

Comparing the Accuracy of Ultrasonographic findings with Post-operative findings in detection of Appendicitis in the Patients with Pain in Right Iliac Fossa

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Original Research Article

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Article History

Received: 22.12.2017

Accepted: 29.01.2018

Published: 15.02.2018

DOI:

10.21276/sjmps.2018.4.2.1



Abstract: Appendicitis represents one of the most common causes of abdominal pain and is the most common emergent surgical condition of the abdomen. Timely diagnosis and treatment of appendicitis is necessary to reduce the risk of perforation which is associated with increased morbidity and mortality. Objective of the study is to determine the accuracy of the ultrasonographic examination in cases of appendicitis confirmed with that of surgeon's post-operative findings. A total number of 100 patients (56 men and 44 women) selected by non-probability convenience sampling over a period of 8 months, with the clinical suspicion of appendicitis, were subjected to abdominal ultrasonographic examination. Ultrasound positive cases were subjected to surgery. The accuracy of ultrasonography in the diagnosis of appendicitis was compared with clinical diagnosis and post-operative findings. Out of 100 cases that underwent ultrasonography, 74 cases were sonographically positive for appendicitis and 16 cases were negative. The overall specificity of ultrasound was 56.52% and the sensitivity was 96.1% in the diagnosis of acute appendicitis, with PPV, NPV of 88.1% and 81.25. Overall accuracy was 87%. Conclusion: Acute appendicitis is a common indication for emergency abdominal surgery. Ultrasonography is still a useful tool in the diagnosis of acute appendicitis in spite of sophisticated investigations like CT abdomen and laparoscopy; thus, reducing the cost of treatment and preventing negative laparotomies.

Keywords: Appendix, Appendicitis, Ultrasound in appendicitis, Sensitivity, Specificity.

INTRODUCTION

Appendicitis represents one of the most common cause of abdominal pain and is the most emergent surgical condition of the abdomen. More than 250,000 cases of appendicitis are diagnosed in the United States each year [1]. In Pakistan the prevalence of appendicitis is 10% and its peak incidence is during the second and third decades of life, it is a disease that occurs across the entire age spectrum [2].

Timely diagnosis and treatment of appendicitis are critical in reducing the risk of perforation which is associated with increased morbidity and mortality. The mortality rate of appendicitis escalates from less than 1% in non-perforated cases to 5% or more in perforated cases. Appendectomy is the most frequent emergent surgery performed worldwide [3].

The appendix in humans is a narrow extension from the terminal end of the cecum and has an internal diameter of 6–7mm. The appendix is usually located in the right lower quadrant of the abdomen. Its position within the abdomen corresponds to a point on the surface known as McBurney's point [4].

Appendicitis is an inflammation of the inner lining of appendix that spreads to its other parts. The inflammatory process soon involves the serosa of the appendix, hence the parietal peritoneum in the region, which causes classical right lower quadrant pain [5].

Several clinical signs and symptoms have been described as suggestive of appendicitis, including central abdominal pain migrating to the right iliac fossa,

fever and nausea/vomiting, signs of peritoneal irritation (rebound tenderness, guarding, rigidity).

Puylaert in 1980 described the method of diagnosing appendicitis ultrasonographically. Graded-compression ultrasound of the right lower quadrant (RLQ) shows the inflamed appendix as a blind ended tubular structure with laminated wall arising from the base of caecum [6]. It appears aperistaltic, non-compressible and diameter more than 6mm. Appendicoliths appear as bright echogenic foci and their visualization is another contributory finding. Similarly there may be increased echogenicity of the peri-appendiceal fat [7].

Ultrasound is a non-invasive and easily available modality. The investigation of its usefulness in diagnosing appendicitis is very helpful.

A study on accuracy of ultrasonography in the diagnosis of acute appendicitis in adult patients showed that imaging is necessary in patients referred with clinically suspected acute appendicitis. The study used Graded-compression ultrasonographic method. Results of study showed that Ultrasonography has an overall sensitivity of 0.86 and a specificity of 0.81, a positive predictive value of 84%, and a negative predictive value of 85% [8].

