

Original Paper

Discovering The True Accuracy of Ultrasonography in The Confirmation of Diagnosis of Acute Appendicitis, a World-wide Dilemma

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Abstract

Background: Acute appendicitis occurs in almost 10 % of western populations. The male-female ratio of approximately 2:1 gradually declines after age 25 years until the gender ratio is equal. Approximately 1% of total surgical procedures are appendectomies. Negative appendectomy rates are increasing and some of the factors that play a massive role in this include clinical evaluation that is not specific and absence of readily available techniques permitting direct visualization of the appendix. Because of this world-wide problem of increasing negative appendectomies, we need a method to confirm the diagnosis of true acute appendicitis.

Objective: This study was conducted to evaluate and estimate the efficacy of ultrasound in the confirmation of diagnosis of acute appendicitis in clinically suspected cases of acute appendicitis and to compare ultrasound findings with surgical findings.

Methods: This study included a total of 100 patients suspected to have acute appendicitis who were admitted to the department of surgery at Al-Karak teaching hospital, Mutah University, from January

2014- December 2015. Abdominal-pelvic sonography with focus on the right lower quadrant graded compression ultrasonography technique was used. The sonographic data was prospectively correlated with clinical operative and histopathological findings.

Results: Graded compression ultrasonography results were analyzed and showed 92.7% sensitivity, 94.5% specificity, 93% accuracy, 94.4% positive predictive value, 92.5% negative predictive value.

Conclusion: Ultrasonography has a higher degree of accuracy so it is a safe and a reliable method in the diagnosis of suspected cases of acute appendicitis. This can help minimize negative appendectomies, perforation rates, and medical expenses on patients. Therefore from the findings in our study, we may begin to put this world-wide issue to rest.

Keywords

Acute appendicitis, ultrasonography, Jordan

1. Introduction

Acute appendicitis develops in approximately 10% of the population in western countries. The maximal incidence occurs in an individual's teens and twenties. The male-female ratio of approximately 2:1 gradually declines after age 25 years until the gender ratio is equal. Approximately 1% of total surgical procedures are appendectomies (Lewis, Holcroft, Boey, & Dunphy, 1975). The preoperative clinical diagnoses are straightforward in 70-80% of cases with an overall negative appendectomy rate of 20%-25% (Birnbaum & Wilson, 2000; Paulson, Kalady, & Pappas, 2003; Yu, Kim, Park, Kim, & Radosevich, 2005). It is generally accepted that in men the negative appendectomy rate is below 20% and rates of 10-15% are commonly reported (Berry Jr. & Malt, 1984). On the other hand, young women commonly present with acute gynecological problems that closely mimic acute appendicitis. There's an increase in reported negative appendectomy rates in ovulating women and thus remains in a disturbingly high range from 34%-46% (Buchman & Zuidema, 1984; Fitz, 1886). Major factors that play a huge role in this continued high negative appendectomy rate are non-specific clinical evaluation, lack of readily available techniques allowing direct visualization of appendix, and identification of specific diagnostic features of acute appendicitis (Jeffrey Jr., Laing, & Lewis, 1987).

The overall mortality rate for acute appendicitis is less than 1% but in elderly patients it is higher ranging 5%-15% (Balsano & Cayten, 1990; "A Sound Approach to the Diagnosis of Acute Appendicitis"). The morbidity, especially in younger women, is 45% which is due to high prevalence of common obstetrical and gynecological disorders (Addiss, Shaffer, Fowler, & Tauxe, 1990; Berry Jr. & Malt, 1984; Lewis et al., 1975). In recent years, ultrasonography has been widely performed during the examination of patients with clinically suspected acute appendicitis because of its safety and diagnostic accuracy (Assefa, Meseret, & Nigussie, 2006; Morin, 2008). In addition, abdominal ultrasonography was first performed in 1981 to demonstrate an inflamed appendix (Rompel, Huelss, Bodenschatz, Reutter, & Darge, 2006). Laparoscopy has been shown by some authors to be particularly useful in young women of reproductive age because gynecological conditions may mimic acute

appendicitis (Jones, 1990). Complication Rate of unnecessary operation is up to 30% (Gilmore et al., 1975; Pearson, 1988). Which is close to that of inflamed appendix (Scher & Coil, 1980).

