9(1):75-79.