A study on diagnostic accuracy of ultrasonography in acute appendicitis showed that diagnosis of acute appendicitis is clinical and to augment the clinical diagnosis, ultrasonography of the abdomen is being used to help in diagnosis. Diagnostic accuracy of USG calculated keeping histopathology of the removed appendix as gold standard showed that US scan has sensitivity of 88%, specificity of 92%, positive predictive value of 94%, negative predictive value of 86%, and overall accuracy of 90% [9].

A study conducted to evaluate the role of ultrasonography in the diagnosis of acute appendicitis and to see the correlation between clinical signs, laboratory investigations and ultrasonographic findings in the evaluation of acute appendicitis showed that overall specificity of ultrasound 88.09% and the sensitivity 91.37%. The study concluded that Ultrasonography is a useful tool in the diagnosis of acute appendicitis [10].

A study conducted to assess the efficacy of ultrasound in the diagnosis of acute appendicitis in clinically suspected cases of acute appendicitis with graded compression technique showed 92.7% sensitivity, 94.5% specificity, 93% accuracy, 94.4% PPV and 92.5% NPV. Ultrasonography is an accurate, safe and reliable method in the diagnosis of suspected cases of acute appendicitis that can help to minimize negative appendectomies and perforation rates [11].

A study conducted to evaluate the sensitivity and specificity of ultrasound in the diagnosis of acute appendicitis at Al-Shefa hospital, Gaza Strip, Palestine showed the overall sensitivity and specificity of ultrasound, using surgical outcome as the gold standard, 84.8% and 83.3% respectively, and the positive and negative predictive values 93.3% and 66.7% respectively [6].

Objective of the study is to determine the accuracy of the ultrasonographic examination in cases of appendicitis confirmed with that of surgeon's post-operative findings.

MATERIAL AND METHODS

Cross sectional study with convenient sampling technique was used to collect the data. Questioner was used as research instrument to collect the data in the emergency department of General hospital Lahore. All the patients presenting with pain in right iliac fossa in emergency department of Lahore General Hospital Lahore were the inclusion criteria of study and all the patients with other problems were excluded from the study. Patients were selected on the basis of pain in right iliac fossa. The sample size of 100 based on Kish Leslie's formula for cross sectional studies.

Study involved the use of high frequency linear array probe of 5 to 7MHz to locate the appendix. All studies were performed in both the transverse and longitudinal planes with a technique referred to as graded compression. A gentle pressure in the area of interest using the ultrasound probe and either one or two hands to palpate the RLQ in the same way as when performing an abdominal examination was used.

Data is tabulated and analyzed by SPSS version 20. The quantitative data (age) is presented in form of mean and standard deviation.

This study involves the use of scientific methods. All the information is taken from books and internet. Written informed consent was signed from all the participants. Information is kept confidential. Participants remained anonymous throughout the study and were informed that there are no disadvantages or risk on the procedure of the study. They were informed that they were free to withdraw at any time during the process of the study.

Study involved following expected outcomes on ultrasonographic assessment of a patient having clinical manifestation of appendicitis.

1. Enlarged Sized appendix
2. Diameter of appendix > 6mm
3. Echogenicity
4. Echogenic peri-appendiceal fat

RESULTS

Among 100 suspected cases of appendicitis ultrasonographic findings were positive in 84 patients and negative in 16 patients as shown in table 1. Ultrasonography was done in all the 100 patients out of which 56 were males and 44 were females shown in graph 2. More male patients were the case of appendicitis as compared to females.

Different age groups were involved in the study and number of patients was different in each age group like 37 patients belong to age group 15-25 year, 40 patients in age group 26-35, 22 patient patients were from age group 36-45 and only 1 patient in age group 46-55 shown in table. Study revealed that the incidence of appendicitis was high in age group 26-35, 15-25 age group was on second number with incidence of appendicitis 37%. Cases of appendicitis were small in age group 46-55. So study showed that people in age group 26-35 are more at risk of appendicitis.

All the patients were selected on the bases of clinical findings like pain in right iliac fossa, fever, nausea, vomiting, rebound tenderness etc. clinical findings were positive in all the 100 patients as shown in table. Clinical findings provide a base to select the patients and study included all those patients having pain in right iliac fossa and positive clinical findings.

