BRIEF REPORT

Ultrasonography and the Alvarado score in the diagnosis of acute appendicitis: impact on the negative appendectomy rate

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Objective. To establish the negative appendectomy rate (NAR) after patients with acute abdomen were evaluated with the Alvarado score and compare it to the NAR in patients evaluated with abdominal ultrasound.

Methods. Cross-sectional, retrospective, descriptive study in patients who underwent emergency surgery for suspected acute appendicitis in a tertiary-care hospital over a period of 1 year.

Results. A total of 225 patients were included. The NAR was 7.11% for the series. An Alvarado score of 5 or more had an odds ratio (OR) of 7.46 (*P*=.0002) for acute appendicitis; sensitivity was 94.2%. Ultrasound findings consistent with acute appendicitis had an OR of 3.58 (*P*=.0125) for the diagnosis; the NAR was 5%.

Conclusions. The high sensitivity of an Alvarado score of 5 or more supports using this tool to evaluate all patients who come to the emergency department with pain in the right iliac fossa. With scores of 7 or more the NAR falls to 3%. Abdominal ultrasound is a rapid, inexpensive diagnostic procedure associated with a low NAR.

Keywords: Appendicitis. Alvarado scale. Ultrasonography.

Ecografía y Escala de Alvarado en el diagnóstico de la apendicitis aguda. Impacto en la tasa de apendicectomía negativa

Objetivo. Establecer la tasa de apendicectomía negativa (TAN) y evaluar las diferencias entre la Escala de Alvarado y la ecografía abdominal en los pacientes con apendicitis aguda (AA) y aquellos con apendicectomía negativa.

Método. Estudio descriptivo, retrospectivo de corte transversal. Se recogieron los pacientes intervenidos de urgencia bajo sospecha de AA durante un año en un hospital de tercer nivel.

Resultados. Se incluyeron 225 pacientes. La TAN fue de 7,11%. Una puntuación en la Escala de Alvarado mayor o igual de 5 obtuvo una *odds ratio* (OR) de 7,46 (p = 0,0002) para padecer AA, con una sensibilidad del 94,2%. La ecografía compatible con AA obtuvo una OR 3,58 (p = 0,0125) y una TAN del 5%.

Conclusiones. La elevada sensibilidad de la Escala de Alvarado para puntuación mayor o igual de 5 hace aconsejable su aplicación en todo paciente que acude al Servicio de Urgencias con dolor en la fosa iliaca derecha. Puntuaciones mayores o iguales a 7 disminuyen la TAN hasta el 3%. La ecografía abdominal es una prueba rápida y barata con una TAN baja.

Palabras clave: Apendicitis. Escala Alvarado. Ecografía.

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Introduction

Acute appendicitis (AA) is the most common cause of acute abdomen requiring urgent surgery. With an individual risk of 7% and an annual incidence in Spain of 132 cases per 100,000 inhabitants[1], it is estimated that the rate of negative appendectomy (NAR) varies between 10% and 30% of the interventions[2]. It has been estimated that these patients present higher morbidity and hospitalization costs than those with AA[3].

The Alvarado Scale stratifies by several items the probability of suffering AA. With a sensitivity of 81% and specificity of 74%4, it is a useful and simple tool to guide the diagnosis. It establishes 4 categories; a score of 0-4 points is negative for AA and the patient should be discharged; from 5 to 6, possible AA and the patient should be placed under observation in the hospital; from 7 to 8, probable AA and patient should undergo surgery; and a score of 9-10 indicates AA, and surgery is indicated. On the other hand, abdominal ultrasonography, with a sensitivity of 83.7% and a specificity of 97.4%[5], has now become the most widely used imaging test for the diagnosis of AA[6].

The aim of the present study was to establish NAR in a third-level hospital during one year of observation. And, secondly, to retrospectively estimate the sensitivity of ultrasound and the Alvarado Scale, as well as assess whether there are differences in the results of the two tests between AA patients and negative appendectomies.

Method

We performed a descriptive, retrospective, cross-sectional study. It included all patients older than 15 years of both sexes undergoing surgery for suspected AA from January 1 to December 31, 2014. These patients were assessed by a member of the general surgery service after an emergency department evaluation at Hospital Universitario Miguel Servet (Zaragoza, Spain). We excluded patients with an established diagnosis of appendicular plastron, inflammatory bowel disease, previous digestive neoplasia, or hospitalized patients.

The variables analysed were age, sex, disease duration, Alvarado Scale score, ultrasound and computed tomography (CT) findings, surgical approach, and intraoperative and anatomopathological diagnoses.

