CLINICOPATHOLOGICAL STUDY OF ACUTE APPENDICITIS WITH SPECIAL REFERENCE TO THE ROLE OF WBC COUNT, C-REACTIVE PROTEIN (CRP), USG AND ALVARADO SCORE IN DIAGNOSIS

General Surgery

Dr. Md. Mushir Reyaz	M.B.B.S, M.S. (Gen. Surg.), Senior Resident, Department of General Surgery, Govt. Medical College and Hospital, Bettiah, W. Champaran, Bihar.
Dr. Kumari Pallavi*	M.B.B.S, M.S. (Gen. Surg.), Senior Resident, Department of General Surgery, Govt. Medical College and Hospital, Bettiah, W. Champaran, Bihar. *Corresponding Author
Dr. C. M. Narayan	M.B.B.S, M.S. (Gen. Surg.), Associate Professor, Department of General Surgery, Govt. Medical College and Hospital, Bettiah, W. Champaran, Bihar.
Dr. Debarshi Jana	Young Scientist (DST), Institute of Post-Graduate Medical Education and Research, A.J.C. Bose Road, Kolkata, West Bengal, India-700020.

ABSTRACT

Background: Acute appendicitis is one of the commonest surgical emergencies in all ages. Diagnosis is mainly clinical, delay in diagnosis definitely increases the morbidity, mortality and cost of treatment, more aggressive surgical approach has resulted in increased white appendectomies.

Methods: A total 140 cases hospitalized with abdominal pain, suggestive of acute appendicitis on the basis of WBC count, C-Reactive protein (CRP), USG and Alvarado scoring system and were subsequently operated, were included in the present study in our institute.

Results: Males belonging to young age group of 21-30 were most commonly affected. Abdominal pain was seen in 100% of patients. Most of the patients of acute appendicitis presented with more than one of above symptoms. The most common presenting symptom was right iliac fossa pain affecting 96.19% of cases (migratory 62.86% and non-migratory 33.33%), followed by anorexia (78.10%) and nausea (66.67%). The other symptoms were fever (65.71%), vomiting (46.67%), constipation (28.57%), right sided flank pain (22.86%), dysuria (19.05%), suprapubic pain (15.24%), diarrhoea (14.29%) and generalized abdominal pain (13.33%) in decreasing order of frequency. Right iliac fossa pain was the most common presentation in non-appendicitis group, followed by anorexia. There was no significant difference in symptoms among these two groups. In this study 54.29% of patients with acute appendicitis had Alvarado score between 7 – 8 and 34.29% of patients with acute appendicitis had Alvarado score between 9 – 10. On the other hand majority of the patients of non-appendicitis group had a score below 7.

Conclusions: Young males are most commonly affected almost always presents with abdominal pain. The Modified Alvarado scoring system is a reliable and practicable diagnostic modality to increase the accuracy in diagnosis of acute appendicitis and thus to minimise unnecessary appendectomy.

KEYWORDS

Acute Appendicitis, Modified Alvarado Score, White Blood Cell, Ultrasound

INTRODUCTION

The importance of appendicitis in surgery results from its propensity for inflammation, which leads to the clinical syndrome known as acute appendicitis. Acute appendicitis is the most common cause of an "acute abdomen" in young adults, and appendectomy is the most frequently performed urgent abdominal operation with a lifetime prevalence of approximately 1 in 7. A typical patient is one presenting with right lower abdominal pain, nausea and vomiting and has got tenderness and guarding in right iliac fossa on examination. However these symptoms & signs are not very specific for appendicitis. Moreover the picture is more confused by the variable position of the appendix. Therefore acute appendicitis needs to be considered in the differential diagnosis of nearly every patient with acute abdominal pain and early diagnosis remains the most important goal.

Although the accuracy of diagnosis of this disease mostly depends on clinical expertise, equivocal or confusing cases do occur, particularly in very young patients, elderly patients and females of reproductive age. This is because they usually have atypical presentation and many other conditions also present like appendicitis. A negative appendectomy rate of 20-40% has been reported in literature. Removing normal appendix is an economic burden both on patients and health resources. On the other hand, delay in surgery can lead to complications like perforation and finally peritonitis. Both the cases are increasingly being criticized now-a-days and have become a matter of great concern to the attending surgeon and as well as to the patient, bearing a socio-medical impact.