Ultrasonography was done in all 100 patients on the bases of positive clinical findings. On ultrasound various parameter like size of appendix, diameter, location, echogenicity, compressibility and periappendiceal fat were considered. On the bases of these ultrasonography was done.

On ultrasound size of appendix was examined in all 100 patients. Size of appendix was enlarged in 84% cases and was normal in 16% shown in table.

Diameter of appendix was different in all cases diagnosed of appendicitis on ultrasonography. Diameter of 6-6.9mm was found in 22 patients, 7-7.9mm in 35 patients and 8-8.9mm in 43 patients as shown in table. This ratio of diameter showed that more patient of

appendicitis presented a diameter of 8-8.9mm. Number of patients was also high with diameter 7-7.9mm. 22 patients presented a diameter of 6-6.9mm.

On ultrasound appendix showed various locations like retrocecal, subcecal and not located. Out of 84 ultrasonographically positive cases, appendix was retrocecal in 66 cases, subcecal in 18 patients and was not located in 16 patients as shown in table and graph 5. These findings suggested that appendix was retrocecal in majority cases as number indicates.

Appendix showed echogenicity in all the 84 cases suspected of appendicitis on ultrasound and was not echogenic in 16 percent of cases as shown in table.

Out of 100 patients appendix was not compressible in 84% cases and 16 percent of cases showed compressibility as shown in table. Non-compressible appendix was indicative of appendicitis while compressibility showed negative ultrasonographic findings and excluded the cases of appendicitis.

Periappendiceal fat was present in all the diagnosed cases of appendicitis and was absent in others. The periappendiceal fat was present in 85 percent cases and absent in 16 cases as shown in table. Presence of Periappendiceal fat is a good indicator of appendicitis.

Ultrasonography showed positive findings in 84 percent cases and negative in 16 cases.

Postoperative findings were different in ultrasonographically positive cases. Out of 84 ultrasound positive cases appendicitis was present in 74 cases as evidenced postoperatively by surgeon opinion. 10 cases showed other findings postoperatively. 16 cases which were sonographically negative but were positive according to clinical findings were followed for a time and out of these 16 cases 3 of cases were also positive of appendicitis when operated on the bases of pain and other clinical findings. Sensitivity, specificity, PPV and NPV were noted and a table of 2x2 was used to depict the findings.

Table-1: Post-operative findings

Ultrasound	Positive	Negative	Total
Positive	74 (TP)	10 (FP)	75
Negative	3 (FN)	13 (TN)	16

TP = True positive, FP = False positive, FN = False negative, TN = True Negative
 Sensitivity = $TP / (TP+FN) * 100 = 96.1\%$
 Specificity = $TN / (FP+TN) * 100 = 56.52\%$
 Positive predictive value = $TP / (TP+FP) * 100 = 88.1\%$
 Negative predictive value = $TN / (TN+FN) * 100 = 81.25\%$
 Accuracy = $(TP + TN) / (TP+TN+FP+FN) * 100 = 87\%$

When the table of 2x2 was used it showed 96.1% sensitivity of ultrasonography to detect true positive cases and specificity of 56.52%. PPV was

88.1% and negative predictive value was 81.25%. Ultrasonography showed the accuracy of 87% to detect the cases of appendicitis.

Table-2: Distribution of cases

Age Group(year)	15-25	37
	26-35	40
	36-45	22
	46-55	1
Sex	Male	56
	Female	44
Clinical Findings	Present	100
	Absent	0
Size of Appendix	Enlarged	84
	Normal	16
Diameter	6-6.9mm	22
	7-7.9mm	35
	8-8.9mm	43
Location	Retrocecal	66
	Subcecal	18
	Not located	16
Echogenicity	Echogenic	84
	Nonechogenic	16
Compressibility	Compressible	16
	Non-compressible	84
Peri-Appendiceal fat	Present	84
	Absent	16
Ultrasonographic Findings	Present	84
	Absent	16
Appendicitis	Present	77
	Absent	23

DISCUSSION

Suspected acute appendicitis is one of the most common diagnostic dilemmas encountered in clinical practice. Although the diagnosis is primarily based on clinical findings, the presentation can be confusing, and classic features may be subtle or difficult to elicit. Moreover, clinical signs and symptoms may overlap with other conditions such as viral gastroenteritis, intussusception, and mesenteric adenitis. In female patients, ovarian conditions may also mimic appendicitis.