The original Alvarado Scale[4] was applied to all patients. Positive ultrasound for AA was considered when a non-compressible appendicular structure with wall thickening of 6 mm or greater and an increase in Doppler flow was observed, or when indirect signs were seen such as increased echogenicity of fat in the right iliac fossa (RIF), cecal wall with inflammatory signs, free fluid in the RIF or abscess.

The anatomopathological study was the reference to confirm or rule out the diagnosis. If no appendectomy was performed, intraoperative diagnosis was considered as the reference.

IBM SPSS Statistics v.23 was used for statistical analyses. A descriptive analysis was performed, and the odds ratio (OR) was calculated with its 95% confidence interval (CI). Student's t-test for quantitative variables and chi-squared for qualitative variables were used for hypothesis testing. Statistically significant results were those whose ORs did not contain the value 1 and the p value was <0.05.

The Ethical Committee of Clinical Research of Aragon (CEICA) found no ethical problem in carrying out the present study.

Results

The study sample comprised 225 patients, 52% (117) men and 48% (108) women. Mean age was 43 years, with no differences between sexes (p = 0.235). We excluded 11 patients who had appendicular plastron and another with Crohn's disease.

The mean [standard deviation (SD)] obtained with the Alvarado Scale was 7.21 (1.76) points, with no difference between sexes (p = 0.600). In false positives, the mean (SD) was 5.68 (1.74), with statistically significant differences with the mean obtained in the cases of AA (p = 0.001).

Ultrasonography was performed in 94.3% (212) of patients. Most (80.2%) ultrasounds showed a positive result for AA. Abdominal CT was performed in 16.9% (38) of patients undergoing surgery. Almost all (97.7%; 220) of the patients underwent a preoperative imaging test, either ultrasonography or CT. In the remaining 2.3% no false positive cases were found, with an average Alvarado Scale score of 5,6[1,6].

A total of 74.2% (167) of the patients underwent laparoscopy. Twelve appendectomy specimens showed no histological alterations, which, together with the 4 interventions where no AA was observed and no surgical procedure was performed, resulted in a NAR of 7.11% (16 cases). No gender differences were found (p = 0.493) nor in disease duration (p = 0.125). The diagnoses were endometriosis (1), salpingitis (2), hemorrhagic ovarian cyst (1), mesenteric adenitis (2), epiplastic appendagitis (1), ileitis (2), appendicular diverticulosis (1), appendicular mucinous neoplasia. No cause to explain the symptoms could be found in five cases.

Table 1 shows the calculated parameters for the Alvarado Scale and the ultrasound.

Discussion

The present study analysed ultrasound findings and Alvarado Scale scores in the diagnosis of AA, in order to assess whether their application decreases NAR. These two techniques were selected for their rapid application, low cost and availability. The existing literature on the use of these techniques in the diagnosis of AA is extensive, with results that support their application in the emergency room[5,6].

The mean Alvarado Scale score, higher than 7 for both sexes, correlated well with the sample, since it included patients undergoing surgery for suspected AA. In published series with similar samples, lower scores were obtained (between 5 and 6).

The NAR was 7.1%, low when compared with similar studies, but consistent with those published by Canavosso et al. of 8.7%[8], Bianchi et al. of 8.4%[2] and Tan et al. of 7.7%[7] (performing CT in 75% of patients). There are series with better results, such as 2% in the study by Ospina et al.[9] and 5.4% of Thurston et al.[10]. In contrast, Alvarado[4] recorded a NAR of 11%.

With regard to negative appendectomies, no gender differences were found, unlike other publications that attribute greater risk to women due to the inclusion of gynecological pathology in the differential diagnosis[1]. This could be due to the widespread use of ultrasound in our sample, which is recommended in women of childbearing age and RIF pain.

The Alvarado Scale is an effective test for the diagnosis of AA when a score equal to or greater than 5 is obtained, with high sensitivity (94.2%). Patients with a score equal to or greater than 7 benefit from lower NAR, at the expense of reducing sensitivity to 72%. The sensitivity obtained in the present study is similar to others found in the literature[8,11]. A score between 5 and 6 is the one that presents the greatest risk of negative appendectomy and therefore, this is when we should take more precautions about indicating urgent surgical intervention.