In this study attempts will be made to undergo a thorough evaluation of all cases of acute appendicitis on the basis of clinical symptoms, physical examinations, some readily available, relatively inexpensive investigations (White Blood Count, C-Reactive Protein, Ultrasonography), and the Alvarado score (Migratory RIF pain = 1, Anorexia = 1, Nausea & vomiting = 1, Tenderness in RIF = 2, Rebound tenderness = 1, Elevated temperature = 1, Leukocytosis = 2, Shift to left = 1, Total score = 10) and to correlate them with the operative and

histopathological findings. The objective is being to improve the diagnostic accuracy and utility of overall management.

AIMS AND OBJECTIVES

1. To study the various modes of presentation of acute appendicitis.
2. To study the different clinical signs elicited in acute appendicitis.
3. To study the role of various investigative procedures with special reference to white blood corpuscle (WBC) count, c-reactive protein (CRP) and ultrasonography (USG) in the diagnosis of acute appendicitis.
4. To evaluate the role of Alvarado scoring system in the diagnosis of acute appendicitis.
5. To find out a way to increase correct diagnosis of acute appendicitis, thereby decreasing negative appendectomy or unnecessary delay in operation.

MATERIALS AND METHODS

1) **Study Area :** Department of General Surgery, Govt. Medical College & Hospital, Bettiah, Bihar.

2) **Study Population:** All patients admitted in General Surgery Ward of GMC, Bettiah, Bihar from May 2019 to April 2020 with provisional clinical diagnosis of acute appendicitis. Chronic appendicitis and pediatrics populations were excluded from this study.

3) **Sample Size :** Total 140 patients were included in this study.

4) **Study Design:** It was a prospective observational study.

5) Parameters Studied:

- (a) Various modes of presentation of acute appendicitis:
- Pain - Site, migration, character
 - Anorexia
 - Nausea
 - Vomiting
 - Fever
 - Constipation

- Diarrhoea
- Dysurea

(b) Different clinical signs elicited in acute appendicitis:

- Tachycardia
- Pyrexia
- Localized tenderness in right iliac fossa (RIF)
- Muscle guarding over RIF
- Rebound tenderness over RIF
- Generalized abdominal tenderness
- Pointing sign
- Dunphy's sign
- Rovsing's sign
- Psoas sign
- Obturator sign
- Tenderness on digital rectal examination (DRE)

(c) Role of various investigative procedures in acute appendicitis:

- Total Leucocyte Count (TLC)
 - As per Alvarado score, $\text{TLC} \geq 10,000/\text{mm}^3$ was taken as a positive cut off value.
- Differential Leucocyte Count (DLC)
 - As per Alvarado score, Neutrophils $\geq 75\%$ was taken as a positive cut off value.
- C-Reactive Protein (CRP)
 - A CRP value ≥ 6 was considered positive.
- Ultrasonography (USG) of abdomen & pelvis
 - Using a linear array transducer (7-14 MHz) in Xario (Toshiba made) machine and "graded compression" technique over the right iliac fossa and the site of maximum tenderness, the landmarks of the caecum, iliac vessels and psoas muscle were identified.
 - An inflamed appendix was demonstrated as a non-compressible blind ending aperistaltic tubular structure arising from the wall of caecum with an outer diameter of $\geq 6\text{mm}$. Other supporting signs which were looked for include periappendiceal fat, appendicolith, prominent periappendiceal fat and phlegmon.
 - Failures to fulfill the above criteria were considered as normal appendix.

