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Could Preoperative Ultrasound Examination Improve the Final Outcome of Appendectomies?

Jaffar Alkhuzaie, MBBCh, MRCSI, CABS, FACS*
Jassim Al Mehza, MBBCh, FACSC* Abdulrahman Bucheery, MBBCh**
Hassan Khuder, MBBS*** Raja Eid, MBBS*** Nooraldin A Ali, MBBCh***

Objective: To assess the efficacy of abdominal ultrasound in diagnosing acute appendicitis.

Design: Retrospective study.

Setting: Salmaniya Medical Complex, Kingdom of Bahrain.

Method: Data collected from files of 312 patients who had appendectomy between 1 January to 31 December 2009.

Result: Three hundred twelve patients had appendectomy, 114 (36.5%) had ultrasound (US) examination and only 57 (50%) showed radiological findings positive for appendicitis.

Thiry-seven (11.9%) patients had negative appendectomy. Twenty-three (11.6%) had negative appendectomy in clinical group, 3 (5.3%) patients were negative in positive ultrasound group and 11 (19.3%) patients in negative ultrasound group.

Conclusion: Ultrasound is not a reliable test to diagnose appendicitis as it carries low sensitivity and specificity, although it showed good predictive positive value.

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Abdominal pain is a common presenting symptom, accounting for nearly 7%-8% of emergency department visits[1,2]. Acute appendicitis is the most common cause of abdominal emergency. The lifetime risk of developing appendicitis is approximately 7% and usually requires surgical treatment.

The overall incidence of this condition is approximately 11 cases per 10,000 populations per year. Acute appendicitis may occur at any age, although it is relatively rare at extremes of age[3].

* Consultant General Surgeon
** Surgical Resident
***Senior Surgical Resident
Department of Surgery
Salmaniya Medical Complex
Kingdom of Bahrain
Email: jaffaremail@gmail.com

The diagnosis of acute appendicitis can be challenging even in the most experienced hands

and is predominantly clinical[3]. Delayed diagnosis may result in perforation of the inflamed appendix, peritonitis, appendiceal mass or abscess formation. Clinical diagnosis of appendicitis is often difficult as it is not possible to have the definitive diagnosis by gold standard test "histopathology" preoperatively[4]. The accepted rate of negative appendectomies ranges from 7% to 25%[2,5].

The current management of appendicitis is to lower the percentage of negative appendectomies and avoid perforation.

Clinical scoring systems are good supporting tools for diagnosing acute appendicitis because they are simple, easy to use and non-invasive, requiring no special equipments. Alvarado score based on analysis of symptoms, sign and laboratory data is easy to apply[6]. Abdominal sonaography became one of the common non-invasive tool used to reach the diagnosis of appendicitis.

The aim of the study is to determine the efficacy of ultrasound in early detection of acute appendicitis.

METHOD

A retrospective study was performed to evaluate patients who had appendectomy in Salmaniya Medical Complex (SMC) from 1 January to 31 December 2009.

The following data were reviewed: age, sex, abdominal pain, nausea, vomiting, urinary symptoms, diarrhea or constipation, anorexia, menstrual cycle, WBC count, urine analysis, temperature, tachycardia, blood pressure, right iliac fossa tenderness, rebound tenderness, guarding, generalized peritonitis, ultrasound, open or laparoscopic appendectomy, operative findings, histopathology report and duration of hospitalization.

Patients were grouped according to the usage of ultrasound or not and Alvarado scoring system. Ultrasound group was subdivided according to suggestive of appendicitis or not. Ultrasound group and Alvarado scoring system were compared and contrasted, see table 1 and 2.

Table 1: Alvarado Scoring System

Symptoms	**Points**
Migration of pain to right lower quadrant	1
Anorexia or acetone in urine	1
Nausea or/and vomiting	1
Signs	
Tenderness in right lower quadrant	2
Rebound pain	1
Elevation of temperature	1
Laboratory	
Leucocytosis	2
Shift to the left	1

Table 2: Impact of Alvarado Scoring

Score	Probability of Appendicitis
≤ 4	Unlikely to be acute appendicitis
5 or 6	Compatible with the diagnosis of acute appendicitis
7 or 8	A probable appendicitis
9 or 10	Very probable appendicitis

Direct visualization of an incompressible appendix with an outer diameter more or equal to 6 mm and echogenic incompressible periappendicular inflamed tissue with or without an appendicolith was the primary criterion to establish ultrasonic diagnosis of acute appendicitis.

