Al-Azhar International Medical Journal

Volume 4 | Issue 11 Article 9

2023
Section: General Surgery

Combining Abdominal Ultrasound with the Alvarado Score in Acute Appendicitis

Mohamed Salah Elden Abdelsalam Helal
Faculty of Medicine, Mansoura University, Resident at General Surgery,
mohamedsalah222558@gmail.com

Abdelwahab Badr Mohamed Badr
Professor of General Surgery, Faculty of Medicine for boys - Al-Azhar University (The Principal Supervisor)

Mohamed Ibrahim Mohamed Shalames
Lecturer of General Surgery, Faculty of Medicine for boys - Al-Azhar University

How to Cite This Article

Helal, Mohamed Salah Elden Abdelsalam; Badr, Abdelwahab Badr Mohamed; and Shalames, Mohamed Ibrahim Mohamed (2023) "Combining Abdominal Ultrasound with the Alvarado Score in Acute Appendicitis," *Al-Azhar International Medical Journal*: Vol. 4: Iss. 11, Article 9.
DOI: https://doi.org/10.58675/2682-339X.2087

ORIGINAL ARTICLE

Combining Abdominal Ultrasound With the Alvarado Score in Acute Appendicitis

Mohamed Salah Elden Abdelsalam Helal [a,*], Abdelwahab Badr Mohamed Badr [b], Mohamed Ibrahim Mohamed Shalames [b]

[a] General Surgery, Faculty of Medicine, Mansoura University, Mansoura, Egypt
[b] General Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: **One of the most frequent reasons for urgent surgery is acute appendicitis. Although prompt diagnosis is essential, most series also report a high rate of negative appendectomy operations. Clinical scoring systems and imaging methods for diagnosing appendicitis are being studied as potential diagnostic parameters for lowering the negative appendectomy rate.**

Aim: **To assess the efficiency of combining abdominal ultrasound with the Alvarado score in correctly identifying cases of acute appendicitis.**

Patients and methods: **The study included 118 patients with clinical suspicion of acute appendicitis. Standardized laboratory tests, a complete medical history, and a physical examination were performed on every patient. All patients also had pelviabdominal US performed by a qualified radiologist, and their Alvarado scores were calculated. Histopathological examination of the specimen from each patient's appendectomy was used as the definitive method of diagnosis.**

Results: **When compared to the histopathological findings, the Alvarado score had a sensitivity and specificity of 67.6 % and 61.5 %, respectively, for the diagnosis of appendicitis. The ultrasound accuracy for appendicitis was 80.7 %, with a sensitivity of 80.4 % and a specificity of 76.9 %. The combination of both parameters showed 96.7 % sensitivity and 88.2 % specificity in diagnosis of acute appendicitis. It also showed positive predictive value (PPV) and negative predictive value (NPV) were 89 % and 83.3 %, respectively.**

Conclusion: **The combined use of Alvarado score and ultrasound examination was associated with higher sensitivity and accuracy in diagnosis of acute appendicitis when compared with each modality alone.**

Keywords: Alvarado, Appendectomy, Appendicitis, Ultrasound

1. Introduction

Acute appendicitis is the most common cause of acute abdominal pain, but because it is primarily a clinical diagnosis with a wide range of possible clinical presentations, it can be difficult to diagnose.[1] An appendectomy should not be decided solely based on clinical features because this could result in the removal of healthy appendices (negative appendectomy). However, patients with a suspicion of appendicitis who delay surgery run the risk of developing the condition. Two clinical scoring systems were found to be useful for diagnosing a variety of surgical conditions.[2] As of late, different scoring frameworks have been created to work on the precision of the finding of instances of intense appendicitis.[3] There have been many scoring frameworks proposed, yet most of them are unreasonably convoluted to be used in a genuine-world clinical setting.[4] Nonetheless, the Alvarado scoring framework is a simple-to-utilize, direct technique that has demonstrated to be helpful in the facility and crisis settings.[5]

Imaging may likewise help. For adult acute appendicitis, computed tomography (CT) is the preferred imaging method.[6]

Accepted 15 June 2023.
Available online 22 January 2024

* Corresponding author. Faculty of Medicine, Mansoura University, Resident at General Surgery Cairo, Egypt.
E-mail address: mohamedsalah222558@gmail.com (M.S. Elden Abdelsalam Helal).

https://doi.org/10.58675/2682-339X.2087

Despite its high accuracy and high specificity (94–98 %) and sensitivity (90–96 %), CT has some drawbacks. Alternative imaging modalities like abdominal ultrasound are frequently used due to the limitations of CT.[7]

Scanning with ultrasound is an easy, fast, and inexpensive procedure that can be repeated.[8]

These include radiation exposure, contrast administration risk,[9] high cost, and development of future malignancies.

