Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/19290
DOI URL: http://dx.doi.org/10.21474/IJAR01/19290

RESEARCH ARTICLE

ROLE OF CRP, WBC COUNT AND USG ABDOMEN IN THE DIAGNOSIS AND EVALUATING THE SEVERITY OF ACUTE APPENDICITIS

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Manuscript Info

Manuscript History
Received: 15 June 2024
Final Accepted: 17 July 2024
Published: August 2024

Abstract

Introduction: Modern imaging and lab testing may not always provide a definitive diagnosis for the most common cause of "acute abdomen" in young adults: acute appendicitis. In an effort to decrease needless appendectomies and enhance results, this study matches histology, CRP, leukocyte count, neutrophil count, and ultrasonography to determine the best reliable diagnostic test.

Methods: In a study of 50 acute appendicitis patients scheduled for appendectomy, TLC, differential count (neutrophil count), CRP, and USG abdomen were evaluated for diagnostic accuracy alongside histopathology. Statistical analysis included descriptive and inferential methods, with continuous data as Mean ± SD and categorical data in percentages, assessing significance at 5%.

Result:92% of the 50 patients who had acute appendicitis had pain that moved from the periumbilical area to the right iliac fossa; most of these patients were between the ages of eleven and twenty. It was more usual for men to have acute appendicitis (76 %). Higher leukocyte counts (52 %), neutrophil counts (48 %), and CRP levels (62 %) were seen in the laboratory high sensitivity (95.56%) and low specificity (20.00%) of ultrasound, indicating a good but sometimes false-positive detection rate of appendicitis. High PPV (100%) and specificity (100%) were exhibited by Total Leukocyte Count, but low accuracy (57.78%) and sensitivity were noted (62.00 %). Low NPV (15.38 %) and accuracy were observed in Neutrophil Count, despite moderate sensitivity (51.11 %) and high PPV (95.83 %) (54.00 %). With a high PPV (96.77%), moderate accuracy, and balanced sensitivity (66.67 %) and specificity (80.00 %), CRP was provided (68.00 %). 90 % of cases had histopathology confirm that they had acute appendicitis.

Conclusion: The study assesses diagnostic procedures for acute appendicitis in individuals experiencing pain in the right iliac fossa. TLC exhibits excellent specificity (100%) but poor accuracy and

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sensitivity (57.78%). (62 %). The sensitivity and accuracy of CRP and neutrophil counts are moderate. USG has a low specificity (0.05%) but a high sensitivity (95.56%). (20 %). Reducing negative appendectomies and improving diagnostic accuracy are achieved by combining TLC, neutrophil count, CRP, and USG.

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Introduction:-

Acute appendicitis is the most common cause of an 'acute abdomen' in young adults[1]. Despite advancements in modern radiographic imaging and diagnostic laboratory investigations, the diagnosis of appendicitis remains essentially clinical, requiring a mixture of observation, clinical acumen, and surgical science. In an age accustomed to early and accurate preoperative diagnosis, acute appendicitis remains an enigmatic challenge and a reminder of the art of surgical diagnosis. It is one of the most common causes of an abdominal emergency, with protean manifestations that may simulate almost any other acute abdominal condition and may be mimicked by a variety of conditions[2].

The accuracy of clinical diagnosis of acute appendicitis is estimated to lie between 76% and 92%[3]. Appendicectomy for suspected acute appendicitis is a common procedure, but the rate of normal appendices unnecessarily being removed remains high (15%-30%) despite several techniques[4]. A normal appendix at appendicectomy represents a misdiagnosis, while a delayed diagnosis of appendicitis may lead to perforation and peritonitis. Perforation may occur in up to 35% of cases, so traditionally, surgeons have accepted a higher incidence of unnecessary appendectomies to decrease the incidence of perforation[5]. This approach is increasingly questioned in today's era of evidence-based medicine. The high rate of negative explorations for appendicitis is a burden faced not only by the general surgeon but also by the patient and society, since appendicectomy results in socioeconomic impacts such as hospital expenses, lost working days, and declined productivity[6].