SPSS version 17 was used for statistical analysis.

RESULT

Seven hundred thirty-four patients had appendectomy in 2009 according to SMC registry record. Three hundred fourteen files were retrieved for data analysis, two patients were excluded because histopathology report was not found; 233 (74.7%) were males and 79 (25.3%) were females. The age ranged from 1 to 64 years, a mean of 29.2 years (SD: +/- 12.908).

Thirty-seven (11.9%) had negative appendectomy and 64 (20.5%) had complicated appendicitis. One hundred eighty-four (56.3%) had open appendectomy, 127 (43.3%) had been operated laparoscopically and one patient (0.3%) had laparotomy. Ultrasound was done for 114 (36.3%) patients, appendix diameter measures 6 mm or more in 57 (50%) patients. The patients were divided into two groups, clinical assessment and ultrasound investigation groups.

One hundred and fourteen patients had ultrasound and 198 did not. Fifty-seven (50%) of ultrasound group showed positive appendicitis. Fourteen (12.3%) had negative appendectomy in ultrasound group and 23 (11.6%) in clinical group. Twenty-five (21.8%) had complicated appendicitis in ultrasound group and 39 (19.7%) in clinical group, see table 3 and figure 1.

Table 3: Comparing Clinical and Ultrasound Groups

	Clinical Group	US Group
Patients Number	198	114
Mean Age	27.56	32.08
Male	87.9%	51.8%
Female	12.1%	48.2%
Negative Appendectomy	11.6%	12.3%
Complicated Appendicitis	19.7%	1.8%

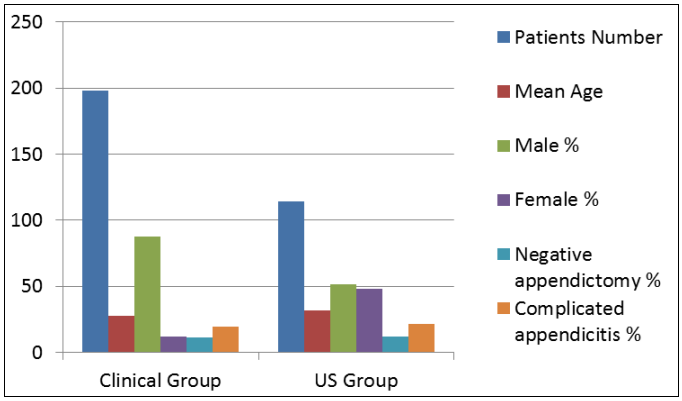

Figure 1: Comparing Results of Clinical and Ultrasound Group

We could apply Alvarado scoring system on 259 patients; therefore, four groups of patients according to the probability of appendicitis were revealed, see table 2 and figure 2. Then we looked for negative appendectomy, complicated appendicitis, usage of ultrasound and positive and negative results in table 4 and figure 3.