Despite its effectiveness for differential diagnosis of gynecologic conditions, this method is highly dependent on the examiner.[10]

If appendicitis is suspected, abdominal ultrasound should be performed immediately. By incorporating the results of an abdominal ultrasound into the equation, the Alvarado score could be improved.[11]

Therefore, to assess the efficiency of combining abdominal ultrasound with the Alvarado score in correctly identifying cases of acute appendicitis.

2. Patients and methods

This is a prospective interventional study that was carried out in Cairo, Egypt, at the General Surgery Department of Al-Azhar University Hospitals. The review was directed for one-year term from July 2021 to June 2022.

In total, 118 patients with symptoms consistent with acute appendicitis were included in the current study.

In the study, people of both sexes under the age of 10 who complained of pain in the right iliac fossa should be checked for appendicitis.

The following criteria were used to exclude cases who have proactively gone through the stomach a medical procedure before, patients with summed-up peritonitis, cases requiring a medical procedure for gynecological or urological conditions, patients with right iliac fossa mass, cases with an ongoing ruptured appendix, patients who recently gave an affixed mass and were conceded for an elective appendectomy, and cases who would not take part in the review.

The study was carried out in accordance with the revised 2013 version of the Helsinki Standards.[12] The study was carried out with the approval of the local ethics committee at Al-Azhar University's Faculty of Medicine and after obtaining written informed consent from the cases that were included.

The cases underwent a comprehensive history and clinical examination, with an emphasis on the abdominal exam to look for signs and symptoms of appendicitis. Additionally, routine preoperative laboratory tests were performed, such as a complete blood count, functions of the liver and kidneys, and random blood glucose.

Investigations into radioactivity: An abdominal radiography was taken in supine and erect positions. Using a linear array transducer with a standard protocol that included graded compression, longitudinal, and transverse RAQ images, all sonographic examinations were carried out at 5 or 7.5 MHz. A patient with symptoms consistent with appendicitis was advised to have abdominal surgery as a diagnostic tool to rule out other possible causes. Intense an infected appendix was thought in view of the ultrasound discoveries, which were recorded and scored on a 5-point scale. The discoveries that got grades of 1 or 2 were considered to be negative, although the discoveries that got grades of 3–5 were considered to be positive for intense an infected appendix Table 1.

2.1. Technique for surgery

The surgeon's clinical judgment alone was the factor that ultimately determined whether or not to perform an appendectomy after taking into account all of the outcomes of the clinical, laboratory, and radiological examinations. All cases received intravenous fluids and antibiotics (ceftriaxone 1 gm and metronidazole 500 mg) at the time of skin incision. Depending on the preference of the anesthesiologist, cases were handled either generally or spinally. An open approach was the traditional appendicectomy method. A grid iron incision was used for the open procedure, while a conventional three-port laparoscopy was performed. The two working ports were put at the right and left iliac districts, while the camera port was put over the umbilicus. After

Table 1. Ultrasound appendicitis score.[13,14]

Score	Findings
1	Represents identification of a normal appendix.
2	Identifies the absence of the appendix but does not indicate the presence of inflammatory changes or free fluid in the abdomen.
3	Identifies the absence of the appendix but the presence of secondary symptoms of appendicitis, such as the presence of a fecalith, pericecal fluid, or increased pericecal echogenicity consistent with infiltration of the mesenteric fat.
4	Indicates the presence of an appendix of a size that is on the verge of being enlarged (5–6 mm).
5	Indicates acute appendicitis, which is defined as an enlarged appendix that is not compressible and has an outer diameter that is greater than 6 mm.

Alvarado scores (Table 2) were computed for each patient solely for the study's purposes. A score of 7 was considered to indicate a high likelihood of acute appendicitis.

