DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY IN THE DIAGNOSIS OF ACUTE APPENDICITIS

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ABSTRACT

Objective: To determine accuracy of ultrasonography in the diagnosis of Acute Appendicitis using histopathologic examination of resected appendix tissue as gold standard.

Study Design: Cross sectional validation Study

Place and Duration of Study: General Surgery Department Combined Military Hospital Lahore from 16th December 2011 to 15th June 2012.

Material and Methods: The estimated sample size on 5% chance of error via WHO sensitivity and specificity calculator was 230. Consecutive (non-probability) sampling technique was used.

Pre-operatively apart from other routine diagnostic work up, ultrasonography was performed by radiologist. The decision to do appendicectomy was made independent of the findings of ultrasonography. After appendicectomy, resected appendix was sent for histopathology.

Two by two tables was used to determine the sensitivity, specificity, true positive and negative values, false positive and negative values and their predictive values. Data was entered in SPSS version 16 to calculate mean and standard deviation for age. Male to female ratio for positive and negative appendicectomies was calculated.

Results: We found Sensitivity of USG 93.1%, Specificity 88.23 %, Positive Predictive value 93.1%, Negative Predictive value 88.23 % and Diagnostic Efficacy 91.3 %. Mean and standard deviation for age was 30.27 and 13.76 respectively. Percentages for positive and negative appendicectomies in males were 77 and 23, while in females 45 and 55 respectively.

Conclusion: Ultrasonography is highly sensitive test with fair degree of specificity in diagnosing Acute Appendicitis and its routine usage will improve diagnostic accuracy.

Keywords: Appendicitis, Histopathology, Ultrasonography.

INTRODUCTION

Acute appendicitis is one of the commonest causes of pain abdomen which requires emergency surgery. Most of the time it is a clinical diagnosis but all patients do not present with the typical symptoms and signs of acute appendicitis[1]. The lifetime incidence of this disease is 12 percent in men and 25 percent in women with approximately 7% of all people. Diagnostic difficulty is encountered especially in those patients who present with atypical findings, with poorly localized abdominal pain and tenderness without either pain migration, nausea or vomiting, fever or leukocytosis[2]. This results in negative laparotomy rate ranging from 15-40%.

Diagnostic accuracy achieved by history and examination only is about 70-80 percent in adults. There are many investigations that have been recommended to improve the diagnosis like leukocyte count, C-reactive protein, laparoscopy, peritoneal aspiration and lavage, C.T. Scan and radioactive scanning. Some scoring systems like Alvarado, Ripasa, Ohmann and Eskelinen score have been formulated to achieve better accuracy in diagnosis. Unfortunately, these are either

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unreliable or invasive or extremely expensive or not practicable in routine in our country. TLC is a very cheap and readily available investigation, but carries a sensitivity and specificity of 83 % and 62.1 % respectively[3].

Ultrasonography is one of the new diagnostic techniques that have improved the diagnostic accuracy and outcome in acute appendicitis[4]. It is non-invasive, inexpensive, easy to perform and available in most parts of our country. Ultrasonographic findings of appendicitis usually comprise of non-compressible, tubular, non-peristaltic, blind-ending structure, 6mm or greater in diameter, or the presence of an appendicolith with a normal-sized appendix[1]. Studies have revealed very high sensitivity and specificity up to 98 % and 82 %, respectively[5]. Because ultrasound is highly user-dependent, operator skill may be an important factor in the diagnostic accuracy of appendicitis. Although CT abdomen is a better option but its hazards like exposure of iatrogenic ionizing radiation, the expensive scanners and unavailability in all medical institutions particularly in developing countries make it less useful.

The rationale of the study on this topic is that other investigations as mentioned above are either unreliable or invasive or not practicable so these investigations can't be used routinely for the diagnosis of acute appendicitis. Ultrasound is cheap and widely available investigation which if found accurate in this study can be employed for the diagnosis of acute appendicitis. In clinical suspicion of appendicitis, ultrasound can confirm or exclude appendicitis, can also identify its complications and alternative diagnosis can also be offered.

MATERIAL AND METHODS

It is a cross sectional validation study which was conducted at General Surgery Department, Combined Military Hospital Lahore from 16th December 2011 to 15th June 2012.

Prevalence of appendicitis in adults is 7 % so anticipated population proportion (p) is 0.07, confidence level is 95 % and absolute precision (d) required is 0.07. By using sensitivity and specificity calculator, the sample size is 229.

Only those cases which fulfilled the inclusion criteria were included in the study; and patients falling into exclusion criteria were excluded. A total of 230 cases were studied during this period and were included in the study. All these 230 patients satisfied the inclusion and exclusion criteria. Consecutive (Non Probability) sampling was used for sample selection.