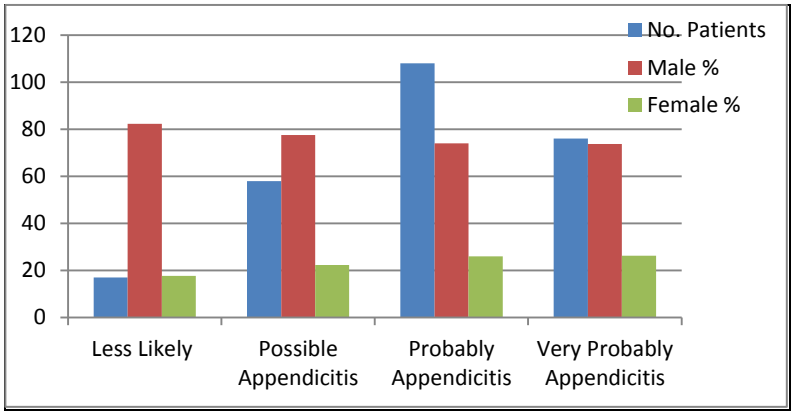

Figure 2: Stratification of Patients According to Alvarado Scoring

Table 4: Comparison According to Alvarado Scoring

	Less likely	Possible Appendicitis	Probably Appendicitis	Very Probably Appendicitis
Patients Number	17	58	108	76
Male	82.3%	77.6%	74%	73.7%
Female	17.7%	22.4%	26%	26.3%
Negative Appendectomy	11.8%	22.4%	12.96%	1.3%
Complicated Appendicitis	11.8%	17.2%	21.3%	25%
US	52.9%	36.2%	33.3%	28.9%
6 mm Appendix	55.5%	66.7%	52.8%	54.5%

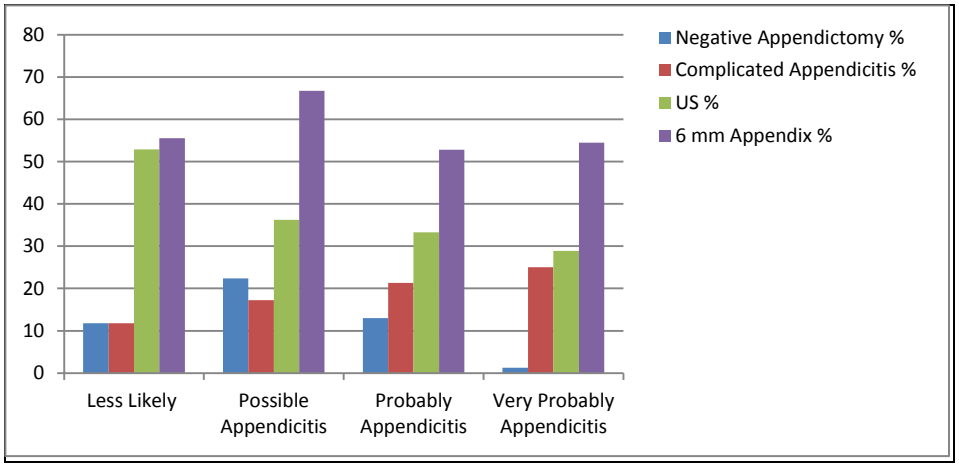

Figure 3: Comparison According to Alvarado Scoring

Finally, we compared the three groups: clinical, US positive and US negative. which resulted in negative rate of 11.6%, 5.3%, 19.3% and complicated appendicitis of 19.7%, 15.8%, 28.1% respectively, see table 5 and figure 5. The negative appendectomy and complicated appendicitis were evaluated, see figures 5 and 6.

Table 5: Comparing Results of Negative and Complicated Appendix between Clinical, US Positive and US Negative Groups

	Clinical Group	US Positive	US Negative
Number of sample	198	57	57
Negative appendectomy	11.6%	5.3%	19.3%
Complicated appendix	19.7%	15.8%	28.1%

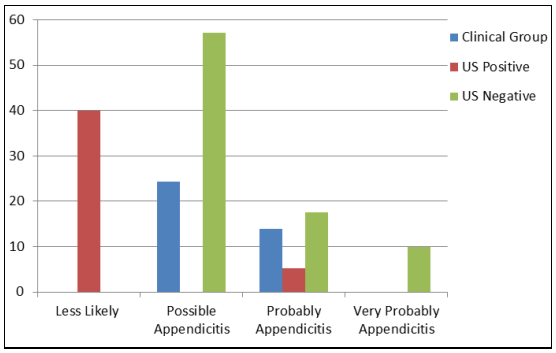

Figure 5: Negative Appendectomy Percentage Comparison According to Alvarado Scoring