The goal of surgical treatment is to remove an inflamed appendix before perforation with a minimal number of negative appendectomies. The question, "Does this patient have appendicitis?" is crucial for several reasons: appendicitis is one of the most common causes of abdominal pain. Western literature reports that 6% of the population has a risk of suffering from appendicitis during their lifetime[7]. Although the overall mortality from appendicitis has dropped from about 26% to less than 1% with the advent of antibiotics and early surgical intervention, it is approximately 5% to 15% in the elderly. The morbidity due to appendicular perforation ranges from 17% to 40%, with higher rates in the elderly and children[8]. Failure to make an early diagnosis can convert acute appendicitis to perforated appendicitis, a disease with potential complications including intra-abdominal abscesses, wound infection, and death[9]. The negative laparotomy rate ranges from 15% to 35% and is associated with significant morbidity[4]. This rate is significantly higher in young women (up to 45%) due to the prevalence of pelvic inflammatory disease (PID) and other common obstetrical and gynecological disorders[10].

In conclusion, acute appendicitis may simulate many other acute abdominal conditions, and despite intensive clinical research and discussion, the diagnosis remains a challenge. Accurate diagnosis is crucial for proper management. This study aims to compare several known and proven investigations for appendicitis, such as CRP, leukocyte count, neutrophil count, and ultrasonography. By comparing the specificity, sensitivity, and positive predictive value of each test with histopathological examination (HPE) reports, we aim to determine which test is the most accurate and sensitive for diagnosing appendicitis. This will improve diagnosis and decision-making, thereby reducing negative and unnecessary appendectomies. We also aim to determine whether normal CRP, TLC count, and USG can exclude the presence of acute appendicitis.

Aim Of The Study:-

To evaluate the accuracy of C- reactive protein, total leukocyte count, neutrophil count and ultrasonography in the diagnosis of acute appendicitis.

Objectives Of The Study:-

1. To find out the specificity, sensitivity, predictive value of positive test and predictive value of negative test of CRP, total leukocyte count, neutrophil count and USG in diagnosing acute appendicitis.

2. To correlate HPE report with the blood investigations reports (CRP, total leukocyte count, neutrophil count) and USG in clinically diagnosed cases of acute appendicitis.
3. To interpret the efficacy to improve the diagnosis and decision making of acute appendicitis and hence reduce negative appendicectomies with the help of these investigations.

Materials And Methods:-

Source of Data

Patients who have been clinically diagnosed of having acute appendicitis and posted for emergency appendicectomy in General Surgery department ,Hospital based study.

Method of collecting Data:

Sampling Procedure

Simple random sampling technique will be used to select the sample for the study.

Study design:

An observational clinical study.

Sample Size:

50 cases of clinically diagnosed acute appendicitis.

Inclusion criteria

All patients diagnosed clinically to have acute appendicitis and subjected for appendicectomy.

Exclusion criteria

1. Patients who are managed conservatively are excluded from the study.
2. Patients admitted for interval appendicectomy following recurrent appendicitis or appendicular mass previously treated conservatively, are also excluded.
3. Concomitant conditions where CRP/ leukocyte count/ neutrophil count is elevated in acute appendicitis patients with associated diseases like:

a. Rheumatoid arthritis.
b. Systemic lupus erythematosus.
c. Glomerular nephritis.
d. Gout.
e. Inflammatory bowel disease.
f. Any other conditions where CRP was raised.

Statistical Methods:[11-14]

The study uses descriptive and inferential statistics, with results for continuous data presented as Mean ± SD (MinMax) and categorical data as Number (%). Significance is assessed at 5% using Chi-square/Fisher Exact test for categorical variables. Assumptions include normal distribution of dependent variables and random, independent samples. Sensitivity, specificity, PPV, NPV, and accuracy are calculated to evaluate the diagnostic properties of CRP, total leukocyte count, neutrophil count, and ultrasound against HPE.

Results:-

Out of 50 patients who underwent operative procedure, 92% came with chief complaint of pain in the periumbilical region migrating to the right iliac fossa. Acute appendicitis was more commonly seen in male patients (38 patients).The majority of participants are aged 11-20 (52%), followed by 21-30 (26%). Older age groups (31-50) are less represented, indicating a younger participant base for the study. Increased leukocyte count was seen in 52%, neutrophil count in 48% cases and CRP in 62%. USG was suggestive of acute appendicitis in 94% of the cases. Among clinical symptoms, abdominal pain was present in all patients (100%), anorexia in 36 (72%) patients, migration of the pain in right iliac fossa 46(92%), vomiting in 38(76%), fever in 31(62%) patients.