All the patients above the age of 17 regardless of gender, with clinical diagnosis of Acute Appendicitis were considered for inclusion into the study. To exclude any other systemic infection patients were evaluated on three parameters, i.e. history, examination and investigations. Blood complete picture was a routine investigation. Patients with chest infection were investigated with chest x-ray; while patients with urinary tract infection were investigated with urine routine examination.

Ultrasonography was performed using 5MHz probe frequency by consultant radiologist. The decision to do appendicectomy was made independent of the findings of ultrasonography. After appendicectomies performed by classified surgeon, resected appendix was sent for histopathological examination by consultant pathologist at Combined Military Hospital Lahore Pathology laboratory (who was unaware of the ultrasound findings). Based on histopathological findings patients were divided into 2 groups:

1. Inflamed Appendix
2. Normal Appendix

Pre-operative ultrasonography findings and histopathology report of resected appendix were endorsed on patient's proforma.

Data analysis and statistical methods

All the data collected through the Proforma was entered into the statistical package for social sciences (SPSS) version 16 and analyzed through its statistical package. Mean and standard deviation was used for quantitative data like age while frequency and percentage was calculated for qualitative data like gender and findings on histopathology and ultrasound. Two by two tables was used to determine the sensitivity, specificity, true positive and negative values, false positive and negative values and their predictive values as follows:

Sensitivity

Sensitivity = a / a +c x 100

Specificity

Specificity = d / b + d x 100

Positive Predictive Value (PPV)

Positive Predictive value = a / a + b x 100

Negative Predictive Value (NPV)

Negative Predictive value = d / c + d x 100

Diagnostic efficacy

Diagnostic efficacy = a + d / a + b + c + d x 100

RESULTS

A total of 230 cases were included in the study after observing inclusion and exclusion criteria. The results were therefore based upon 230 cases. The results of this study have been summarized in tables-1- 3.

The mean age and standard deviation for histopathology proven appendicitis was 30.39 and 13.79 and for positive USG findings was 30.39 and 13.96 respectively.

The statistical analysis of the study was done using a 2 x 2 table for comparison of USG with histopathological diagnosis of Appendix (table.1). These figures are based on the data of 230 patients. Sensitivity of USG was 93.1 %, Specificity 88.23 %, Positive predictive value 93.1%, Negative predictive value 88.23 % and the Diagnostic efficacy 91.3 % (table-2).

The percentage of positive and negative appendicectomy in males was 77% and 23%, while in females it was 45% and 55% respectively (table.3). The frequency of diagnosis of acute appendicitis and normal appendix based on USG, and Histopathology was 145 & 85, and 145 & 85 respectively.

DISCUSSION

It is without any doubt that acute appendicitis puts a lot of burden when to talk about present day emergency abdominal surgery. It always tests the clinical judgment and professional capabilities of a surgeon if not all but in majority of cases; especially in women, children and old patients. It is very important for a general surgeon to make an early accurate diagnosis of acute appendicitis, not only to prevent perforation and peritonitis but also to prevent unnecessary operation. Different diagnostic modalities are available for diagnosis of Acute Appendicitis at an early stage. TLC, Urine RE, CRP and CT scan abdomen are the most effective methods, however none of them is perfect and all have advantages and disadvantages. Though the combination of various diagnostic modalities will give the best results, yet a search for the single best and reliable technique will continue.

At present, the role of abdominal imaging is indicated in most of the cases of clinical appendicitis[6]. However, the choice of which study to use, either US or CT remains a point of contention. Whenever role of a diagnostic test is justified, the most important factor in consideration is its sensitivity, specificity, positive and negative predictive values, invasiveness, availability, cost and its hazards. CT abdomen clearly has its advantages, with sensitivity approaching 100% and its ability not to be operator dependent, and in patients in which ultrasound is difficult to perform, such as those who are obese. However, the risks of contrast administration, exposure to ionizing radiation, cost and non-availability are all limiting factors.

USG alone in the diagnosis of acute appendicitis carries a high sensitivity and specificity. Authors have claimed sensitivity in the range of 98% and specificity of 82%. Others have proved sensitivity of 92% and specificity of 88%[7]. Its cost effectiveness, availability and non-invasiveness have made it more appealing and useful diagnostic tool in acute appendicitis. Diagnostic accuracy, reported to range from 71 to 97 percent, is dependent on operator skill. Major advantages of ultrasonography include noninvasiveness, short time, no radiation exposure, and potential for discovering other causes of abdominal pain.

