

## Original Research Article

# Clinicopathological evaluation of acute appendicitis and the role of ultrasound in diagnosis: a prospective study

Tony Mathew<sup>1</sup>, Amit Shivshankar Ammanagi<sup>2\*</sup>

Department of Surgery, <sup>1</sup>Believers Church Medical College, Thiruvalla, Kerala, <sup>2</sup>JN Medical College, Belagavi, Karnataka, India

**Received:** 21 March 2019

**Accepted:** 17 April 2019

### \*Correspondence:

Dr. Amit Shivshankar Ammanagi,  
E-mail: [amit.ammanagi@gmail.com](mailto:amit.ammanagi@gmail.com)

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

## ABSTRACT

**Background:** Acute appendicitis is the most common acute surgical condition of the abdomen. Delay in treatment of acute appendicitis causes lot of complication. Study was done with the objective to study the clinical and pathological presentations of acute appendicitis, to evaluate the role of ultrasound in early diagnosis of acute appendicitis and to reduce negative appendectomy in patients.

**Methods:** This is a prospective study done on 100 patients with acute right lower abdominal pain clinically presumed to be of appendicular origin. A thorough history, clinical examination and ultrasound scan, was done for all cases. All ultrasound positive cases were subjected to surgery and some negative cases were also taken for surgery based on clinical suspicion. The ultrasound diagnosis was compared with clinical findings, operative findings and histopathological examination reports.

**Results:** The overall accuracy of clinical diagnosis (Alvarado scoring system) with histopathology findings was 72%. The overall sensitivity and specificity was 70.3% and 81.3% respectively and positive predictive value of was 95.2% whereas the negative predictive value was 34.2%. The overall accuracy of ultrasound with histopathology report was 93%, with a sensitivity of 96.4%, specificity of 75%, and a positive predictive value of 95% and a negative predictive value of 80%. Negative appendectomy rate was 8.82% in females and 3.63% in males.

**Conclusions:** The Alvarado scoring system combined with ultrasound can therefore be used as a cheap and inexpensive way of confirming acute appendicitis thus reducing negative appendectomy rate.

**Keywords:** Acute appendicitis, Alvarado scoring system, Ultrasound

## INTRODUCTION

Acute appendicitis is the most common surgical emergency with a prevalence rate of 1 in 7.<sup>1</sup> The risk of incidence is more in males compared to females (1.1:1).<sup>2</sup> Appendicitis is an inflammatory process which may result in perforation, abscess formation, generalised peritonitis, bowel obstruction and rarely death with a mortality rate of 0.08%, rising to 0.5% in the event of a perforated appendix.<sup>3</sup> The diagnosis of appendicitis in early stages still remains a challenge. It can be easily diagnosed in its classical form. Unfortunately, these classic symptoms may vary from person to person.<sup>4</sup>

Therefore an accurate and timely diagnosis of atypical appendicitis remains clinically challenging and is one of the most commonly missed problems in the emergency department.

Ultrasound is an important tool to diagnose acute appendicitis. The main advantages of ultrasound were it is non-invasive, cheap and easy to perform to diagnose the condition.<sup>5</sup> Scoring systems were also developed to aid the diagnosis by estimating the probability scores in individual patients. The best among them is Alvarado scale.<sup>6</sup> It comprises of 8 weighted clinical indicators - three symptoms, three signs and two laboratory findings;

migratory pain, anorexia, nausea and/or vomiting, right lower quadrant tenderness, rebound tenderness, pyrexia, leucocytosis ( $>10 \times 10^9/L$ ) and a neutrophilic shift to the left  $>75$ . The diagnostic accuracy of the Alvarado score has been reported as 90.9% for a score of 7-10 and 100% for a score of 0-4.

Objective of the current study was to assess the clinical and pathological evaluation of acute appendicitis, the role of ultrasound in early diagnosis of acute appendicitis and to reduce negative appendicectomy in patients.

## METHODS

This prospective study was done on patients with right lower abdominal pain, admitted in HSK Hospital Bagalkot, in whom acute appendicitis was suspected from January 2013 to June 2014. Patients of age group above 12 years with acute right lower abdominal pain clinically presumed to be of appendicular origin were included in the study. Patients less than 12 years of age with other pre-existing illeocecal pathologies like tuberculosis or malignancies and who were not willing for appendicectomy were excluded.