The most common per operative finding was acutely inflamed appendix (66%) followed by gangrenous appendix (22%), normal appendix (10%) and perforated appendix (2%). All the appendicectomy specimens were sent for HPE examination.

However, histopathological diagnosis was acute appendicitis in 90% and normal histology was seen in 10% cases. Correlation of the TLC, neutrophil count, CRP and ultrasonography with histopathological reporting was done.

- **Ultrasound**: High sensitivity (95.56%) but low specificity (20.00%), indicating it detects appendicitis well but has many false positives.
- **Total Leukocyte Count**: High specificity (100%) and PPV (100%) but low sensitivity (57.78%) and accuracy (62.00%).
- **Neutrophil Count**: Moderate sensitivity (51.11%) and specificity (80.00%), with high PPV (95.83%) but low NPV (15.38%).
- **CRP**: Balanced sensitivity (66.67%) and specificity (80.00%), with high PPV (96.77%) and moderate accuracy (68.00%).
- **Overall**: Ultrasound is best for detecting appendicitis, while CRP provides a good balance of sensitivity and specificity.

Table 1:- Distribution of study participants based on age.

AGE	FREQUENCY	PERCENT (%)
1-10	02	04.0
11-20	26	52.0
21-30	13	26.0
31-40	08	16.0
41-50	01	02.0
Total	50	100

Mean ± SD: 21.76±9.059

Table 2:- Distribution of study participants based on sex.

SEX	FREQUENCY	PERCENT
FEMALE	12	24
MALE	38	76
TOTAL	50	100

Table 3:- Clinical symptoms according to gender.

	FEMALE n(%) n = 12	MALE n(%) n= 38	TOTAL
ABDOMINAL PAIN	12(24)	38(76)	50(100)
MIGRATING	10(20)	36(72)	46(92)
ANOREXIA	7(14)	29(58)	36(72)
VOMITING	9(18)	29(58)	38(76)
FEVER	08(16)	23(46)	31(62)

Table 4:- Clinical signs and blood investigations according to gender.

	FEMALE n(%)	MALE n(%)	TOTAL n(%)
RIF TENDERNESS	12(24)	37(74)	49(98)
REBOUND TENDERNESS	07(14)	25(50)	32(64)
GUARDING	06(12)	19(38)	25(50)
TACHYCARDIA	05(10)	23(46)	28(56)
ROVSING SIGN	05(10)	23(46)	28(56)
TLC	06(12)	20(40)	26(52)
NEUTROPHIL	05(10)	19(38)	24(48)

CRP	10(20)	21(42)	31(62)

Table 5:- Ultrasound abdomen and pelvis according to gender.

	FREQUENCY		TOTAL
	FEMALE n(%)	MALE n(%)	
Acute appendicitis (AA)	11(22%)	36(72%)	47(94%)
Normal appendix (NA)	01(02%)	02(04%)	3(6.0%)
TOTAL	12(24%)	38(76%)	50(100%)

Table 6:- Intra Operative Findings of Appendix.

	FREQUENCY	PERCENT
Normal appendix (NA)	05	10.0
Inflamed and thickened (IA)	33	66.0
Perforated appendix	01	2.0
Gangrenous appendix	11	22.0
Total	50	100.0

Table 7:- Correlation of ultrasound abdomen and pelvis and histopathological examination report.

USG	**HISTOPATHOLOGICAL EXAMINATION REPORT**		**TOTAL n(%)**
	ACUTE APPENDICITIS n(%)	**NORMAL APPENDIX n(%)**	
ACUTE APPENDICITIS	43(86)	04(08)	47(94)
NORMAL APPENDIX	02(04)	01(02)	3(06)
TOTAL	45(90)	05(10)	50(100)

Fisher exact test, P= 0.276,Sensitivity= 95.56%,Specificity= 20.00 %,PPV= 91.49%,NPV= 33.33 % and Accuracy= 88.00%

Table 8:- Correlation of total leukocyte count and histopathological examination report.

