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Role of Ultrasonography in the Diagnosis of Acute Appendicitis

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Abstract **Original Research Article**

Introduction: Acute appendicitis is still prevalent as a major surgical emergency. Due to the fast progress of the ailment, surgery is often the most sensible approach to manage it. But any surgery comes with its fair share of risk. If the diagnosis of the disease can be made more accurate prior to surgery, the error rate of negative appendectomy can be greatly reduced. ***Aim of the study:*** The aim of the study was to evaluate the role of ultrasonography in the diagnosing acute appendicitis. ***Methods:*** This prospective cross-sectional study was conducted at the Department of Surgery, Faridpur Medical College Hospital, Faridpur, Bangladesh. The study duration was 6 months, from November 2013 to April 2014. A total of 100 cases were selected from those admitted to the emergency department of the study hospital with pain in the right lower quadrant of the abdomen for the purpose of this study. ***Result:*** Among the 100 participants of the study, histopathological diagnosis showed that 86% were acute appendicitis cases and 14% had normal appendicitis. Gender or age had no significant association with histopathological diagnosis, but male prevalence was observed in the study, with a high prevalence of young adults. The original site of pain was periumbilical pain shifted to the right iliac fossa for half the participants. Pain duration was between 18-24 hours for 36% of the cases. All participants presented with pain, fever, anorexia, and nausea had a high prevalence among participants. The sensitivity and specificity of high-resolution ultra-sonogram were 84.9% and 85.7% respectively. ***Conclusion:*** Appendicitis is a disease of the young, and can occur in participants of both genders. Histopathological diagnosis has no significant association with patient age or gender. Ultra-sonogram has high sensitivity and specificity ratio in diagnosing acute appendicitis and also has a high positive predictive value but low negative predictive value.

Keywords: Appendix, Appendicitis, Histopathological, Unremarkable, Ultra-sonogram.

INTRODUCTION

Acute appendicitis is still one of the most common surgical emergencies [1]. The diagnosis of this disease is primarily clinical in nature [2]. A typical patient is one presenting with right lower abdominal pain, nausea, and vomiting, and has tenderness and guarding in the right iliac fosse on examination. However, these signs & symptoms can mimic many other acute abdominal conditions [3]. The picture becomes even more confused by the variable position of the appendix [4]. Despite many advances in diagnostic modalities, the diagnosis is still doubtful in 30-40% of cases [5]. And the definite diagnosis of acute appendicitis still remains a clinical decision augmented by appropriate tests. A high degree of diagnostic accuracy is required to reduce the incidence of negative appendectomies, which remains as high as 20% [6]. A recent study had shown that the incidence of appendicitis is around 50% among women of the reproductive age group [7]. Many studies suggest appendicitis to be a disease in young adults [8]. It used to be called the disease of developed countries with an association of high protein intake, but the incidence is also increasing in developing countries. Apart from a careful history and clinical examination, total and differential leukocyte count, ESR and CRP can prevent half of the unnecessary surgeries and can result in the reduction of negative appendectomy (to15.2%) and appendix rupture [9, 10]. Often if WBC, ECR, and CRP are in a normal range before the operation, the diagnosis of Acute appendicitis is unlikely, and the surgeon should consider other diagnosis methods [11]. Leukocyte count is the most useful test, and in non-

perforated appendicitis, the leukocyte count has a slight increase [12]. An Elevated leukocyte count can help confirm acute appendicitis among patients [13]. The measurement of CRP in most studies has also been effective in the approval of Acute appendicitis [14]. Appendectomy carries a complication rate of 4-15%, as well as the associated costs and discomfort of hospitalization and surgery. Therefore, the goal of the surgeon is to make an accurate diagnosis as early as possible. Puylaert popularized the use of ultrasonography in the diagnosis of acute appendicitis in 1986, one hundred years after Fitz published the first study on the condition [15, 16]. Additionally, it has been demonstrated that ultrasound is quite sensitive and specific for diagnosing various illnesses that produce right lower quadrant pain in addition to acute appendicitis [17]. Before the invention of high-resolution real-time sonography, acute appendicitis could not be regularly evaluated. However, due to the high-frequency transducers' current availability and improved resolution, it is simpler to identify appendicular disorders. In our region of the nation, very few studies have been out, and enough information was lacking about the use of sonography in assessing instances of appendicitis that were clinically suspected. In order to prevent needless negative laparotomies, this study was done to determine the function of sonography in either diagnosing or excluding appendicitis as the etiology of acute abdomen.