In the present study, a positive ultrasound result for AA quadrupled the probability of having it. Its sensiti-

Table 1. Results calculated for Alvarado Scale scores and Ultrasound findings

	Appendicitis (n)	No appendicitis (n)	OR (95% CI)	p	S	PPV	NAR
Alvarado Scale score							
≥ 5	197	11	7.46 (2.23-24.95)	0.0002	94.2%	94.8%	5.2%
< 5	12	5	(Reference)				
≥ 7	151	5	5.73 (1.91-17.20)	0.0006	72.2%	96.8%	3.2%
< 7	58	11	(Reference)				
Alvarado Scale score							
5-6	46	6				88.5%	11.5%
7-8	92	4				95.9%	4.1%
9-10	59	1				98.4%	1.6%
Ultrasound							
Positive	161	9	3.58 (1.25-10.26)	0.0125	82%	94.7%	5.3%
Negative	35	7	(Reference)				
Ultrasound + Alvarado Scale score ≥ 5	153	7	4.57 (1.61-13.00)	0.0022	78%	95.7%	4.3%
Rest	43	9	(Reference)				

	Appendicitis (n)	No appendicitis (n)	NAR by age	Mean (SD) Alvarado Scale score	
				General	No Appendicitis
Edad					
15-39	108	9	7.6%	7.15 (1.9)	5.77 (1.7)
40-59	55	4	6.7%	7.37 (1.3)	4.50 (1.7)
≥ 60	46	3	6.9%	7.16 (1.7)	7.00 (1.0)

OR: odds ratio; CI: confidence interval; S: sensitivity; PPV: positive predictive value; NAR: negative appendectomy rate.

vity was around 85%, similar to that published by Pintado et al.[5] and higher than others such as Poortman et al.6 (77%) and Peixoto et al.[12] (65%). Ultrasound was performed in 94% of patients, which shows its almost routine use in the diagnosis of all RIF pain with a suspicion of AA. In other studies on ultrasound in the diagnosis of AA, this did not reach 70%[13].

The Alvarado Scale and ultrasound showed that they are complementary tests to reduce the NAR, oscillating in our sample between 2% (ultrasound or Alvarado Scale scores 5-6) and 4% (Alvarado Scale score equal to or greater than 7).

The studies that associate ultrasound and Alvarado Scale score highlight the low probability of AA when both are negative (Alvarado equal to or less than 4 points)[14]. The patients who benefited most from this association in our study were those with scores of 5-6.

Therefore, the Alvarado Scale appears to be an effective tool for initial stratification of the risk of AA in all patients with RIF pain[15], after which, ultrasound could be applied in cases of intermediate probability (5-6), in women of childbearing age or in cases where diagnostic doubt persists. We consider that CT to rule out appendicular pathology should be restricted to cases of suspected appendicular pathology with doubtful or inconclusive ultrasound findings, and in cases of acute abdomen of uncertain etiology, which should be avoided in young patients or fertile women of childbearing age.

The main limitations of our study are its retrospective and non-randomized nature. In addition, we did not have data on those individuals with suspected AA in whom acute appendicular pathology was ruled out by ultrasound or the Alvarado Scale, so we were unable to calculate the specificity of the two tests.

Conflicting interests

The authors declare no conflict of interest reated to this article.

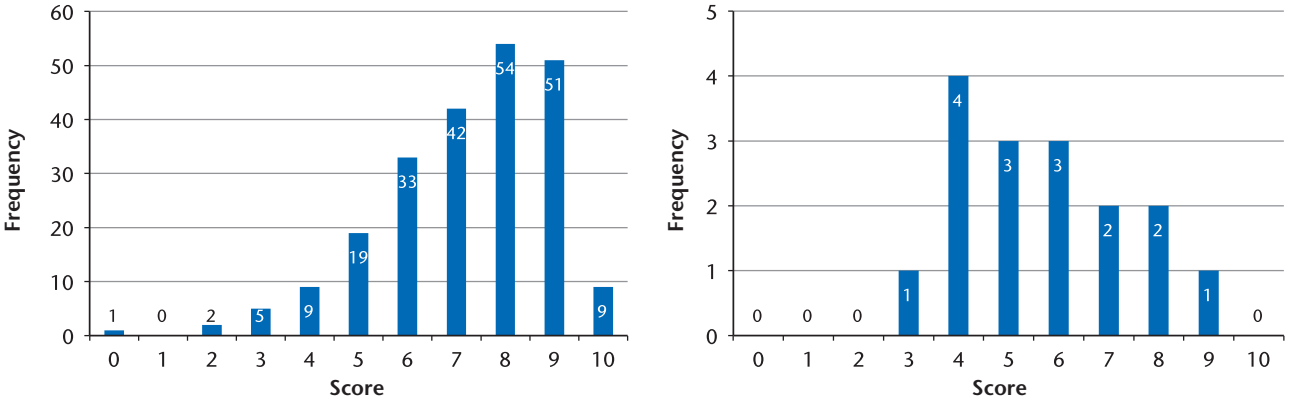

Figure 1. Alvarado Scale score for the whole sample (left) and for patients with negative appendectomy (right).

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Ethical Responsibilities

The Ethics and Clinical Research Committee of Aragon approved the study.

Informed consent was obtained from participants.

All authors have confirmed the maintenance of confidentiality and respect for patient rights in the author's responsibilities document, publication agreement and transfer of rights to EMERGENCIAS.

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