A pretested proforma was used to collect relevant information (patient data, presenting complaints, clinical findings, lab investigations, sonological findings, HPR etc.) from all the selected patients. Particular attention was paid to the history of previous illness, past history of similar complaints, diet and bowel habits and essential investigations especially total white cell count and ultrasonography of abdomen were done for all patients. Modified Alvarado score was applied on these patients. The sonographic findings were recorded as positive and negative for acute appendicitis. All USG positive cases were taken for surgery. All USG negative cases were retained for 48 hours under observation and decision to operate was made depending on progress in their clinical course and surgeon's decision.

The cases subjected to surgery were adequately prepared by IV fluids, electrolyte supplementation, administration of broad spectrum antibiotics intravenously (usually combination of IV Cephalosporins + Amikacin + Metronidazole) etc.

Surgery (open/laparoscopic) was done under spinal/general anesthesia. The operative findings were noted, with special reference to appendicular position, peri-appendiceal collection, and presence of perforation or fecolith. All the specimens of appendix were sent for histopathological confirmation. Cases were watched for any postoperative complications and treated wherever needed. Post operatively sutures were removed on 7-9 days and the patients histopathological reports were collected by that time.

The data collected was analysed using Microsoft excel and presented in numbers and percentages.

## RESULTS

In this study 100 patients with right lower abdominal pain, admitted in HSK Hospital Bagalkot, in whom acute appendicitis was suspected were taken. Table 1 presents the Clinical characteristics of study participants. There was a preponderance of young patients in our study, with incidence being more common in 3rd and 2nd decade with 42% (42 cases out of 100) and 27% (27 cases) respectively, next common in 4th decade of life. Men outnumbered women by 61 to 39. About 53% of patients presented with pain around umbilicus, of which 52% later shifted to right iliac fossa. Majority of the patients had aching type of pain. Nausea or vomiting was the common symptom noted in 82% of patients followed by anorexia (80%). Majority of subjects had diet habit of mixed type (77%) and 23% of patients were vegetarians. In our study, 66% had pulse  $> 90$  /min and 38% had low grade fever. On clinical examination, tenderness in RIF was the most consistent feature (100%). Rebound tenderness was present in 47% of the cases. 70% patients had total leucocyte of more than 10,000 cells/cumm. Alvarado Score was 7 or more in 62 cases, 5-6 in 16 cases, less than 5 in 22 cases.

All 100 cases were subjected to ultrasonography and high frequency probe was used in some cases. In our study 85 cases were positive for appendicitis. Out of these 74 cases was uncomplicated acute appendicitis. Perforated acute appendicitis was diagnosed in 6 cases. 1 case was diagnosed as appendicular abscess and 6 cases were diagnosed as chronic appendicitis.

All the 85 cases including other 5 cases after detailed examination underwent surgery. Out of 90 surgeries 78 were done under spinal anaesthesia and 12 under general anaesthesia. 35 surgeries were done laproscopically and remaining 55 were open surgeries. The incision commonly employed was grid-iron incision (46 cases) and was extended whenever faced with difficulties and better exposure was required. Lower midline incision was used in 7 cases and in 2 cases Lanz incision was used (Table 3).

In our study 66.3% appendix was retrocaecal, 28% were pelvic and 2.2% were subcaecal in position. Out of 90 cases operated, in 61 cases appendix were found to be inflamed, 14 cases appendix were congested, 4 cases it was gangrenous and in 8 cases appendix was perforated. In 3 cases appendix were looking normal, of which one case was diagnosed as acute pancreatitis based on intraoperative findings and appendicectomy was not done for that patient (Table 4).

In our study 89 appendectomy specimen were sent for histopathological study, 45 cases were diagnosed as acute appendicitis, 28 cases diagnosed as chronic appendicitis, 8 cases diagnosed as acute suppurative appendicitis, 2 cases diagnosed as acute gangrenous appendicitis and one case is diagnosed as acute eosinophilic appendicitis. Out of 89

appendectomy specimen 5 were found as normal after histopathological examination of which 3 were males and 2 were females (Table 5).

**Table 1: Clinical characteristics of study participants.**

Variables	Number of patients (N)	Percentage (%)
<b>Age (in years)</b>		
11-20	27	27
21-30	42	42
31-40	19	19
41-50	7	7
51-60	3	3
61-70	2	2
<b>Sex</b>		
Male	61	61
Female	39	39
<b>Site of pain</b>		
Right iliac fossa	100	100
Umbilical	53	53
Epigastric	2	2
Lumbar	4	4
Hypogastric	2	2
<b>Migration of pain</b>		
Present	52	52
Absent	48	48
<b>Symptoms</b>		
Nausea or vomiting	82	82
Fever	42	42
Anorexia	80	80
Constipation	13	13
Diarrhoea	6	6
Urinary complaints	17	17
<b>Type of diet</b>		
Vegetarian	23	23
Mixed	77	77
<b>Clinical signs</b>		
Pulse rate >90	66	66
Elevated temperature	38	38
Right iliac fossa tenderness	100	100
Rebound tenderness	47	47
Guarding	33	33
<b>Total leukocyte count distribution</b>		
<10000 cells/mm <sup>3</sup>	30	30
>10000 cells/mm <sup>3</sup>	70	70
<b>Alvarado score</b>		
7 or more	62	62
5 or 6	16	16
Less than 5	22	22