Many studies have found promising value in abdominal ultrasonography for the confirmation of acute appendicitis (Lee, 2003; Zielke, Sitter, Rampp, Bohrer, & Rothmund, 2001). In general, negative appendectomy may be reduced by ultrasonography, along with clinical evaluation (Fujii et al., 2000; Styrud, Josephson, & Eriksson, 2000). These studies show a sensitivity 75%-98% & accuracy 87%-96% (Larson, Pierce, & Ellinger; J. Puylaert, 1986). Therefore this study was conducted to evaluate diagnostic accuracy of ultrasonography & to reduce high negative appendectomy rate (Friday, 2006).

1.1 Objectives

This study aims to determine and assess the sensitivity, specificity, and accuracy of ultrasonography for the diagnosis of acute appendicitis and to compare ultrasound findings with surgical findings.

2. Methodology

A prospective study was carried out in the department of radiology at Mutah University, Al-Karak Teaching hospital in the south of Jordan. A total of 100 patients suspected of acute appendicitis were included in the study.

Inclusion criteria:

Patients more than 14 years of age who presented with right lower quadrant pain lasting less than 48 hours and diagnosed clinically as acute appendicitis.

Exclusion criteria:

- 1- Patients with clinical symptoms & signs of appendicular abscess mandating conservative management.
- 2- Patients to whom ultrasonography could not be performed
- 3- Patients who didn't undergo acute appendicitis

Ultrasonography was performed on patients using 3.5 MHz convex and 7.5 MHz linear transducers. After taking a detailed history, performing a complete physical examination, and taking blood sample for complete blood count, the results are said to be positive if the examination met at least one of the criteria of Puylaert et al. (1987) which includes:

- Non compressible swollen appendix with a diameter, greater than 7 mm and wall thickness greater than 3mm
- Lack or absence of normal wall layer.
- Appendicolith
- Increase and hyper-echogenicity of periappendiceal fat
- Appendicular abscess
- Periappendiceal fluid connection

3. Results

The total number of subjects enrolled in the study was 100; ages ranging from 15-60, 54% of subjects were under 20 years old and 56% were males; the mean age was 28 years.

The most affected age group were the subjects under 20 years old; 76% of cases were below 40 years, there were no differences between age groups and gangrenous appendicitis as shown in Table 1 below.

Table 1. Distribution of Appendicitis Cases, Mutah University – Al-Karak, 2015 by Age Group

Age groups	Gangrenous	Other	Total
<20	18	36	54
20-39	6	16	22
40-49	10	8	18
50-59	3	3	6
TOTAL	37	63	100

Chi square 4.29, p-value 0.23

By ultrasonography it was found that the appendix in 76% of cases had a diameter equal to or more than 6mm, 68% had positive Target sign, and 38% had fluid in the right iliac fossa. 67% had both diameter equal to and more than 6mm and target sign positive but only 36% of cases had diameter of more than 7mm, target sign positive, and fluid in RIF as shown in Table 2 below.

Table 2. Distribution of Appendicitis Cases, Mutah University – Al-Karak, 2015 by Ultrasound Findings

Ultrasound Finding	Frequency	Percent
DIA $\geq$ 6mm	76	76
Target Sign	68	68
RIF	38	38
DIA $\geq$ 6mm and target	67	67
DIA $\geq$ 6mm and target and FRIF	36	36

And out of 100 cases almost 37% had gangrenous appendicitis, as shown in Figure 1 below.

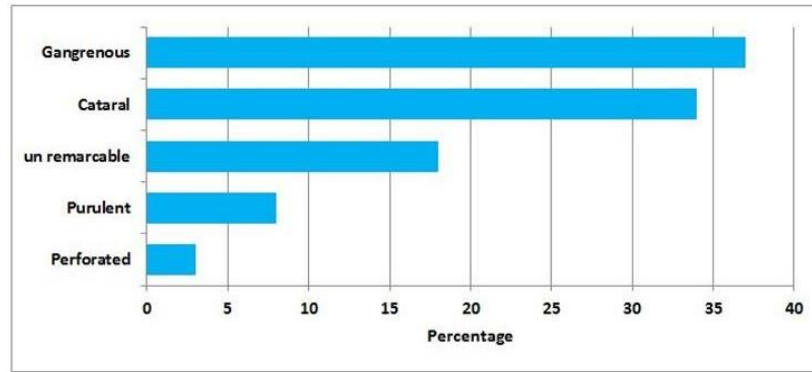


Figure 1. Distribution of Appendicitis Cases, Mutah University – Al Karak, 2015 by Type of Appendicitis