Table 2. Alvarado scoring system.[15]

Feature	Score
Migration of pain	1
Anorexia	1
Nausea	1
Tenderness in the right-lower quadrant	2
Rebound pain	1
Elevated temperature	1
Leukocytosis	2
Shift of white blood count to the left	1

abdominal exploration, three taeniae were discovered, assisting in the identification of the cecum. The appendiceal base was then identified by gently retracting the cecum. After locating the appendix's base, any surrounding adhesions were cut out to free it. In the open procedure, the mesoappendix was either ligated and divided, or it was divided using intermittent coagulation diathermy in the laparoscopic procedure. At the appendiceal base, a vicryl 2/0 transfixation suture was used. From that point onward, the reference section was separated only distal to the spellbound stitch. The wound or one of the working ports was used to extract the appendix. In the open approach, the abdominal wound was closed in layers after proper hemostasis, whereas in the laparoscopic approach, only the skin over the ports was closed.

2.2. Examination of the histopathology

The pathology lab analyzed each and every surgical sample. Histopathology results from the careful case were arranged and related with the two appraisals. Histopathological findings were utilized as the definitive diagnostic criteria in this study due to the fact that appendicitis can occur in an appendix that appears to be healthy.

2.3. Postoperative follow-up

Following a medical procedure, all patients were brought to the recuperation region. They were then brought into the inner ward. Unless complications were anticipated, patients were permitted to leave the hospital on the first or second postoperative day.

Information gathered was coded, handled, and investigated with SPSS adaptation 26 for Windows (Factual Bundle for Sociologies) (IBM, SPSS Inc, Chicago, IL, USA). Number (frequency) and percentage qualitative data were presented. Quantitative information was communicated as mean ± SD/middle (Reach).

3. Results

The current study included 118 patients with suspicion of acute appendicitis. The mean age of the included cases was 30.69 years (range, 14–53). Anorexia was the most common symptom, as it was reported by 83.1 % of patients, followed by nausea (73.7 %) and migratory pain (54.2 %). Regarding the detected signs, abdominal tenderness and rebound tenderness were detected in 57.6 % and 75.4 % of patients, respectively, whereas elevated temperature was noted in 72.9 % of patients. Leukocytosis was detected in 71.2 % of patients, while leukocytic shift to the left was detected in 55.1 % of our patients. Regarding complete blood count (CBC) parameters, hemoglobin had a mean value of 11.43 gm/dl (range, 9.3–13.6), while platelets had a mean value of 276.34 × 10^3/ml (range, 101–441). In addition, the leukocytic count ranged between 6.3 and 20.2 × 10^9/l (mean = 12.59) (Table 3). According to the previous score, 46.6 % of patients had no appendicitis, while the remaining 53.4 % had appendicitis (Tables 4–6). Positive

Table 3. Demographic, clinical, and laboratory data in the cases of the study.

Items	Study cases $N = 118$
Age (y)	
Mean ± SD	30.69 ± 11.96
Median (range)	29 (14–53)
	Number (percent)
Sex	
Male	68 (57.6)
Female	50 (42.4)
Symptoms and signs	
	Number (percent)
Migration of pain	64 (54.2)
Anorexia	98 (83.1)
Nausea	87 (73.7)
Tenderness in the lower-right quadrant	68 (57.6)
Rebound tenderness	89 (75.4)
Elevated temperature	86 (72.9)
Leukocytosis	84 (71.2)
Shift of WBC count to the left	65 (55.1)
Hemoglobin level (gm/dl)	
Mean ± SD	11.43 ± 0.88
Median (range)	11.4 (9.30–13.60)
WBCs (x109/l)	
Mean ± SD	12.59 ± 2.62
Median (range)	12.7 (6.30–20.20)
Platelets (x103/ml)	
Mean ± SD	276.34 ± 78.89
Median (range)	279 (101–441)

Table 4. Risk stratification and incidence of appendicitis according to Alvarado score, ultrasound score, and Alvarado and ultrasound score in the cases of the study.