(d) Role of Alvarado scoring system in diagnosis of acute appendicitis:

1. ALVARADO SCORE (MANTRELS)
 2. Migratory RIF pain = 1
 3. Anorexia = 1
 4. Nausea or vomiting = 1
 5. Tenderness in RIF = 2
 6. Rebound tenderness = 1
 7. Elevated temperature ($\geq 37.3^\circ\text{C}$) = 1
 8. Leukocytosis ($\text{TLC} \geq 10,000/\text{mm}^3$) = 2
 9. Shift of WBC to the left (Neutrophils $\geq 75\%$) = 1
- Total value = 10
Positive cut off value was taken as ≥ 7

RESULTS

A total of 140 patients with clinical impression of acute appendicitis were included in this study. In this study, the disease affected male and female in the ratio of 1:1.5, affecting male sex in 40% and the female sex in 60% of cases. Wrong clinical diagnosis was also more in female population (65.71%). All patients underwent thorough clinical evaluation, preoperative total leukocyte count (TLC), differential leukocyte count (DLC) and C-reactive protein (CRP) measurement along with Alvarado scoring. Preoperative ultrasonography (USG) was done in 96 (68.57%) patients.

Out of 140 patients, 132 patients underwent emergency appendectomy, 4 patients underwent laparotomy for pelvic pathology (2 cases of ruptured ectopic pregnancy and 2 cases of twisted ovarian cyst), 2 patients responded on conservative management (1 case of right ureteric calculus and 1 case of right tubo-ovarian mass) and 2 patients underwent interval appendectomy following initial conservative management because of appendicular lump.

Out of 132 patients of emergency appendectomy, 103 patients had histologically inflamed appendix, the rest 29 patients had histologically normal appendix. 2 patients with appendicular lump, who underwent interval appendectomy, also had histologically confirmed appendicitis. Therefore, among 140 patients with clinical diagnosis of acute appendicitis, **appendicitis group** became 105 and

non-appendicitis group became 35 (29 histologically normal appendix + 5 pelvic pathology + 1 ureteric calculus). Operative interventions were done in 138 patients (132 emergency appendectomies + 4 emergency surgeries for pelvic pathology + 2 interval appendectomy).

Table 1 Age Distribution (n=140)

Age group (in years)	Appendicitis group (n=105)		Non-appendicitis group (n=35)		Total (n=140)	
	No.	%	No.	%	No.	%
13 - 20	33	31.43	13	37.14	46	32.86
21 - 30	42	40.00	10	28.57	52	37.14
31 - 40	23	21.90	8	22.86	31	22.14
41 - 50	4	3.81	3	8.57	7	5.00
51 - 60	2	1.90	0	0.00	2	1.43
≥ 61	1	0.95	1	2.86	2	1.43

Table 2 Sex Distribution (n=140)

Sex	Appendicitis group (n=105)		Non-appendicitis group (n=35)		Total (n=140)	
	No.	%	No.	%	No.	%
Male	42	40.00	12	34.29	54	38.57
Female	63	60.00	23	65.71	86	61.43

Table 3 Preoperative CRP Value In mg/l (n=140)

CRP value in mg/L	Appendicitis group (n=105)		Non-appendicitis group (n=35)		Total (n=140)	
	No.	%	No.	%	No.	%
<6	8	7.62	30	85.71	38	27.14
6 - 50	76	72.38	5	14.29	81	57.86
50 - 100	17	16.19	0	0.00	17	12.14
>100	4	3.81	0	0.00	4	2.86

Table 4 Alvarado Score (n=140)

Alvarado score	Appendicitis group (n=105)		Non-appendicitis group (n=35)		Total (n=140)	
	No.	%	No.	%	No.	%
9 - 10	36	34.29	1	2.86	37	26.43
7 - 8	57	54.29	9	25.71	66	47.14
5 - 6	11	10.48	12	34.29	23	16.43
≤ 4	1	0.95	13	37.14	14	10.00

Table 5 USg Results (n=96)

USG findings	Appendicitis group (n=72)		Non-appendicitis group (n=24)		Total (n=96)	
	No.	%	No.	%	No.	%
Aperistaltic blind ending tube	67	93.06	2	8.33	69	71.88
Outer transverse diameter $\geq 6\text{mm}$	66	91.67	1	4.17	67	69.79
Noncompressibility	55	76.39	2	8.33	57	59.38
Loculated periappendiceal fluid	59	81.94	0	0.00	59	61.46
Prominent periappendiceal fat	37	51.39	0	0.00	37	38.54
Appendicolith	31	43.06	1	4.17	32	33.33

DISCUSSION

According to various studies, incidence of appendicitis gradually rises from birth, peaks in the late teen years, and gradually declines in the geriatric years. Nearly 70% of patients with acute appendicitis are less than 30 years of age.