Percentage of types of appendicitis from highest to lowest as shown in the figure: gangrenous, catarrhal, unremarkable, purulent, and perforated.

There is no gender difference in acute appendicitis but there is a significant association between gender and gangrenous appendicitis, 44% of males had gangrenous appendicitis in comparison to only 27% of females as shown in Table 3 below.

Table 3. Association between Gender and Gangrenous Appendicitis, Mutah University – Al-Karak, 2015

	Gangrenous	other	total
Male	25	31	56
Female	12	32	44
Total	37	63	100

Chi square 17.1, p-value 0.00000

There was also a significant association between increasing diameter, equal to or more than 6mm, with gangrenous appendicitis. There were no cases where the diameter was less than 6 mm and the patient had gangrenous appendicitis as is noted below in Table 4.

Table 4. Association between Ultrasonography and Gangrenous Appendicitis, Mutah University – Al-Karak, 2015

DIA >	Gangrenous	Others	Total
>= 6mm	37	39	76
6 mm or less	0	24	24
TOTAL	37	63	100

Fisher Exact 0.000001

Target sign was positive in 65% of cases, the sensitivity was 95.59%, specificity was 46.88 %, positive predictive value was 79.27% and negative predictive value was 83.33%. Right iliac fossa collection or fluid collection was seen in 38%. Additionally the appendix with a transverse diameter of more than 7 mm was identified in 73% of cases. Correlation of findings of ultrasonography, intra-operative, and histopathological examination was statistically significant (X^2 42.36, p 0.0000).

4. Discussion

Our study showed that the overall accuracy of ultrasound in diagnosing acute appendicitis as seen in our study had a sensitivity of 85.7%, specificity of 100%, positive predictive value of 100%, negative predictive value of 6.7%, and accuracy percentage of 85.9%.

We found that a threshold diameter of 6 mm or more is critical in diagnosing acute appendicitis; this criterion was more sensitive for the diagnosis. In a study done by Jeffery, 78 out of 80 (97.5%) patients had visible appendices with transverse diameter equal to or more than 6mm. Graded compression ultrasonography, as popularized by Puylaert, is a readily available, noninvasive, highly accurate mean of diagnosing appendicitis and a variety of relevant disease (Khanal, Ansari, & Pradhan, 2008). Prospective studies have shown the overall accuracy of ultrasonography in diagnosing acute appendicitis ranges between 87%-98%, specificity 89%-99%, and sensitivity 86%-97% (Fujii et al., 2000; HIMENO et al., 2003; Khanal et al., 2008). Our findings are thus parallel to results from other studies done by Puylaert et al., Yousef et al. and Lakhey et al., Abu-Yousef et al., (1987), Lakhey (2000), Puylaert et al. (1987).

Moreover, in our study there was no difference in gender in incidence of acute appendicitis but we had slight male preponderance in incidence of gangrenous appendicitis. Whereas in a study done by Julien (1986), acute appendicitis was more frequent in females. But other studies worldwide done by Lakhey (2000) showed male dominance. So in the United States males have a higher rate of incidence of appendicitis than female. But for all age groups the overall ratio is 1.4:1 (Addiss et al., 1990). In the United States, highest incidence of acute appendicitis is seen in the population age group of 10-30 years which is similar to our study with the highest incidence seen in the population age group of 15-35 years.

5. Conclusion

Generally speaking ultrasonography is an accurate, safe, and reliable method in diagnosis of suspected cases of acute appendicitis and this can help minimize negative appendectomy, perforation rates, and unnecessary medical procedures and expenses on patients around the world. We thus propose ultrasonography should be done for all patients presenting with suspected appendicitis.

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