TLC	**HISTOPATHOLOGICAL EXAMINATION REPORT**		**TOTAL n(%)**
	ACUTE APPENDICITIS n(%)	**NORMAL n(%)**	
POSITIVE	26(52)	0(0)	26(52)
NEGATIVE	19(38)	05(10)	24(48)
TOTAL	45(90)	05(10)	50(100)

Fisher exact test, P= 0.20,Sensitivity= 57.78%,Specificity= 100%,PPV=100%,NPV= 20.83% and Accuracy= 62.00%

Table 9:- Correlation of neutrophil count and histopathological examination report.

NEUTROPHIL COUNT	**HISTOPATHOLOGICAL EXAMINATION REPORT**		**TOTAL n(%)**
	ACUTE APPENDICITIS n(%)	**NORMAL n(%)**	
POSITIVE	23(46)	01(02)	24(48)

NEGATIVE	22(44)	04(08)	26(52)
TOTAL	45(90)	05(10)	50(100)

Fisher exact test, P= 0.20,Sensitivity= 51.11%,Specificity= 80.00%,PPV= 95.83%,NPV= 15.38% and Accuracy= 54.00%

Table 10:- Correlation of CRP and histopathological examination report.

CRP	**HISTOPATHOLOGICAL EXAMINATION REPORT**		**TOTAL n(%)**
	ACUTE APPENDICITIS n(%)	**NORMAL n(%)**	
POSITIVE	30(60)	01(02)	31(62)
NEGATIVE	15(30)	04(08)	19(38)
TOTAL	45(90)	05(10)	50(100)

Fisher exact test, P= 0.062,**Sensitivity=** 66.67%,**Specificity=** 80.00%,**PPV= 96.77%**,**NPV= 21.05%** and **Accuracy=** 68.00%

Discussion:-

In the study of 50 patients with acute appendicitis, 38 (76%) were male and 12 (24%) were female, indicating a male predominance. The condition was most common in the 11-20 year age group for both genders. Clinical diagnosis was accurate in 45 (90%) cases, resulting in a negative appendectomy rate of 10%. All patients (100%) experienced abdominal pain, 36 (72%) had anorexia, 46 (92%) reported migration of pain, 38 (76%) had vomiting, and 31 (62%) experienced fever. Clinical signs included right iliac fossa tenderness in 49 patients (98%), rebound tenderness in 32 (64%), and guarding in 25 (50%), indicating severe inflammation. Rovsing's sign was present in 26 (52%) patients, and tachycardia in 28 (56%). The mean age of presentation was 21.76 years. Elevated leukocyte count was observed in 26 (52%) cases, increased neutrophil count in 24 (48%) cases, and elevated CRP in 31 (62%) cases. The most common intraoperative finding was an acutely inflamed appendix (33 cases, 66%), followed by gangrenous appendix (11 cases, 22%), normal appendix (5 cases, 10%), and perforated appendix (1 case, 2%). Histopathological diagnosis confirmed acute appendicitis in 45 (90%) patients, including 10 (20%) females and 35 (70%) males. Normal histology was observed in 5 (10%) cases, comprising 2 (4%) females and 3 (6%) males. Our study is compared with other studies as follows.

Total Leukocyte Count And Acute Appendicitis

The sensitivity, specificity, predictive value of positive test and predictive value of negative test of TLC in our study is 57.78%, 100%, 100%, 20.83% respectively and accuracy 62%.

Our results are in accordance with other studies as shown in the table.

Table 27:- Correlation of leukocyte count with acute appendicitis.

	Sensitivity	Specificity	Predictive value positive test	Predictive value in negative test
Shefkixharra et al[15]	79.1%	68%	93.6%	-
Haider Kamran et al[16]	76.5%	73.7%	92.5%	-
Nasir Ali et al [17]	74.4%	72.7%	90.6%	44.4%
Present study	57.78%	100%	100%	20.83%

Shefkixharra et al[15]the WBC, Neutrophil count and measurement of CRP were randomly collected preoperatively from all involved patients. The WBC was altered in 77.5%of the cases, Neutrophil count in 72.3% and CRP in 76.9% cases. In those with positive appendicitis, the CRP and WBC values were elevated in 126 patients (72.8), whereas neutrophil count was higher than 75% in 117 patients (67.6%). Out of 106 patients with triple positive tests, 101(95.2%) had appendicitis. The sensitivity, specificity and positive predictive values of the 3 tests in combination were 95.3%, 72.2% and 95.3% respectively.

