

ROLE OF ULTRASONOGRAPHY FOR EVALUATION OF ACUTE APPENDICITIS: A UNAMID EXPERIENCE

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ABSTRACT

Objective: To evaluate the accuracy of ultrasound findings as compared to operative findings and positive predictive value of ultrasonography in the diagnosis of acute appendicitis.

Study Design: Cross sectional study.

Place and Duration of Study: Pak Field Hospital – 7 (Level III) United Nations African Union Mission in Darfur (UNAMID) Darfur, Sudan, from Mar 2015 to Mar 2016.

Methodology: All patients presenting with clinically suspected acute appendicitis (Alvarado's score >4) were referred for right lower quadrant sonography. Three point scale was used to grade sonographic findings ranging from grade 1 to grade 3. Fifty One patients with persistent symptoms and/or positive sonographic findings were operated. Operative findings were also graded on a 3 point scale. Subsequently, sonographic and operative findings were compared. Surgical findings were considered gold standard to assess diagnostic accuracy of sonography.

Results: Out of 51 patients 46 (90.2%) were males and 5 (9.8%) were females. Mean age of the patients was 32.3 ± 7.3 years. Among the study subjects, 15 (29.4%) patients were from Nigeria followed by 12 (23.5%) from Pakistan, 7 (13.7%) from Egypt and 17 (33.5%) from other countries.

The sonographic findings were detected positive for acute appendicitis in 40 (78.4%) and negative in 11 (21.6%) out of 51. All Fifty-one patients underwent surgery. The surgical findings were positive for appendicitis in 43 patients (84.3%). Four patients with negative sonographic findings did have acute appendicitis according to surgical findings. The positive predictive value was 90.9%. There was good agreement between sonographic findings and surgical findings, which was statistically significant. ($\kappa_w=0.70$ [95% CI, 0.49-0.91]).

Conclusion: In our study, sonography has a high PPV and NPV. Sonography should be considered as a primary screening tool in the algorithm of evaluation of acute appendicitis.

Keywords: Appendicitis, Sonography, Operative, UNAMID.

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INTRODUCTION

Acute appendicitis is the most common diagnosis in young adults presenting with 'acute abdomen' in ER and appendectomy is the most frequently performed urgent abdominal operation¹. Although modern radiographic imaging has improved diagnostic accuracy, however the diagnosis of acute appendicitis remains essentially clinical. In 1886, Reginald Fitz presented a paper titled 'Perforating inflammation of the vermiform appendix' in the first meeting of the Association of American Physicians². Later

Charles McBurney described the clinical manifestations of acute appendicitis³.

The individual lifetime risk of appendectomy is 8.6% for males and 6.7% for females^{4,5}. Acute appendicitis is common in childhood with the highest incidence in the second and third decades of life. The incidence of appendectomies has steadily decreased in Western countries since 1990⁵. In the present era, In the present era, the incidence of both appendicitis and appendectomy is high in industrialized countries in Asia, the Middle East and Southern America, probably due to increased use of diagnostic imaging with higher detection rate of mild appendicitis and an increase rate of appendectomies for mild non-perforated appendicitis^{5,6}.

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Received: 16 Apr 2018; revised received: 17 Nov 2020; accepted: 22 Dec 2020

Puylaert in the 1980s described the role of ultrasonography for the diagnosis of acute appendicitis⁷. In 1994, study by Balthazar showed better accuracy, sensitivity and negative predictive value of computed tomography as compared to ultrasonography⁶. However, while CT scan is considered gold standard in the diagnosis of appendicitis, due to ionizing radiation and increased risk of malignancy, its liberal use is being questioned⁸. Multiple authors have proposed the use of ultrasonography as the first diagnostic modality for suspected appendicitis, with CT scan of the abdomen reserved for ultrasound negative or equivocal cases to prevent radiation exposure⁹. In certain populations like paediatric patients, females and thin lean patients, ultrasonography has higher reported specificity for appendicitis and it can help delineate other abdominal or pelvic pathologies¹⁰. The rationale of this study was to assess the efficacy and positive predictive value (PPV) of sonography and the correlation between operative and ultrasound findings in the diagnosis of acute appendicitis.