With the advent of good quality transducers and graded compression technique the distance between the ultrasound probe and inflamed appendix can be decreased, the gas filled gut loops can be displaced or compressed there by increasing the visualization of the appendix.

As it is said that appendicitis is the disease of younger age, my study supports this view but no age is immune to appendicitis. In my study maximum number of patients was seen in the second and third decade (37% between age group 15-25 and 40% between 26-35 years). As compared to a study by Qureshi, A, *et al.* [12] the cases of appendicitis were more in second decade of life i.e 45% the age group of 12-20. Their

study on the sensitivity of ultrasonography in appendicitis showed 45% cases of appendicitis in age group 12 to 20. My study showed 37% cases in second decade of life.

Both sex males and females were included in study and the ratio of males to females was 56 and 44. More male patients were infected with appendicitis as contrast to a study by Shirazi *et al.* [11], the ratio of male to female was 46 and 64. Appendicitis involves both sexes it is not a disease of only one particular sex.

In study all the patients were selected on bases of clinical findings. Clinical findings were present in all the 100 cases included in my study. All the patients gave positive history of pain in right iliac fossa, vomiting and rebound tenderness etc. As compared to a study by Alia, N, *et al.* [13] showed clinical findings in all patients included in the study. Their study showed that all the patients included in study had history of abdominal pain. 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.

The study showed variability in the positions of appendix. Appendix in the humans can take one of

several position. Out of 100 patients, appendix was retrocecal in 66% cases, subcecal in 18 patients and was not located in 16 cases due to negative appendicitis or other reasons. In comparison to a study by Iqbal T, *et al.* [14] the position of appendix was retrocecal in 57 cases. Subcecal in 28 cases out of 100 patients selected for study. In another study by K. G. Patel *et al.* [15] appendix was retrocecal in 62% cases.

Ultrasonographic findings were positive in 84% of cases in my study. These ultrasonographic findings were negative in 16 patients. Ultrasound showed the sensitivity of 96.1% to detect true positive cases and specificity of 56.52%. PPV was 88.1% and negative predictive value was 81.25%. Ultrasonography showed the accuracy of 87% to detect the cases of appendicitis. In comparison to a study by Tauro F, *et al.* [10] the sensitivity of USG was 91.35%, specificity 88.09%, PPV of 91.37% and NPV of 88.09%. Tauro F, *et al.* [10] conducted a study on diagnostic accuracy of ultrasonography and result of their study showed the accuracy of 90% to detect positive cases.

Taylor *et al.* [16] conducted a study to evaluate the diagnostic value of ultrasonography in appendicitis. Their study included 121 patients with right lower abdominal pain. Ultrasonography was done and the results of their study showed the sensitivity of 71.4%, specificity 78.5%, PPV of 94.8% and NPV of 33.3%. The overall accuracy of ultrasonography was 72.5 %.

CONCLUSION

Ultrasonography is a very useful diagnostic tool for acute appendicitis. It is non-invasive and easily available which can give good results in experienced hands. It can help in diagnosing appendicitis in doubtful and equivocal cases, saving not only time and money but also reducing morbidity and mortality resulting from delay in diagnosis and consequences of perforated appendicitis.

In clinically suspected cases of pain right iliac fossa, the use of ultrasonography is valuable to establish acute appendicitis or alternate diagnosis. It can be recommended as a valuable screening tool in clinically suspected cases of acute-appendicitis.

In conclusion ultrasound by graded compression technique is a useful adjuvant to the clinical armamentarium of the present day surgeon. It can reduce the negative appendectomy rate without adversely affecting the perforation rate particularly in equivocal cases. However US findings should be correlated carefully with clinical findings.

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