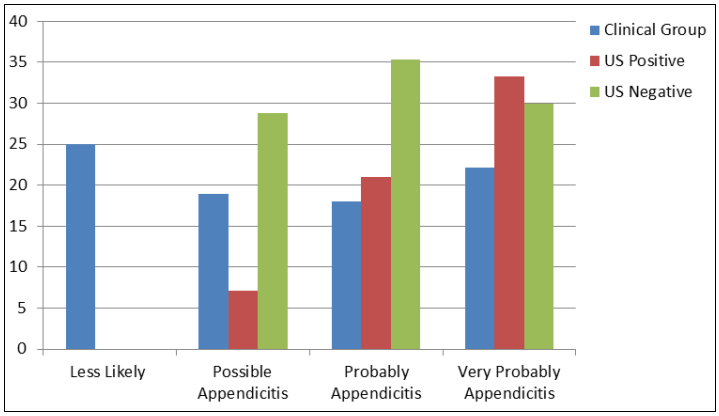

Figure 6: Complicated Appendicitis Percentage Comparison According to Alvarado Scoring

DISCUSSION

Acute appendicitis is a common and challenging diagnosis in daily surgical practice. It is a clinical diagnosis and many patients present with atypical history and findings on examination. The accuracy of diagnosing acute appendicitis on clinical grounds ranges from 70 to 87%[7]. The chance of undergoing an appendectomy during a lifetime is high, up to 23% in females and 12% in males[2].

It is safer to proceed to surgical intervention when in doubt, because a negative appendectomy is preferable to a perforation. A negative appendectomy rate of 7%-30% has been accepted to be the clinical standard because that kept the rate of perforated appendicitis 7%-30%[8-10]. Morbidity was 5%-15% after negative appendectomy, which is not significantly different from cases of non-perforated appendicitis[8,11,12]. Perforation compared to no perforation is associated with a double increased in mortality rate[10].

Ultrasound and computed tomography have been advocated to reduce the negative appendectomy rate[13,14]. The ideal test should be 100% sensitive and 100% specific and should have a predictive value of 100%. Also, there should be no false positive or false negative results, so that the total joint probability should add up to 100%, currently no such test is available.

Implementation of US and CT in clinical studies resulted in high accuracy of diagnosing appendicitis. A low negative appendicitis rate could be achieved without adverse events due to a delay in treatment because of false negative imaging[15].

CT evaluated by general radiology staff has similar accuracy to that of sonography[16]. Ultrasound is inexpensive, rapid test, non-invasive and requires no patient preparation or contrast material. Graded compression ultrasound is operator dependent and requires high level of expertise. The ultrasound images are not helpful for reevaluation. Moreover there are many limitation for ultrasound e.g., obese patients, retrocecal appendix or severe abdominal pain[14,17]. Another important limitation of sonography is that the sensitivity and specificity for perforated appendicitis are lower than for non-perforated appendicitis[18]. The sensitivity of ultrasonic detection of appendicitis is 55 to 98% and the specificity is 78 to 100%[3,6,9,17,18-22].

However, perforated appendicitis and negative appendectomy have not declined despite the use of US and CT scan[23]. Perforation rates have remained at constant level, approximately 20% over the last decade[2,7,10,13].

Although US is non-invasive, the tests add expense, burden hospital resources and can delay surgical intervention[14]. Moreover, false negative results may delay surgery and subsequently increase morbidity[24].

Livingston et al found a slow but steady increase in the incidence of perforated appendicitis despite a decline in non-perforated appendicitis until a nadir in 1995, after which the incidence of non-perforated appendicitis increased presumable due to advancement in imaging diagnosis and low-morbidity laparoscopic surgical techniques, while the incidence of perforated appendicitis continued on the same slow steady climb[25,26].

The Alvarado score was originally described in 1986. However, this score alone is not accurate enough to diagnose or exclude appendicitis[27,28]. Alvarado found the cut-off point of score 6 will have potential perforations, 5.8% and 8.7% will be unnecessary operation. But if score 5 potential perforation will drop to 2.9% and the unnecessary operations would rise to 11.2 %[6]. Alvarado reported that patients with a score 7 or higher could be acute appendicitis, a probability of 93%[17]. The Alvarado score is dynamic and can be recalculated at intervals over 12 to 24 hours of observation as often occurs in patient with an intermediate score[29]. Alvarado score showed poor result in assessment of women, children and elderly patient[28].