Table 6 presents the comparison of Alvarado score and ultrasound reports with histopathology report (HPR). Out of 62 cases with score >7 histopathology reports were positive for appendicitis in 59 cases and negative in 3

cases. Patients with score <7 showed positive HPR in 25 cases and negative in 13 cases. On ultrasonography (USG), 85 cases were diagnosed with acute appendicitis. Among them, 81 histopathology reports were positive and 4 were negative.

**Table 2: Distribution of USG abdomen diagnosis.**

USG diagnosis	Number of patients (N)	Percentage (%)
Acute appendicitis	74	74
Appendicular perforation	6	6
Appendicular abscess	1	1
Chronic appendicitis	4	4
Colitis	2	2
Ureteric calculi	3	3
Cystitis	2	2
Intestinal obstruction	1	1
Ovarian cyst	1	1
PID	1	1
Normal	5	5

**Table 3: Types of incision used.**

Incision	Number of patients	Total
Laparoscopic	35	35
Grid iron	46	55
Lanz	2	
Lower midline	7	
Total	90	90

**Table 4: Distribution of position and intraoperative findings of appendix.**

Distribution	Number of patients	Percentage (%)
<b>Position of appendix</b>		
Retrocaecal	59	66.4
Pelvic	25	28.1
Subcaecal	2	2.2
Preileal	2	2.2
Postileal	1	1.1
Total	89	100
<b>Intraoperative findings</b>		
Normal	3	3.3
Congested	14	15.7
Inflamed	61	67.8
Gangrenous	4	4.4
Perforated	8	8.8
Total	90	100

As shown in Table 7, the overall accuracy of clinical diagnosis with HPR was 72%. The overall sensitivity and specificity was 70.3% and 81.3% respectively. The Chi square value is 15 and p value is 0.0001 which is highly significant. An overall positive predictive value of

clinical analysis was 95.2% whereas the negative predictive value was 34.2%. The overall accuracy of ultrasound with HPR was 93%, with a sensitivity of 96.4%, specificity of 75%, a positive predictive value of 95% and a negative predictive value of 80%. The Chi square value is 53.78 and p value is 0.0001 which is highly significant.

**Table 5: Distribution of various HPR reports.**

Histopathology reports	Number of patients		Total	%
	Male	Female		
Normal	3	2	5	5.6
Acute appendicitis	29	16	45	50.56
Acute suppurative appendicitis	4	4	8	9
Acute gangrenous appendicitis	1	1	2	2.2
Acute eosinophilic appendicitis	0	1	1	1.1
Chronic appendicitis	17	11	28	31.5
Total	54	35	89	100

**Table 6: Comparison of Alvarado score and ultrasound reports with histopathology.**

	HPR+VE (n=84)	HPR -VE (n=16)	Total (n=100)
<b>Alvarado score</b>			
>7	59	3	62
<7	25	13	38
<b>Ultrasound reports</b>			
USG +ve	81	4	85
USG -ve	3	12	15

**Table 7: Comparison of clinical results and ultrasound with histopathological report.**

Clinical diagnosis	Estimate (%)	Lower-Upper 95% CIs
<b>Sensitivity</b>	70.3	59.75-78.96
<b>Specificity</b>	81.3	56.99-93.41
<b>Positive predictive value</b>	95.2	86.71-98.34
<b>Negative predictive value</b>	34.2	21.21-50.11
<b>Diagnostic accuracy</b>	72	62.51-79.86
<b>Ultrasound</b>		
<b>Sensitivity</b>	96.4	90.02-98.78
<b>Specificity</b>	75	50.5-89.82
<b>Positive predictive value</b>	95.3	88.52-98.16
<b>Negative predictive value</b>	80	54.81-92.95
<b>Diagnostic accuracy</b>	93	86.25-96.57