Usg Abdomen And Acute Appendicitis

The sensitivity, specificity, positive predictive value of test and negative predictive value of test in our study is 95.56%, 20%, 91.49%, 33.33% and accuracy of 88%.

Table 28:- Comparison of role of USG abdomen in diagnosis of acute appendicitis with other studies.

	Sensitivity	Specificity	Predictive value of the positive test	Predictive value of negative test	Accuracy
Tauro L F et al[18]	91.37%	88.07%	91.37%	88.09%	90%
Lohani Bet al[19]	78.72%	60%	94.87%	23.07%	76%
Shirzad Nasir et al[20]	71.2%	83.3%	97.4%	25%	72.4%
Present study	95.56%	20%	91.49%	33.33%	88%

Tauro L F et al [18] the above observation shows that all the cases presented with pain in the right iliac fossa (RIF) and clinical suspicion of acute appendicitis which were the selection criteria for the present study. Tenderness in RIF was the most common sign elicited in all the cases (100%). Irrespective of the pathology, vomiting was found to be present in 91% of the cases. Murphy's triad of symptoms i;e pain in the abdomen, vomiting and fever held good in the diagnosis of acute appendicitis in their study.

A total of 58 cases were diagnosed to have appendicular pathology by USG and all these patients were operated upon. Out of the 58 operated cases, 53 were HPE positive and 5 were found to be negative on HPE. The overall specificity (88.09%) and sensitivity (91.37%) of USG in diagnosing appendicular pathology were high, indicating accurate diagnosis by USG in almost all patients with pain in RIF.

C-Reactive Protein And Acute Appendicitis

In our study, serum CRP estimation in diagnosis of acute appendicitis yielded a sensitivity of 66.67%, specificity of 80%, positive predictive value of 96.77%, negative predictive value of 21.05% and accuracy of 68%.

Table 29:- Comparision of role of CRP in diagnosis of acute appendicitis with other studies.

	Sensitivity	Specificity	Predictive value of positive test	Predictive value of negative test
Shefkixharra et al[15]	81.1%	72%	94.7%	
Pablo Ortega Debellon et al[21]	90.9%	74.3%	79.8%	74.3%
Present study	66.67%	80%	96.67%	21.05%

Pablo Ortega Deballon[21] C-reactive protein increased with the severity of appendicitis and predicted accurately perforation (r^2=0.613; P< 0.0005), showing the highest accuracy among inflammatory markers (areas under the ROC curve were 0.846,0.753 and 0.685 for C-reactive protein, leukocyte and granulocytes, respectively; P < 0.001). Accuracy improved when C-reactive protein and leukocytes were combined (positive and negative predictive values were 93.2 percent and 92.3 percent, respectively). Concluded that C-reactive protein is a helpful marker in the management of patients with right iliac fossa pain. It increases with the evolution of the inflammatory process. Its predictive values improve in combination with the leukocyte count. A patient with normal C-reactive protein and leukocytes has a very low probability of appendicitis and should not undergo surgery.

Conclusions:-

The study evaluates the diagnostic performance of various tests for acute appendicitis in patients with right iliac fossa pain. TLC shows high specificity and positive predictive value (100%) but low sensitivity (57.78%) and accuracy (62%). Neutrophil counts have moderate specificity (80%) and high positive predictive value (95.83%) but lower sensitivity (51.11%) and accuracy (54%). Serum CRP estimation demonstrates balanced sensitivity (66.67%) and specificity (80%), with high positive predictive value (96.77%) and accuracy (68%). Ultrasonography (USG) exhibits high sensitivity (95.56%) and accuracy (88%) but low specificity (20%). No single test is a definitive gold standard; however, combining TLC, neutrophil count, CRP blood tests, and USG optimizes diagnostic accuracy and

reduces negative appendectomies. These combined diagnostic approaches enhance the reliability of acute appendicitis diagnosis, guiding appropriate clinical decisions and improving patient outcomes.

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