METHODOLOGY

A cross sectional study was conducted at Pak Field Hospital - 7 (Level III) United Nations African Union Mission in Darfur (UNAMID), Sudan, after hospital ethics committee review and formal approval. The reference prevalence of acute appendicitis was 44.272%¹¹. Using convenience sampling technique, total 60 patients were initially included, out of which symptoms settled in 6 patients and three patients did not consent for surgery hence they were dropped out. Study was done on 51 patients with clinically suspected acute appendicitis (Alvarado score > 4).

Patients of both genders and any age group presenting with acute abdominal pain with clinical diagnosis of acute appendicitis were included in study after informed written consent. The patients who refused to consent and patients unfit for anaesthesia were excluded from study. Similarly, known and newly diagnosed patients of right renal calculi, hydronephrosis and ovarian

pathology on ultrasonography were also excluded.

All patients with clinically suspected acute appendicitis (alvarado score >4) were referred for sonography. Three point scale was used to grade sonographic findings namely grade 1 (Appendix not visible or normal looking), grade 2 (Inflamed appendix with diameter more than 6mm) and grade 3 (Grossly inflamed appendix with periappendicular fluid or only secondary signs of appendicitis). Fifty One patients with persistent symptoms and positive sonographic findings were operated. Operative findings were also graded on a three point scale with normal looking appendix graded as 1, inflamed appendix as grade 2 and grossly inflamed appendix with periappendicular fluid as grade 3. Subsequently, sonographic and operative findings were compared. Data of all patients was collected on a pre-designed data form. Patients were followed up for 6 months post operatively or till their repatriation to home country. Surgical findings were considered gold standard to assess diagnostic accuracy of sonography.

Statistical Package for Social Sciences (IBM SPSS) version 20.0 was used to analyse data. Relevant descriptive statistics i.e. frequency and percentage was estimated for age, gender, demographic details as well as categorical grouped variables. Cohen weighted κ coefficient was applied using Microsoft Excel with add on Analyse it to verify agreement between radiological and operative findings. Values between 0.61 and 0.80 were considered good agreement. Positive and negative predictive values were calculated using 2x2 table.

RESULTS

During the study period, 51 patients were admitted with clinical suspicion of acute appendicitis. Out of 51 patients 46 (90.2%) were males and 5 (9.8%) were females. Mean age of the patients was 32.3 ± 7.3 years. Among the study subjects, 15 (29.4%) patients were from Nigeria followed by 12 (23.5%) from Pakistan, 7 (13.7%) from

Egypt and 4 (7.8%) patients were from Nepal (figure).

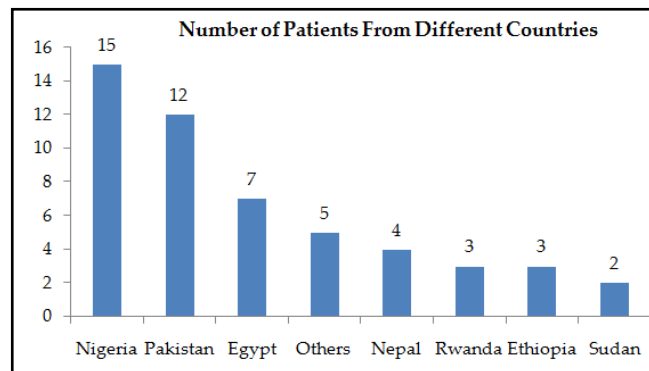


Figure: Demographic details of patients. (Others = 1 patient each from Bangladesh, Jordan, South Africa, Tanzania and Togo).

After investigations all clinically suspected patients were subjected to ultrasonography followed by surgery. The sonographic findings were detected positive for acute appendicitis in 40 (78.4%) and negative in 11 (21.6%) out of 51. All

Table: Sonographic diagnosis compared with surgical findings in patients who underwent surgery.