## DISCUSSION

Our study found appendicitis to be more common in the third decade, with 42% patients being between 21 to 30 years of age. The average mean age of presentation was 27.9 years, with a standard deviation of 22.5 years. This finding is in concordance with the other series reported. Male to female ratio was 3.05:1.95. Men are believed to suffer from appendicitis more often because, probably, the male is being subjected to more stress and strain. These observations were in accordance with the findings of Addis et al.<sup>2</sup>

In our series, pain in abdomen was the predominant symptom (100%) followed by anorexia (80%). According to Hardin study, anorexia was present in 100%, 85% according to study conducted by Kallan et al.<sup>7</sup> Nausea and vomiting was present in 82% of cases in present series. This was mainly seen in acute appendicitis. In study conducted by Owen et al, 84% of patients presented with nausea or vomiting.<sup>8</sup>

In the current study, right lower quadrant tenderness was the most commonly elicited sign, being found in all patients studied (100%). It was about 95% in study conducted by Kallan et al and 99% in study by George et al.<sup>7,9</sup> Rebound tenderness was found in 47% patients, maximum association being with perforated appendicitis and gangrenous appendicitis. According to study conducted by Owen et al rebound tenderness was seen in 60% of patients.<sup>8</sup>

Leukocytosis or neutrophilia (total count >10000) was present in 70% cases and only 3% it was raised above 20,000. Mild to moderate leukocytosis was observed in acute appendicitis. Mean total white blood cell count was 11512 cells/cumm with standard deviation 3306 cells/cumm and there was polymorphonuclear predominance. In gangrenous and perforated appendicitis the leukocytosis was proportionally higher. The degree of leukocytosis appears to be related to the degree of inflammation and absorption of toxic products of infection. These factors probably stimulate the bone marrow to release stored WBC and accelerate leukocytosis. This may be the reason for increasing degree of leukocytosis in complicated appendicitis. This also explains the shift towards immature cells. A study by Hoffmann et al, 60-90% of all patients with acute appendicitis have total and differential leucocytes of more than 10,000cells/mm<sup>3</sup> and neutrophils of >75%.<sup>10</sup> As in any case of acute infection, it is associated with mild leukocytosis, ranging from 10,000-18,000 cells/mm<sup>3</sup>. If the counts are >18,000 cells/mm<sup>3</sup> we should suspect perforated appendix with or without abscess.<sup>10</sup>

Alvarado score of 7 or more which confirms the diagnosis of acute appendicitis proved both intra operatively and histopathologically. In this series 62% had a score of 7 or more. 67.2% of male and 53.84% of females had a score of above 7. The percentage of



incidence in males was higher in as study done by Bhattacharjee et al.<sup>12</sup>

For ultrasound examination, graded compression, as described by Puylaert et al was used in our study to displace bowel loops from the right iliac fossa, the aim being to oppose the external abdominal musculature with the psoas muscle.<sup>13</sup> The caecum and the external iliac vessels were found to be useful anatomic landmarks.

In the present series appendix was visualized only in 64% of the patients. In a study by Puylaert et al 88.5% of the patients on ultrasound was reported visualization of the appendix.<sup>13</sup>

In the present study a periappendiceal collection was present in only 32 patients out of 100, but was specific for acute appendicitis when present. Puylaert et al reported a diagnostic accuracy of 89% for appendicular abscess.<sup>13</sup> John et al found ultrasound to be particularly useful in detecting peri-appendiceal collection, with all cases in their series being diagnosed by ultrasound.<sup>13</sup>

Faecolith was found only in 1 case in our study. Jeffery et al had suggested that, with positive clinical findings, a faecolith should be taken to indicate acute appendicitis, irrespective of the diameter of the appendix.<sup>15</sup>

Out of 100 cases studied 90 cases got operated. Appendectomy was done in 89 cases. One case was diagnosed as acute pancreatitis based on intraoperative findings and appendectomy was not done for that patient. In this study 5 specimens were normal appendix. This negative rate (5.6%) was within the acceptable rate of 15-20%. The 5 cases, which were found to be negative on biopsy, were analyzed separately. Ultrasound had accurately reported 2 of the 5 cases as negative. Ultrasound was found to be negative in 15 cases. These 2 cases along with 10 cases which were treated conservatively together form the true negative i.e. 12 cases.