Variables	Study cases $N = 118$
Alvarado score	
Mean ± SD	6.72 ± 1.83
Median (range)	7 (1–10)
	Number (percent)
Risk of appendicitis according to Alvarado score	
Low risk of acute appendicitis	12 (10.2)
Moderate risk of acute appendicitis	43 (36.4)
High risk of acute appendicitis	63 (53.4)
Incidence of appendicitis	
No appendicitis	55 (46.6)
Appendicitis	63 (53.4)
Ultrasound score	
Risk categories	
Score 1	10 (8.5)
Score 2	29 (24.6)
Score 3	29 (24.6)
Score 4	31 (26.3)
Score 5	19 (16.1)
Incidence of appendicitis	
No appendicitis	38 (32.2)
Appendicitis	80 (67.8)
Histopathology	
Incidence of appendicitis	
No appendicitis	26 (22)
Appendicitis	92 (78)
Risk categories	
Normal appendix	26 (22)
Catarrhal appendicitis	47 (39.8)
Suppurative appendicitis	34 (28.8)
Gangrenous appendicitis	11 (9.3)

Table 5. Predictive value of Alvarado score in detection of appendicitis as compared with histopathology.

	Histopathology	
	No appendicitis ($n = 26$) No (%)	Appendicitis ($n = 92$) No (%)
ALVARADO score	16 (TN) (61.5)	39 (FN) (42.4)
No appendicitis ($N = 55$)		
Appendicitis ($N = 63$)	10 (FP) (38.5)	53 (TP) (67.6)
Sensitivity	67.6 %	
Specificity	61.5 %	
Accuracy	58.5 %	
PPV	84.1 %	
NPV	29.1 %	

predictive value (PPV) and positive predictive value (NPV) were 89 % and 83.3 %, respectively (Table 7).

4. Discussion

The purpose of the current study was to determine whether or not the Alvarado score and abdominal ultrasound can accurately identify cases

Table 6. Predictive value of ultrasound in detection of appendicitis as compared with histopathology.

	Histopathology	
	No appendicitis ($n = 26$) No (%)	Appendicitis ($n = 92$) No (%)
Ultrasound	20 (TN) (76.9)	18 (FN) (19.6)
No appendicitis ($N = 38$)		
Appendicitis ($N = 80$)	6 (FP) (23.1)	74 (TP) (80.4)
Sensitivity	80.4 %	
Specificity	76.9 %	
Accuracy	79.7 %	
PPV	92.5 %	
NPV	52.6 %	

Table 7. Predictive value of combined Alvarado and ultrasound in detection of appendicitis as compared with histopathology.

	Histopathology	
	No appendicitis ($n = 26$) No (%)	Appendicitis ($n = 92$) No (%)
Combined ALVARADO and ultrasound	15 (TN) (57.7)	3 (FN) (3.3)
No appendicitis ($N = 18$)		
Appendicitis ($N = 100$)	11 (FP) (42.3)	89 (TP) (96.7)
Sensitivity	96.7 %	
Specificity	57.7 %	
Accuracy	88.2 %	
PPV	89 %	
NPV	83.3 %	

of acute appendicitis. Al-Azhar University Hospitals hosted the study, which included 118 patients with ages ranging from 14 to 53, with a mean age of 30.69 years.

In the current study, we included 68 (57.6 %) males and 50 (42.4 %) females, with a slight male predominance. Other studies by Martin et al.[16] and Ojuka and Sangoro[17] found that the average age of their patients was 26.3 years, and another found that the average age of their potential subjects was 26.8 ± 13.2 in line with Shauib et al.[18] findings.

Moreover, according to Addiss et al.,[19] the lifetime frequency of an infected appendix is 8.6% in males and 6.7 % in females with a proportion of 1.4:1.

Furthermore, Yazar et al.[20] found that of the 200 patients who were considered for the study, 137 (68.5 %) were male and 63 (31.5 %) were female. The total leukocytic count in this study was 12.59 × 109/l, with a range of 6.30–20. In another previous study by Aji et al.,[21] white platelet (WBC) counts that are greater than 10 500 cells/L have been found in 80–85 % of grown-ups who have been determined to have appendicitis.

In our review, histopathological assessment of the extracted addendums uncovered a ruptured appendix in 78 %, while the excess cases showed no

obsessive highlights of a ruptured appendix. Our rate of unsuccessful appendectomy was 22 %. This is consistent with Al-Hashemy et al.[22] rates revealed in the writing of 8–33 %.