In this study, most of the patients with acute appendicitis were in third decade of life (40.00%), followed by second decade (31.43%), whereas it had also affected the sixth (1.90%) and seventh (0.95%) decade of life. On the other hand negative appendectomies were more common in second decade (37.14%) of life. Thus the findings were corroborative with the other studies.

According to various studies, the disease is slightly more common in males, with a male: female ratio of 1.4:1.

But in our study the disease was more common in female population with a male: female ratio of 1:1.5. Wrong clinical diagnosis was also more in female population.

Studies consistently show that 80-85% of adults with appendicitis have a WBC counts greater than 10,500 cells/mm³. Fewer than 10% of patients with appendicitis have a WBC count less than 10,500 cells/mm³.

In our study, taking positive cut off value of TLC as $\geq 10,000/\text{mm}^3$, diagnostic accuracy became as follows: sensitivity = 84.76%, specificity = 80.00%, positive predictive value = 92.71%, negative predictive value = 63.64%, % of false negative = 15.24% and % of false positive = 20.00%. These findings corroborate with the previous studies.

Studies consistently show that neutrophilia greater than 75% occurs in 78% of patients. Fewer than 10% of patients with appendicitis have a neutrophilia less than 75%.

In this study, taking positive cut off value of neutrophilia as $\geq 75\%$, the diagnostic accuracy of neutrophilia became as follows: sensitivity = 80.00%, specificity = 88.57%, positive predictive value = 95.45%, negative predictive value = 59.62%, % of false negative = 20.00% and % of false positive = 11.43%. These findings corroborates with other studies.

Multiple studies have examined the sensitivity of CRP alone for the diagnosis of appendicitis in patients selected to undergo appendectomy.

In our study majority of the patients with acute appendicitis had a positive CRP value - 72.38% had a value between 6 – 50, 16.19% had a value between 50 – 100 and 3.81% had a value >100 . Values were higher in perforated appendicitis. On the other hand only 14.29% of patients of non-appendicitis group had a positive CRP value.

Diagnostic accuracy of CRP was as follows: sensitivity = 92.38%, specificity = 85.71%, positive predictive value = 95.10%, negative predictive value = 78.95%, % of false negative = 7.62% and % of false positive = 14.29%. These findings corroborates with other studies.

Various studies have examined the role of Alvarado score in the diagnosis of appendicitis.

In this study, 54.29% of patients with acute appendicitis had Alvarado score between 7 – 8 and 34.29% of patients with acute appendicitis had Alvarado score between 9 – 10. On the other hand majority of the patients of non-appendicitis group had a score below 7.

As a score of ≥ 7 had a higher chance of appendicitis, it had been taken as a positive cut off value. Being so, the diagnostic accuracy of Alvarado score became as follows: sensitivity = 88.57%, specificity = 71.43%, positive predictive value = 90.29%, negative predictive value = 67.57%, % of false negative = 11.43% and % of false positive = 28.57%. Therefore the diagnostic accuracy of Alvarado score in our study was slightly higher.

The sonographic diagnosis of acute appendicitis has a reported sensitivity of 55 to 96% and a specificity of 85 to 98%. The positive and negative predictive values of ultrasonography have impressively been reported as 91 or 92%, respectively.

In our study, diagnostic accuracy of USG was as follows: sensitivity = 93.10%, specificity = 91.67%, positive predictive value = 97.10%, negative predictive value = 81.45%, % of false negative = 6.94% and % of false positive = 8.33%. These findings corroborates with other studies.

The most common USG findings in appendicitis group were aperistaltic blind ending tube (93.06%), outer transverse diameter $\geq 6\text{mm}$ (91.67%), loculated periappendiceal fluid (81.94%) and noncompressibility (76.39%). Other less common findings were prominent periappendiceal fat (51.39%) and appendicolith (43.06%). On the other hand except loculated periappendiceal fluid and prominent periappendiceal fat other findings were also present in very few numbers of cases in the non-appendicitis group.