Henrik found the clinical judgment of a junior surgeon was disappointing and diagnostic aids are desirable to reduce the negative appendectomy rate. Diagnostic ultrasound is performed poorly as routine procedure. Application of an up to date scoring system might be of some help to patients with a high or low probability of acute appendicitis[30].

Sonography as a standard procedure in the workup of acute appendicitis can be worthwhile only if the surgeon can rely on it to operate. Concern still exists that the overuse or reliance of radiologic tests may distract from careful and timely clinical assessment. How high should accuracy of CT and sonography in acute appendicitis be to convince the surgeon not to operate? If a small risk of a perforated acute appendicitis is still present even when both CT and sonography show a normal appendix, most surgeons will ignore the result[16].

In our study we found low sensitivity and specificity of ultrasound in diagnosing acute appendicitis. Review of literature revealed wide variation of ultrasound results which might reflect different equipment, operator's training and expertise[31]. One of the weaknesses in our study is the fact that it is retrospective in nature, making it difficult to elucidate the process involved in deciding on preoperative imaging, the timing of surgery and the type of surgery.

CONCLUSION

Ultrasound in our institute showed low sensitivity and specificity which made ultrasound an unreliable method for diagnosing acute appendicitis, as there is no statistical significance between the rates of negative appendectomies if ultrasound was done comparing with the group operated based on clinical finding alone.

Diagnostic imaging will continue to play a large role in the evaluation of patients with suspected appendicitis. The choice of imaging modality depends upon local expertise and should be made with consideration of the individual patient.

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REFERENCES

1. Armstrong C. Practice Guidelines. ACEP Releases Guidelines on Evaluation of Suspected Acute Appendicitis. Am Fam Physician 2010; 81(8): 1043-44.
2. Addiss DG, Shaffer N, Fowler BS, et al. The Epidemiology of Appendicitis and Appendectomy in the United States. Am J Epidemiol 1990; 132(5): 910-25.
3. Petroianu A. Diagnosis of Acute Appendicitis. Int J Surg 2012; 10(3): 115-9.
4. Tamanna MZ, Eram U, Hussain AM, et al. Alvarado Score in Diagnosis of Acute Appendicitis. International Journal of Basic and Applied Medical Sciences 2012; 2(1): 66-70. Available at: http://www.cibtech.org/J%20MEDICAL%20SCIENCES/ PUBLICATIONS/2012/JMS-02-01-PDF/13-23%20AFTER%20Corrections-Alvarado.pdf. Accessed on 12.2.2012.
5. Hale DA, Molloy M, Pearl RH, et al. Appendectomy: A Contemporary Appraisal. Ann Surg 1997; 225(3): 252-61.
6. Alvarado A. A Practical Score for the Early Diagnosis of Acute Appendicitis. Ann Emerg Med 1986; 15(5): 557-64.
7. Andersson RE. Meta-analysis of the Clinical and Laboratory Diagnosis of Appendicitis. Br J Surg 2004; 91(1): 28-37.
8. Hoffmann J, Rasmussen OO. Aids in the Diagnosis of Acute Appendicitis. Br J Surg 1989; 76(8): 774-9.
9. Binnebösel M, Otto J, Stumpf M, et al. Acute Appendicitis. Modern Diagnostics--Surgical Ultrasound. Chirug 2009; 80(7): 579-87.
10. Blomqvist PG, Andersson RE, Granath F, et al. Mortality after Appendectomy in Sweden, 1987-1996. Ann Surg 2001; 233(4): 455-60.
11. Arnbjörnsson E. Scoring System for Computer-Aided Diagnosis of Acute Appendicitis. The Value of Prospective Versus Retrospective Studies. Ann Chir Gynaecol 1985; 74(4): 159-66.
12. Van Way CW 3rd, Murphy JR, Dunn EL, et al. A Feasibility Study of Computer Aided Diagnosis in Appendicitis. Surg Gynecol Obstet 1982; 155(5): 685-8.
13. Weyant MJ, Eachempati SR, Maluccio MA, et al. The Use of Computed Tomography for the Diagnosis of Acute Appendicitis in Children Does Not Influence the Overall Rate of Negative Appendectomy or Perforation. Surg Infect 2001 Spring 2(1): 19-23.