A past Egyptian review by Elsherbiny et al.[23] directed at Mansoura College revealed that the negative appendectomy rate was 12 %, which is lower than our discoveries. In addition, Al Awayshih and colleagues reported that 20 patients – 14 females and six males – had normal appendixes, corresponding to a 20 % negative appendectomy rate that was close to our findings. Elsherbiny and others[23] reported that the Alvarado score could identify patients with appendicitis with a specificity of 91.7% and a sensitivity of 56.8 %. It was 61 % accurate in assessing patients with appendicitis suspicion.

According to previous research by Farooq et al.,[24] ultrasound has a sensitivity that ranges from 49 to 90 %, a specificity that ranges from 47 to 100 %, a positive predictive value that ranges from 84 to 93 %, and an overall accuracy that ranges from 72 to 94 % when it comes to the diagnosis of acute appendicitis. The Alvarado score was found to be 94.1 % sensitive, 33.3 % specific, 88.8 % positive predictive value, 50 % negative predictive value, and 85.5 %.

In another study of Pinto et al.,[25] ultrasound's sensitivity and specificity in diagnosing acute appendicitis were 75 % and 69.2 %, respectively.

Other studies by Parsijani et al.[26] have praised US's diagnostic accuracy for appendicitis. Our reported findings are within the previous ranges.

According to George et al.,[27] findings regarding US specificity and sensitivity were 91 % and 88.13 %, respectively.

In the study by Puylaert et al.[28] and his colleagues, while the same values were 100 % and 89 %, Jeffrey et al.[29] reported that US had a sensitivity of 96.2 % and a specificity of 89.9 %, respectively, while another study found that the same two parameters were 86 % and 89 %, respectively.

Samudre and Munde[30] found that abdominal US had lower diagnostic parameters: responsiveness 78 %, particularity 25 %, positive prescient worth 94.26 %, and negative prescient worth 6.97 %.

4.1. Conclusion

The combination of Alvarado score and ultrasound assessment prompted an undeniable expansion in the responsiveness and precision of identifying intense an infected appendix. As ultrasound is generally accessible in crisis settings, this mix ought to be applied for patients thought to have a ruptured appendix to diminish the negative appendectomy rates.

Conflicts of interest

None declared.

References

1. Al Awayshih MM, Nofal MN, Yousef AJ. Evaluation of Alvarado score in diagnosing acute appendicitis. *The Pan Afr Med J*. 2019;34.
2. Frountzas M, Stergios K, Kopsini D, Schizas D, Kontzoglou K, Toutouzas K. Alvarado or RIPASA score for diagnosis of acute appendicitis? A meta-analysis of randomized trials. *Int J Surg*. 2018;56:307–314.
3. Podda M, Pisanu A, Sartelli M, et al. Diagnosis of acute appendicitis based on clinical scores: is it a myth or reality? *Acta Biomed: Atenei Parmensis*. 2021;92:4.
4. Wilasrusmee C, Anothaisintawee T, Poprom N, McEvoy M, Attia J, Thakkinstian A. Diagnostic scores for appendicitis: a systematic review of scores' performance. *Br J Med Med Res*. 2014;4:711.
5. Ohle R, O'Reilly F, O'Brien KK, Fahey T, Dimitrov BD. The Alvarado score for predicting acute appendicitis: a systematic review. *BMC Med*. 2011;9:1–13.
6. Gwynn LK. The diagnosis of acute appendicitis: clinical assessment versus computed tomography evaluation. *J Emerg Med*. 2001;21:119–123.
7. Raman SS, Lu DS, Kadell BM, Vodopich DJ, Sayre J, Cryer H. Accuracy of nonfocused helical CT for the diagnosis of acute appendicitis: a 5-year review. *Am J Roentgenol*. 2002;178:1319–1325.
8. Lessin MS, Chan M, Catallozzi M, et al. Selective use of ultrasonography for acute appendicitis in children. *Am J Surg*. 1999;177:193–196.
9. Fu J, Zhou X, Chen L, Lu S. Abdominal ultrasound and its diagnostic accuracy in diagnosing acute appendicitis: a meta-analysis. *Front Surg*. 2021;8:233.
10. Baruch Y, Canetti M, Blecher Y, Yogev Y, Grisaru D, Michaan N. The diagnostic accuracy of ultrasound in the diagnosis of acute appendicitis in pregnancy. *J Matern Fetal Neonatal Med*. 2020;33:3929–3934.
11. Mán E, Simonka Z, Varga A, Rárosi F, Lázár G. Impact of the Alvarado score on the diagnosis of acute appendicitis: comparing clinical judgment, Alvarado score, and a new modified score in suspected appendicitis: a prospective, randomized clinical trial. *Surg Endosc*. 2014;28:2398–2405.
12. Association WM. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA*. 2013;310:2191–2194.
13. Kansakar N, Agarwal P, Singh R, et al. Evaluation of combined use of modified Alvarado score and Ultrasound in predicting acute appendicitis: a prospective study. *Int Surg J*. 2018;5:3594–3597.
14. Pacharn P, Ying J, Linam LE, Brody AS, Babcock DS. Sonography in the evaluation of acute appendicitis: are negative sonographic findings good enough? *J Ultrasound Med*. 2010;29:1749–1755.
15. Ohle R, O'Reilly F, O'Brien KK, Fahey T, Dimitrov BD. The Alvarado score for predicting acute appendicitis: a systematic review. *BMC Med*. 2011;9:139–152.
16. Martin RF. Acute appendicitis in adults: clinical manifestations and differential diagnosis. In: Weiser M, Chen W, eds. *UpToDate.: Online*. Waltham, Massachusetts: Wolters Kluwer; 2022.
17. Ojuka D, Sangoro M. Alvarado vs lintula scoring systems in acute appendicitis. *Anna Afr Surg*. 2017;14:1.
18. Shuaib A, Shuaib A, Fakhra Z, Marafi B, Alsharaf K, Behbehani A. Evaluation of modified Alvarado scoring system and RIPASA scoring system as diagnostic tools of acute appendicitis. *World J emerg med*. 2017;8:276.

19. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. *Am J Epidemiol*. 1990;132:910–925.
20. Yazar AS, Erdoğan S, Şahin C, Güven Ş. Reliability of ultrasonography and the Alvarado scoring system in acute appendicitis. *Turk J Pediatr*. 2018;60:173–179.
21. Aji N, Aliyu S. Appendicitis and its surgical management experience at the university of maiduguri teaching hospital Nigeria. *Niger J Med*. 2012;21:223–226.
22. Al-Hashemy AM, Seleem MI. Appraisal of the modified Alvarado score for acute appendicitis in adults. *Saudi Med J*. 2004;25:1229–1231.
23. Elsherbiny MW, Emile SH, Abdelnaby M, Khafagy W, Elshobaky A. Assessment of the diagnostic accuracy of alvarado scoring system combined with focused ultrasound in the diagnosis of acute appendicitis. *J Br Surg*. 2020;107:e594–e595.
24. Farooq A, Zameer S, Khadim R. Diagnostic accuracy of ultrasound in acute appendicitis in comparison with alvarado score keeping histopathological correlation as gold standard. *PAFMJ*. 2020;70:807–811.
25. Pinto F, Pinto A, Russo A, et al. Accuracy of ultrasonography in the diagnosis of acute appendicitis in adult patients: review of the literature. *Crit Ultrasound J*. 2013;5:1–3.
26. Parsijani PJ, Zarandi NP, Paydar S, Abbasi HR, Bolandparvaz S. Accuracy of ultrasonography in diagnosing acute appendicitis. *Bulletin of Emergency & Trauma*. 2013;1:158.
27. George M, Siba P, Charan P, Rao R. Evaluation of ultrasonography as a useful diagnostic aid in appendicitis. *IJS Surg*. 2002;64:436–439.
28. Puylaert J. Acute appendicitis: US evaluation using graded compression. *Radiology*. 1986;158:355–360.
29. Adams DH, Fine C, Brooks DC. High-resolution real-time ultrasonography: a new tool in the diagnosis of acute appendicitis. *Am J Surg*. 1988;155:93–97.
30. Samudre SS, Munde AS. Comparative study between clinical diagnosis using modified Alvarado score and ultrasound imaging in decreasing negative appendectomy rate. *Int Surg J*. 2021;8:1185–1189.