OBJECTIVE

General Objective

- To evaluate the role of ultrasonography in the diagnosing acute appendicitis

METHODS

This prospective cross-sectional study was conducted at the Department of Surgery, Faridpur Medical College Hospital, Faridpur, Bangladesh. The study duration was 6 months, from November 2013 to April 2014. A total of 100 cases were selected from those admitted to the emergency department of the study hospital with pain in the right lower quadrant of the abdomen for the purpose of this study. Informed written consent was obtained from either the patient or their legal guardian before admission to the study. Ethical review for the study was obtained from the ethical review committee of the study hospital. For all participants, data were obtained on admission by using a questionnaire designed for the study. Routine investigations like hemoglobin, total leukocyte count, differential leukocyte count, ESR, and urine R/M/E were done in all cases. X-ray of KUB, CRP, and high-resolution ultra-sonogram of the whole abdomen was also done. Emergency appendectomy was performed in all cases by maintaining a standard operating procedure. Condition of the peritoneal cavity and appendix was recorded after opening the abdomen. After collection, data were processed and analyzed with the help of SPSS version 16.0. Statistical analysis was done, and a p-value of 0.05 or less was recognized as statistically significant.

Inclusion Criteria

- Patients aged ≥15 years (Both genders)
- Patients presenting with pain in the right lower quadrant of the abdomen.
- Patients who had given consent to participate in the study.

Exclusion Criteria

- Patients aged <15 years
- Patients with a presentation of urological, gynecological, or surgical problems other than appendicitis
- Patients with mass in the right iliac fossa.
- Unable to answer the criteria question.

RESULTS

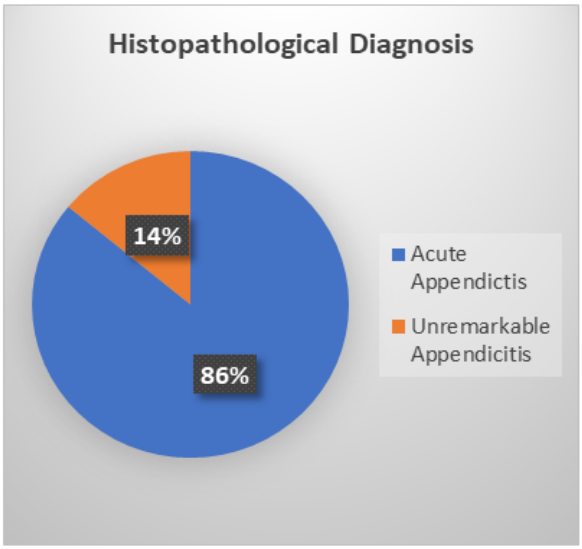

Figure 1: Histopathological diagnosis of the study participants (n=100)

The figure shows the distribution of the patients on the basis of histopathological diagnosis. According to the diagnosis, acute appendicitis was observed in 86% of the patients, while the remaining 14% had unremarkable or normal appendicitis.