Surgery	Sonography		Total n (%)
	Positive n (%)	Negative n (%)	
Positive	39 (76.5)	4 (7.8)	43 (84.3)
Negative	1 (2.0)	7 (13.7)	8 (15.7)
Total	40 (78.4)	11 (21.6)	51 (100)

Table-II: Alvarado score.

Findings	Points
Migrating Pain to the right lower quadrant	1
Nausea / Vomiting	1
Anorexia	1
Tenderness	2
Rebound tenderness	1
Body temperature $\geq 37.3^{\circ}\text{C}$	1
Leukocytosis	2
Shift to left of Neutrophils	1

Score:

0-4: Less likely to be acute appendicitis. Outdoor follow up.

5-6: Possible acute appendicitis. Indoor investigations.

7-8: High probability of acute appendicitis.

9-10: Definite acute appendicitis. Needs surgical exploration.

Fifty-one patients underwent surgery. The surgical findings were positive for appendicitis in

43 patients (84.3%). Four patients with negative sonographic findings did have acute appendicitis and one patient with positive sonography had normal appendix per-operative (table). There was good agreement between sonographic findings and surgical findings, which was statistically significant. ($\kappa = 0.70$ [95% CI, 0.49-0.91]). Out of 7 patients with negative sonographic and operative findings for acute appendicitis, ovarian cyst was found in 1 patient. Ultrasonography showed a negative predictive value of 85.7% and a positive predictive value of 90.9%. Diagnostic accuracy of ultrasonography was 90.2%.

DISCUSSION

Acute appendicitis is the most common cause of acute abdominal pain in patients presenting in ER that requires surgical treatment. The peak incidence of acute appendicitis is seen in the second and third decade of life and it is uncommon before the age of 5 and after the age of 50 years⁴. Before puberty, the incidence of acute appendicitis is equal among males and females. Teenager and young males are affected more commonly than females and this greater incidence in males decline after the age of 25¹². Wide geographic, racial and occupational variations reported in the incidence of acute appendicitis are probably due to differences in dietary fibre consumption.

The acute appendicitis is diagnosed clinically; however, there is 10% to 30% incidence of unnecessary appendicectomies for an incorrect diagnosis of appendicitis¹³. The presentation of acute appendicitis can be confusing and clinical features may be subtle making it one of the most common diagnostic dilemmas in clinical practice. Due to overlapping symptoms and clinical signs intussusception, mesenteric adenitis, viral gastroenteritis and ovarian conditions in female patients may be confused with appendicitis. The difficult clinical diagnosis of appendicitis is assisted by a number of clinical and laboratory based scoring systems like the most widely used Alvarado Score (MANTRELS) and Appendicitis Inflammatory Response Score^{14,15}.

After clinical examination and laboratory investigations, patients with an equivocal score benefit from imaging studies to reduce the rate of negative appendectomy. Imaging plays a key role in the evaluation of all cases of acute abdomen and the ideal imaging test for such cases is the one that is safe, fast, inexpensive, reproducible and readily available. The most commonly used imaging tests in evaluation of possible appendicitis are ultrasonography and computed tomography (CT) scan.

Abdominal ultrasound examination has become a valuable tool for diagnosis in acute abdomen. Ultrasound examination has diagnostic accuracy in excess of 90 percent in children, thin adults and females with suspected gynaecological pathology^{10,16}. Graded compression ultrasonography is inexpensive, can be performed rapidly without contrast medium, and is safe in pregnant patients¹⁷. On ultrasound, the appendix is seen as a blind-ending, aperistaltic bowel loop in the right lower abdomen. Increased anterior-posterior diameter of >6mm, thickening of the appendicular wall and the presence of periappendicular fluid are highly suggestive of appendicitis. Whereas an easily compressible appendix with diameter measuring <5 mm excludes the diagnosis of appendicitis¹³. In a metaanalysis, Doria described the overall sensitivity of ultrasound as 88% and 83% and its specificity as 94% and 93%, for children and adults, respectively¹⁸.