Nicolas Kessler et al[7] evaluated Sensitivity, Specificity of USG, TLC and CRP in diagnosis of

		Histopathology of appendix	
		Inflammed Appendix	**Normal Appendix**
Signs of acute appendicitis on ultrasonography	Yes	True Positive [a]	False Positive [b]
	No	False Negative [c]	True Negative [d]

Table-1: 2 x 2 Table: Accuracy of USG in diagnosis of Acute Appendicitis.

		Histopathology of Appendix		
		Inflamed appendix	Normal appendix	
Signs of acute appendicitis on ultrasonography	Yes	True Positive (a)	False Positive (b)	a + b
		135	10	145
	No	False Negative (c)	True Negative (d)	c + d
		10	75	85
		a + c	b + d	a + b + c + d
		145	85	230

Table-2: Diagnostic Accuracy of USG.

Diagnostic Accuracy	**Calculation based upon 2 x 2 table**	**Percentage**
Sensitivity	a / a +c x 100	93.1
Specificity	d / b + d x 100	88.23
Positive Predictive Value	a / a + b x 100	93.1
Negative Predictive Value	d / c + d x 100	88.23
Diagnostic Efficacy	a + d / a + b + c + d x 100	91.3

Table-3: Percentage for Positive and Negative Appendectomy in Males and Females (n=230).

Gender	**Histopathology of Appendix**	**Total number of cases**	**Percentage**
Male	Acute Appendicitis	100	77
	Normal Appendix	30	23
Female	Acute Appendicitis	45	45
	Normal Appendix	55	55

acute appendicitis. They concluded that US-aided identification of a normal appendix was a significantly more common finding for the exclusion of appendicitis than was the normality of both WBC and CRP levels (72% vs. 47%) and had a significantly higher NPV (98% vs. 84%). TLC and CRP in diagnosis of Acute Appendicitis were also of interest for Khan MN et al[3] They showed that TLC and CRP both they not very specific. The sensitivity and specificity of WCC in this study was 83 % and 62.1 % and that for CRP was 75.6 % and 83.7 %.

A retrospective study of patients who underwent US for right iliac fossa pain suggesting acute appendicitis assessed the accuracy of ultrasonic diagnosis[5]. When the appendix was detected, the sensitivity, specificity and accuracy of ultrasound for making a diagnosis of appendicitis were 97.6 %, 82.0 %, 91.5 %, respectively.

Randen A Van et al[8] performed a study in which appendicitis was assigned to 284 of 942 evaluated patients (30%). Of 147 patients with a thickened appendix, local probe tenderness and peri-appendiceal fat infiltration on US, 139 (95%) had appendicitis. On CT, 119 patients in whom the appendix was completely visualised, thickened with peri-appendiceal fat infiltration, 114 had a final diagnosis of appendicitis (96%). When at least two of essential features were present on US or CT, sensitivity was 92% (95% CI 89–96%) and 96% (95% CI 93–98%), respectively.

In another study 802 patients were included. Use of CT was kept to a minimum (17.9%), with a US:CT ratio of approximately 6:1. Positive and negative predictive values for the clinical diagnosis of appendicitis were 63 and 98%, respectively; for US 94 and 97%, respectively; and for CT 100 and 100%, respectively[9] Despite the established superiority that CT has over ultrasound for the diagnosis of appendicitis, recent studies have advocated for a first-line ultrasound approach with adult patients presenting with possible appendicitis[10,11].

Diagnostic efficacy of USG in our study was found to be 91.3%. The highest values of Diagnostic efficacy found in the literature are 93.70%[2]. Generally speaking positive USG findings in a patient with suspicion of Acute Appendicitis has a high diagnostic accuracy. Its use as a routine but in conjunction with other diagnostic tools like clinical judgment, TLC and CRP levels will definitely bring the surgeon to the brink of a much accurate diagnosis.

Acute Appendicitis is a common abdominal emergency that urge for early surgery to prevent complications. Such condition demands early diagnosis with confidence to avoid unnecessary operation. Many diagnostic tools have been advocated to improve diagnostic accuracy, not a single proved to be the best one. Usefulness of US in the diagnosis of acute appendicitis is now established. Our results are comparable to any of the internationally and locally conducted studies.

CONCLUSION

Based on this study we make following conclusions:

In conclusion ultrasound is a useful adjuvant to the clinical armamentarium of the present day surgeon. It can reduce the negative appendicectomy rate without adversely affecting the perforation rate particularly in equivocal cases.

An important additional advantage of ultrasound is the diagnosis of alternative conditions in abdomen mimicking acute appendicitis.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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