Table 1: Association between the age group of the patients and histopathological diagnosis (n=100)

Age	Histopathological diagnosis		P-Value*
	Acute appendicitis n (%)	Unremarkable Appendix n (%)	
15-20	40(46.51)	03(21.43)	0.093
21-30	28(32.56)	05(35.71)	
32-40	10(11.63)	03(21.43)	
41-50	05(5.81)	02(14.29)	
51-60	03(3.49)	01(7.14)	
Mean Age	28.571±1.202		
Total	86(100.00)	14(100)	

* Fisher's Exact test was employed to analyze the data

It was observed that among the 86 acute appendicitis cases, a majority (46.51%) were from the youngest age group of 15-20 years, while another 32.56% were from the age group of 21-30 years. Similarly, among the 14 unremarkable appendix cases, the majority belonged to the earlier age groups. There was no statistical association between the age group of the patients and the histopathological diagnosis of acute appendicitis (p=0.093).

Table 2: Association between gender of the patients and histopathological diagnosis (n=100)

Gender	Histopathological Diagnosis		P* Value
	Acute appendicitis n (%)	Unremarkable Appendix n (%)	
Male	51(59.3)	07 (50.0)	0.163 (NS)
Female	35(40.7)	07(50.0)	
Total	86(100.0)	14(100.0)	

Among the participants, a total of 58 were male and 42 were female. Among the acute appendicitis cases, 59.3% were male and 40.7% were female. The gender distribution was 1:1 among the normal appendix cases. There was no statistical association between the gender of the patients and the histopathological diagnosis of acute appendicitis (p=0.163)

Table 3: Distribution of patients according to site of pain (n=100)

The original site of pain	Frequency	Percentage
Peri-umbilical pain shifts of RIF	50	50.0
Right iliac fossa	30	30.0
Epigastric pain shifted to RIF	13	13.0
Whole abdomen	07	07.0
Total	100	100.0

Half of the participants had presented with periumbilical pain shifted to the right iliac fossa (RIF), 30% had pain in the right iliac fossa, and 13% had epigastric pain to the right iliac fossa 7% had pain in the whole abdomen.

Table 4: Distribution of patients according to the duration of pain (n=100)

Duration of the pain	Frequency	Percentage
<6 hours	05	5.0
6-12 hours	09	9.0
12-18 hours	11	11.0
18-24 hours	36	36.0
24-48 hours	27	27.0
>48 hours	12	12.0
Total	100	100

For 36% of the participants, the duration of pain was between 18 to 24 hours, followed by 24 to 48 hours in 27%, less than 6 hours in 0.5%, between 6 to 12 hours in 09%, between 12 to 18 hours in 11%, and in 12% of the participants the pain was more than 48 hours.

Table 5: Distribution of patients according to clinical presentation (n=100)

Clinical presentation	Frequency	Percentage
Pain	**100**	**100.0**
Fever	**66**	**66.0**
Anorexia	**85**	**85.0**
Nausea	**65**	**65.0**
Vomiting	**53**	**53.0**
Diarrhea	**13**	**13.0**
Constipation	**25**	**25.0**

Multiple clinical features were present among all the participants. All the patients had pain in the abdomen; fever was present in 66% of patients, anorexia in 85%, nausea in 65%, vomiting in 53%, constipation in 25%, and diarrhea in 13% of the patients as features pulse was 100/min or less in 76% and more than 100/min was in 24% of patients. The temperature was normal in 15%, 98.6- 100°F in 61%, and more than 100°F in 24% of cases. Tenderness was localized in 76% and diffused in 24% of patients. Other positive signs were muscle guard (72%), pointing sign (82%), rebound tenderness (74%), Rovsing's sign (70%) Psoas test (60%), and Obturator test (24%).

Table 6: Distribution of patients according to clinical findings (n=100)

Primary Variables	Secondary Variables	Frequency	Percentage
Pulse	≤100/min	76	76.0
	>100min	24	24.0
Temperature	<98.6°F	15	15.0
	98.6-100°F	61	61.0
	>100°F	24	24.0
Tenderness	Localized	71	71.0
	Diffuse	29	29.0
Muscel guard	Present	64	64.0
	Absent	36	36.0
Pointing sign	Present	82	82.0
	Absent	18	18.0
Rebound tenderness	Positive	76	76.0
	Negative	24	24.0
Rovsing's sign	Positive	70	70.
	Negative	30	30.0
Psoas test	Positive	60	60.0
	Negative	40	40.0
Obturator	Positive	43	43.0
	Negative	57	57.0

Table 7: Distribution of the patient based on the position of the appendix (n=100)

Position of appendix	Frequency	Percentage
Retrocaecal	68	68
Pelvic	28	28
Paracaecal	1	1
Subcecal	2	2
Postileal	1	1
Total	100	100

The appendix was found retrocaecally in 68%, pelvic in 28%, Subcecal in 2%, and paracecal and post ileal each comprised 1% of the patients.