Ultrasound has several advantages and disadvantages as a diagnostic modality for appendicitis. The disadvantages of ultrasound include patient discomfort evoked by transducer pressure, operator dependence and limited use in obese adults. The advantages of ultrasonography include non-invasiveness, short acquisition time, lack of radiation exposure, safe, relatively inexpensive, and widely available¹⁹. Other advantages include excellent imaging modality for the reproductive organs and the potential for discovering other causes of abdominal pain. For these reasons, it is especially useful in children and women of childbearing age to minimize radiation exposure to reproductive organs. In our study,

ovarian cyst was found in 1 patient. The literature shows that the ultrasonography can be performed by non-radiologist emergency physicians with specificities of 90% and higher depending on the age of the patient and equipment used¹.

The computed tomography (CT) scan as a diagnostic modality for appendicitis has accuracy of 93% to 98% in a number of studies because of its ability to show normal appendix more reliably and with greater consistency than ultrasonography⁸. With high-resolution CT scan, the inflamed appendix appears dilated (>5 mm) and thick walled with signs of inflammation in the form of periappendicular fat stranding, thickened meso-appendix and free fluid. Unlike ultrasonography, intraperitoneal fat in obese patients actually improves the diagnostic accuracy of CT scan for appendicitis²⁰. In older patients with diagnostic uncertainty and differential diagnosis of diverticulitis and neoplasm Contrast-enhanced CT scan is the most useful diagnostic tool. Despite the potential usefulness in reducing negative appendectomies, the significant disadvantages of the CT scan are expensiveness, significant radiation exposure, limited use during pregnancy and allergy to contrast agents²¹.

Several studies have compared the use of ultrasonography and CT scan in the diagnosis of acute appendicitis. Wiersma *et al*²² reported visualisation of normal appendix in 82% of asymptomatic children on ultrasonography. In most of the studies, visualization of appendix is included in diagnostic criteria. But like a few other studies we considered ultrasound findings positive when secondary signs of appendix were present even if appendix was not visualised²³. The findings were considered negative if appendix and secondary signs of appendix were absent thus excluding acute appendicitis on the basis of negative ultrasonography. Using these criteria, the NPV was 85.7%, similar to results in prior studies²⁴. Three patients with acute appendicitis in our study had false-negative and one patient had false positive sonographic findings. Retrocecal and retroileal appendixes are difficult to visualize, whereas anterior appendixes are relatively easy to identify. In

our study, 1 patient who had falsepositive sonography has ruptured right ovarian cyst with free fluid in the pelvis and right iliac fossa. The PPV in our study (90.9%) was also comparable with other studies^{10,24}. Our study focused mainly on the screening value of sonography, with the sonograms interpreted in a manner to avoid missing any cases with positive findings, subtle but non-specific signs that might have indicated acute appendicitis, such as fluid in the right paracolic gutter, were interpreted as positive results (grade 3 sonographic findings).

Our study was limited mainly to United Nations Force serving in UNAMID Dafur, Sudan and generally to IDPs in Nyala. This study was also limited by non availability of CT scan and histopathology at level III hospital, and higher operator dependency for ultrasonographic examination. However, our study was aided by the screening protocol at our institution for exclusion of appendix. In conclusion, sonography was found to have a high NPV (85.7%) in our study, for the exclusion of acute appendicitis even if the appendix was not visualized. With increased workload, time allocation for each patient is decreased and it becomes very difficult to perform graded compression for localization of appendix. The role of sonography in screening algorithms for the evaluation of suspected acute appendicitis is supported, particularly in young female patients for whom the gonadal radiation dose should be kept to a minimum. However, further imaging can be performed if clinical signs and symptoms become worse or strongly suggest appendicitis.

CONCLUSION

Sonography using graded compression has high diagnostic accuracy for acute appendicitis. Our study also showed that sonography has high PPV, NPV and diagnostic accuracy. Therefore, sonography should be used as a primary screening tool in the algorithm of evaluation of acute appendicitis. Further imaging like CT scan should be reserved for patients with equivocal sonography and persistent clinical signs and symptoms.

CONFLICT OF INTEREST

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

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