The sensitivity and specificity of clinical results with histopathology was 70.3% and 81.3%. In the study of Crnogorac et al the score has a sensitivity of 87% and specificity of 60%.<sup>16</sup> In our series, the overall accuracy of ultrasound was 93%, with a sensitivity of 96.4%, specificity of 75% in diagnosing appendicitis. This was comparable to the findings of Subashet al.<sup>17</sup>

According to Korner et al the negative appendectomy rate for males is 9.3% and for females is 22.2%.<sup>18</sup> In study conducted by Mohanty et al negative appendectomy rate for male is 4.8% and females is 6.7%.<sup>19</sup> The present study shows negative appendectomy rate of 8.82% in females and 3.63% in male. In females, negative appendectomy rate is high. This is probably due to pelvic inflammatory diseases, ruptured follicular cysts etc. These conditions are not

properly diagnosed on ultrasound and can mimic acute appendicitis.

## CONCLUSION

Diagnosis of acute appendicitis can be made by combining clinical signs and symptoms with USG reports. USG is a non-invasive investigation and plays an important role in identifying alternative causes of RIF pain thus excluding appendicular pathology. It acts as a useful adjunct in the diagnosis of acute appendicitis and prevents negative laparotomies.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

## REFERENCES

1. Stephens PL, Mazzucco JJ. Comparison of ultrasound and the Alvarado score for the diagnosis of acute appendicitis. *Conn Med.* 1999;63(3):137-40.
2. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. *Am J Epidemiol.* 1990;132:910-25.
3. Blomqvist PG, Andersson RE, Granath F, Lambe MP, Ekblom AR. Mortality after appendectomy in Sweden. *Ann Surg.* 2001;233:455-60.
4. Lee SL, Walsh AJ, Ho HS. Computed Tomography and Ultrasonography Do Not Improve and May Delay the Diagnosis and Treatment of Acute Appendicitis. *Arch Surg.* 2001;136(5):556-62.
5. Bondi M, Miller R, Zbar A, Hazan Y, Appelman Z, Caspi B, et al. Improving the diagnostic accuracy of ultrasonography in suspected acute appendicitis by the combined transabdominal and transvaginal approach. *Am Surg.* 2012;78:98-103.
6. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Ann Emerg Med.* 1986;15:557-64.
7. Kalan M, Talbot D, Cunliffe WJ, Rich AJ. Evaluation of the modified Alvarado score in the diagnosis of acute appendicitis: a prospective study. *Ann R Coll Surg Engl.* 1994;76(6):418-9.
8. Owen TD, Williams H, Stiff G, Jenkinson LR, Rees BI. Evaluation of the Alvarado score in acute appendicitis. *J R Soc Med.* 1992;85(2):87-8.
9. George MJ, Siba PP, Charan PK, Rao RRM. Evaluation of Ultrasonography as a Useful Diagnostic Aid in Appendicitis. *IJS Surg.* 2002;64:436-9.
10. Hoffmann J, Rasmussen OO. Aids in the diagnosis of acute appendicitis. *Br JSurg.* 1989;76(8):774-9.
11. Brunicki FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Pollock RE. In: Schwartz's Principles of Surgery. 8<sup>th</sup> ed. McGraw-Hill Companies Inc; 2005: 1119-1135.

12. Bhattacharjee PK, Chowdhury T, Roy D. Prospective evaluation of modified Alvarado score for diagnosis of acute appendicitis. *J Indian Med Assoc*. 2002;100(5):310-1.
13. Puylaert JB. Acute appendicitis: US evaluation using graded compression. *Radiology*. 1986;158(2):355-60.
14. John H, Neff U, Kelemen M. Appendicitis diagnosis today: clinical and ultrasonic deductions. *World J Surg*. 1993;17(2):243-9.
15. Jeffrey RB Jr, Laing FC, Lewis FR. Acute appendicitis: high-resolution real-time US findings. *Radiology*. 1987;163(1):11-4.
16. Crnogorac S, Lovrenski J. Validation of the Alvarado score in the diagnosis of acute appendicitis. *Med Pregl*. 2001;54(11-12):557-61.
17. Subash KC, De A, Pathak M, Sathian B. Diagnostic Role of Ultrasonography in Acute Appendicitis: A Study at a Tertiary Care Hospital. *American J Public Health Res*. 2015;3(5):23-8.
18. Korner H, Sondenaa K, SoreideJa, Andersen E, Nysted A, Lende TH, et al. The study of negative appendectomy rates in Male and Female: age specific and Sex specific analysis. *World J Surg*. 1997;21:313-7.
19. Mohanty SK, Sil K. Evaluation of modified Alvarado score in decreasing negative appendectomy rate – our experience. *IJS*. 2000;62(5):342-3.

**Cite this article as:** Mathew T, Ammanagi AS. Clinicopathological evaluation of acute appendicitis and the role of ultrasound in diagnosis: a prospective study. *Int Surg J* 2019;6:1471-6.