Table 8: Concordance of Ultra-sonogram and histopathological diagnosis (n=100)

High-resolution Ultra sonogram diagnosis	Histopathological Diagnosis		Total
	Acute appendicitis n (%)	Unremarkable Appendix n (%)	
Acute Appendicitis	51(59.30)	02(14.29)	53
Abscess/collection	22(25.58)	0(0.0)	22
Unremarkable	13(15.12)	12(85.71)	25
Appendix total	86(100)	14(100)	100

Among 86 patients with histopathological diagnosis of acute appendicitis, 73 patients were diagnosed with acute appendicitis in high-resolution ultra-sonogram diagnosis. Among 75 patients with a high-resolution ultra-sonogram diagnosis of acute appendicitis, 73 patients and 2 patients were diagnosed with acute appendicitis and an unremarkable appendix with histopathological diagnosis respectively. Among 25 patients with a high-resolution ultra-sonogram diagnosis of the unremarkable appendix, 13 patients and 12 patients were diagnosed with acute appendicitis and an unremarkable appendix with histopathological diagnosis respectively.

Table 9: Sensitivity and specificity of Ultra-sonogram (n=100)

High-resolution Ultra-sonogram diagnosis	**Histopathological Diagnosis**	
	Positive	**Negative**
Positive	73 (TP)	2 (FP)
Negative	13 (FN)	12 (TN)
Sensitivity	84.9%	
Specificity	85.7%	
Positive Predictive Value	97.3%	
Negative Predictive Value	48.0%	

Holding the histopathological findings as to the gold standard, We observed that Ultra-sonogram findings revealed 73 true positives (TP) cases, 2 false positives (FP) cases, 13 false negatives (FN) cases, and 12 true negatives (TN) cases. So, the sensitivity and specificity of high-resolution ultra-sonogram were 84.9% and 85.7% respectively.