14. Unlü C, de Castro SM, Tuynman JB, et al. Evaluating Routine Diagnostic Imaging in Acute Appendicitis. Int J Surg 2009; 7(5): 451-5.
15. Poortman P, Oostvogel HJ, Bosma E, et al. Improving Diagnosis of Acute Appendicitis: Results of a Diagnostic Pathway with Standard Use of Ultrasonography Followed by Selective Use of CT. J Am Coll Surg 2009; 208(3): 434-41.
16. Poortman P, Lohle PN, Schoemaker CM, et al. Comparison of CT and Sonography in the Diagnosis of Acute Appendicitis: A Blinded Prospective Study. AJR Am J Roentgenol 2003; 181(5): 1355-9.
17. Birnbaum BA, Wilson SR. Appendicitis at the Millennium. Radiology 2000; 215(2): 337-48.
18. Borushok KF, Jeffrey RB, Laing FC, et al. Sonographic Diagnosis of Perforation in Patients with Acute Appendicitis. AJR Am J Roentgenol 1990; 154(2): 275-8.
19. Abu-Yousef MM, Bleicher JJ, Maher JW, et al. High-Resolution Sonography of Acute Appendicitis. AJR Am J Roentgenol 1987; 149(1): 53-8.
20. Puylaert JB, Rutgers PH, Lalisang RI, et al. A Prospective Study of Ultrasonography in the Diagnosis of Appendicitis. N Engl J Med 1987; 317(11): 666-9.
21. Puylaert JB. Acute Appendicitis: US Evaluation Using Graded Compression. Radiology 1986; 158(2): 355-60.
22. Franke C, Böhner H, Yang Q, et al. Ultrasonography for Diagnosis of Acute Appendicitis: Results of a Prospective Multicenter Trial. Acute Abdominal Pain Study Group. World J Surg 1999; 23(2): 141-6.
23. Weyant MJ, Eachempati SR, Maluccio MA, et al. Interpretation of Computed Tomography Does Not Correlate with Laboratory or Pathologic Findings in Surgically Confirmed Acute Appendicitis. Surgery 2000; 128(2): 145-52.
24. Flum DR, McClure TD, Morris A, et al. Misdiagnosis of Appendicitis and the Use of Diagnostic Imaging. J Am Coll Surg 2005; 201(6): 933-9.
25. Brown MA. Imaging Acute Appendicitis. Semin Ultrasound CT MR 2008; 29(5): 293-307.
26. Livingston EH, Woodward WA, Sarosi GA, et al. Disconnect between Incidence of Nonperforated and Perforated Appendicitis: Implications for Pathophysiology and Management. Ann Surg 2007; 245(6): 886-92.
27. Howell JM, Eddy OL, Lukens TW, et al. Clinical Policy: Critical Issues in the Evaluation and Management of Emergency Department Patients with Suspected Appendicitis. Ann Emerg Med 2010; 55(1): 71-116.
28. Malik AA, Wani NA. Continuing Diagnostic Challenge of Acute Appendicitis: Evaluation through Modified Alvarado Score. Aust N Z J Surg 1998; 68(7): 504-5.
29. Owen TD, Williams H, Stiff G, et al. Evaluation of the Alvarado Score in Acute Appendicitis. J R Soc Med 1992; 85(2): 87-8.
30. Jahn H, Mathiesen FK, Neckelmann K, et al. Comparison of Clinical Judgment and Diagnostic Ultrasounography in the Diagnosis of Acute Appendicitis: Experience with a Score-Aided Diagnosis. Eur J Surg 1997; 163(6): 433-43.
31. Simonovsky V. Sonographic Detection of Normal and Abnormal Appendix. Clinical Radiology 1999; 54 (8): 533-9.