According to various studies, surgical site infections are the most common complications seen after appendectomy (5%). Small bowel obstruction occurs in less than 1% of patients after appendectomy for uncomplicated appendicitis and in 3% of patients with perforated

appendicitis. The risk for infertility following appendectomy in childhood appears to be small.¹³¹ There are rare reports of appendicocutaneous or appendicovesical fistulas after appendectomy, typically for perforated appendicitis.

The most common complication in appendicitis group was wound infection (5.71%), followed by pulmonary complications and urinary tract infection (each 2.86%). Other complications were prolonged ileus (1.90%), adhesive intestinal obstruction (1.90%) and incisional hernia (0.95%).

Wound infection, pulmonary complications and prolonged ileus – all had occurred in 6.06% of cases in non-appendicitis group. Urinary tract infection had occurred in 3.03% of cases.

The mortality rate after appendectomy is less than 1%. In our study, there was no mortality.

CONCLUSION

To conclude, the initial step of diagnosis of acute appendicitis is mainly clinical and the clinical diagnostic accuracy (CDA) in literature varies between 67% - 80%. In our study clinical diagnostic accuracy (CDA) was found to be 75%.

On application of Alvarado score, the diagnostic sensitivity increased to 88% in our study.

The addition of CRP and ultrasonography increased the diagnostic accuracy further to the extent of 90% - 95%.

Therefore, proper evaluation of patients presenting with acute abdomen with suspicion of acute appendicitis include thorough clinical examination, Alvarado scoring, C-reactive protein (CRP) measurement and ultrasonography (USG). These are particularly important in very young patients, elderly patients and females of reproductive age group. By doing these, diagnostic accuracy of acute appendicitis will increase, negative appendectomy rate will reduce and overall management will improve.

REFERENCES

- O'Connell PR. The vermiform appendix. In: Williams NS, Bulstrode CJK, O'Connell PR, editors. *Bailey & Love's short practice of surgery: Abdominal*. 25th ed. London, UK: Hodder Arnold; 2008. p.1204-1218.
- Delic J, Savkovic A, Isakovic E. Variations in the position and point of origin of vermiform appendix. *Med Arch*. 2002; 56(1): 5-8.
- Delic J, Kirkwood KS. The appendix. In: Townsend CM, Beauchamp RD, Evers BM, Mattox KL, editors. *Sabiston textbook of surgery, The biological basis of modern surgical practice: Abdomen*. 18th ed. Vol-2. Philadelphia, USA: Saunders, Elsevier; 2008. p.1333-1347.
- Tsoulfas G, Howe JR. Amyand's hernia: Appendicitis in an incarcerated hernia. *Surg Rounds* 2004;27:515–517.
- Jaffe BM, Berger DH. The appendix. In: Brunicaudi FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Pollock RE, Matthews JB, editors. *Schwartz's principles of surgery: Specific consideration*. 9th ed. New York: McGraw-Hill; 2010. p.1073-1091.
- Smink DS, Soybel DI. Appendix and appendectomy. In: Zinner MJ, Ashley SW, editors. *Maignot's abdominal operations: Small intestine and colon*. 11th ed. New York: McGraw Hill; 2007. p.589-612.
- Sing I, Pal GP. *Human Embryology: Alimentary System*. ÉÉ: Gastrointestinal Tract. 8th ed. New Delhi, India: Macmillan India Limited; 2007. p.148-165.
- "What is the function of the human appendix? Did it once have a purpose that has since been lost?". *Scientific American*. 1999-10-21. Retrieved 2008-07-01.
- Bollinger, R.R.; Barbas, A.S.; Bush, E.L.; Lin, S.S. & Parker, W. (21 December 2007). "Biofilms in the large bowel suggest an apparent function of the human vermiform appendix". *Journal of Theoretical Biology* 249 (4): 826–831. doi:10.1016/j.jtbi.2007.08.032. ISSN 0022-5193. PMID 17936308.
- Associated Press. "Scientists may have found appendix's purpose". MSNBC, 5 October 2007. Accessed 17 March 2009.