DISCUSSION

The age limit of the patients varied from 15 years to 60 years with a mean age of 28.571±1.202 years (mean ±SD). Overall incidences were more in the 2nd and 3rd decades 43% and 33% respectively. 13% of the patients were between the age group of 31-40 years, 7% of the patients were between the age group 41-50 years, and 4% of the patients were between the age group 51-60 years. This was in line with the findings of various other studies, that recognize appendicitis as a disease of the young, but can occur in patients of all ages and genders.[18],[19] In the present study, the male: female ratio was 1.4:1, and there was no significant association between gender and histopathological diagnosis of appendicitis. The slightly higher male prevalence was similar to the findings of various other studies [19-24]. In this study, 50% of patients presented with periumbilical pain shifted to the right iliac fossa (RIF), 30% had pain in the right iliac fossa, 13% had epigastric pain shifted to the right iliac fossa 7% had pain in the whole abdomen. Migration of pain from the periumbilical area to the right lower quadrant was the most discriminating feature of the patient's history. According to the studies by Craig *et al*., and Kazarian *et al*., observed that the most common constant symptom was abdominal pain localized to right lower quadrant [25, 26]. In the current study, all the patients had pain in the abdomen, fever was present in 66% of patients, anorexia in 85%, nausea in 65%, vomiting in 53%, constipation in 25%, and diarrhea in 13% of the patients as presenting features. This study showed that pulse was ≤100/min in 76% of the patients, and more than 100/min in 24% of patients. The temperature was normal in 15% of patients, 98.6-100°F in 61%, and more than 100°F in 24% of cases. Tenderness was localized in 76% and diffused in 24% of patients. Other positive signs were muscle guard (72%), pointing signs (82%), rebound tenderness (74%), Rovsigns's sign (70%), Psoas test (60%), and obturator test (24%). In a study by Khan *et al*., it was found that pulse was ≤90/min in 85% and more than 90 /min was in 15% of patients, temperature around 100°F in 90% and above 100°F in 10% of cases, pointing sign in 90%, rebound tenderness in 76%, and positive Rovsing's sign in 78%.[27] The position of the appendix was Retrocaecal in a majority (68%) of the cases. Pelvic in 28%, subcecal in 2%, and appendicitis at paracecal and post ileal position was present in 1 patient each. Histopathological acute appendicitis was found in 86% of patients, and the remaining 14% were found unremarkable appendix. So diagnosis accuracy was 86% and diagnosis error or negative appendectomy was performed in 14% of patients. These results were in concordance with multiple other studies with a <15% error rate [19, 28, 29]. Among the 86 patients with an acute appendicitis histological diagnosis, 73 patients had an acute appendicitis diagnosis based on a high-resolution Ultra-sonogram. Among 75 patients with a high-resolution Ultra-sonogram diagnostic of acute appendicitis, 73 patients and 2 patients, respectively, had a histological diagnosis of acute appendicitis and an unremarkable appendix. When histopathology was used to confirm the high-resolution ultra-sonogram diagnosis of an unremarkable appendix in 25 patients, 13 patients, and 12 patients, respectively, were diagnosed with acute appendicitis and an unremarkable appendix. Therefore, the sensitivity and specificity of high-resolution ultra-sonogram were 84.9% and 85.7% respectively. These results were supported by the study of Ko *et al*., that found the sensitivity and specificity of Ultra-sonogram were 85.2% and 100% respectively [30].

Limitations of the Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

Appendicitis is a disease of the young and can occur in participants of both genders. Histopathological diagnosis has no significant association with patient age or gender. Ultra-sonogram has high sensitivity and specificity ratio in diagnosing acute appendicitis and also has a high positive predictive value but low negative predictive value.

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Conflict of interest: None declared.

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

REFERENCES

1. Pal, K., & Khan, A. (1998). Appendicitis: A challenge. *J Park Med Assoc*, 48(7), 189-192.
2. Abbassi, A., Shah, Y. (1998). Acute appendicitis in children, *J Surg Pakistan*, 2, 28-30.
3. Davenport, M. (1996). Acute abdominal pain in children. *BMJ*, 312(7029), 498-501.
4. Delić, J., Savković, A., & Isaković, E. (2002). Variations in the position and point of origin of the vermiform appendix. *Medicinski arhiv*, *56*(1), 5-8.
5. Andersson, R. E., Hugander, A. P., Ghazi, S. H., Ravn, H., Offenbartl, S. K., Nyström, P. O., & Olaison, G. P. (1999). Diagnostic value of disease history, clinical presentation, and inflammatory parameters of appendicitis. *World journal of surgery*, *23*(2), 133-140.
6. Erylimaz, R., Sahin, M., Amlimoglu, O., Bas, G., & Ozkan, O. (2001). The value of c-reactive protein and leukocyte count I preventing negative appendicec-tomies. *Ulus Travma Derg*, 7(3), 142-143.
7. Andersson, R., Lambe, M., & Bergström, R. (1999). Fertility patterns after appendicectomy: historical cohort study. *BMJ*, *318*(7189), 963-967.
8. Peltokallio, P., & Tykkä, H. (1981). Evolution of the age distribution and mortality of acute appendicitis. *Archives of Surgery*, *116*(2), 153-156.
9. Nordback, I., & Harju, E. (1988). Inflammation parameters in the diagnosis of acute appendicitis. *Acta chirurgica scandinavica*, *154*(1), 43-48.
10. Zinner, M. J., & Ashely, S. W. (2007). Maingots abdominal operations 11th ed, New York: Mc Graw-Hill, 589-611.
11. Lowerence, W. W., Doherth, G., & Gerard, M. (2003). Current surgical diagnosis and trteatment, 1st ed New York: Mcgraw tlill, 668-674.
12. Bainey, K. R., & Bhatt, D. L. (2009, January). Acute pericarditis: appendicitis of the heart?. In *Mayo Clinic Proceedings* (Vol. 84, No. 1, pp. 5-6). Elsevier.
13. Sack, U., Biereder, B., Elouahidi, T., Bauer, K., Keller, T., & Tröbs, R. B. (2006). Diagnostic value of blood inflammatory markers for detection of acute appendicitis in children. *BMC surgery*, *6*(1), 1-8.
14. Baghi, I. (2006). Assocoation Rate of leukocytosis, Increases CRP and ESR with acute appendicitis. *J Guilan Univ Med Sci*, 15(57), 54.
15. Seal, A. (1981). Appendicitis: a historical review. *Canadian Journal of Surgery*, *24*(4), 427-433.
16. Puylaert, J. B. (1986). Acute appendicitis: US evaluation using graded compression. *Radiology*, *158*(2), 355-360.
17. Abu-Yousef, M. M. (2001). Ultrasonography of Right Lower Quadrant. *Ultrasound Quarterly*, 17(4), 221-225.
18. Santacroce, L., & Ochoa, J. B. (2008). Appendicitris updated May 1, 2009. http//emedicine.medscape.com/article/195652. Accessed on 12 Sep 2009
19. Singhal, R., Angmo, N., Somaiah, N., Majumdar, H., & Chaturvedi, K. U. (2007). A rtrospctive review of the histopathology and clinicpathologic correlates of appendices removed from patients of acute appendicitis. *Minerva Chir*, 62, 11-18.
20. Mahbub, R. E., Khan, B. R., & Biswas, K. (1991). A comparative study of clinical and histodiagnosis of acute appendicitis. *Bangladesh Med J*, 20, 22-24.
21. Gauf, C. L. (2000). Diagnosing Appendicitis Across the life span. *Clinical practice*, 12(4), 129-133.
22. Kabir, E. (1996). Acute appendicitis, correlation between clinical, peroperative and histopathological diagnosis. A prospective study of 90 cases (dissertation). IPGM&R, Dhaka. Bangladesh College of Physicians & surgeons. Dhaka.
23. Islam, M. S. (2001). Clinicopathological study of acute appendicitis in a teaching hospital-study of 100 cases. Department of Surgery, MMCH, Mymensingh.
24. Azad, M. A. S. (2003). Correlation between clinical diagnosis of acute appendicitis and operative finding: a study of 100 cases in a teaching Hospital (dissertation) Bangladesh College of Physicians & surgeons. Dhaka.
25. Carig S. (2009). Appendicitis: Acute updated Jun 1, 2009. http//emedicine.medscape.com/article/773895. Accessed on 12 Sep 2009
26. Kaizarian, K. K., & Roeder, W. J. (1970). Decreasing morality and increasing morbidgy from acute appeendcitis. *The American Journal of surgery*, 119, 681-685.
27. Khan, S. A., Gafur, M. A., Islam, A., & Rahman, M. S. (2011). Correlation between clinical presentation, peroperative finding and histopathological report in acute appendicitis. *Mymensingh medical journal: MMJ*, *20*(4), 570-577.
28. Silberman, V. A. (1981). Appendectomy in a large metropolitan hospital: retrospective analysis of 1,013 cases. *The American Journal of Surgery*, *142*(5), 615-618.
29. Law, D., Law, R., & Wiseman, B. The containing challenge of perforated appendicitis. *Am J Surg*, 133-135.
30. Berenji, M., EshaghHoseini, N., GhaziSaeadi, R., & Vagharian, V. (2010). Association rate of leukocytosis increased CRP and ESR with acute appendicitis. *EBNESINA*, *13*(1), 24-27.