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ORIGINAL ARTICLE

Clinical predictors of acute appendicitis: in a Portuguese Paediatric Department

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Abstract:
Background and aims: Acute appendicitis (AA) is a challenging diagnosis in children because the symptoms can mimic other common causes of abdominal pain. Clinical scoring systems, as the Alvarado score (AS), are tools that can predict the risk of AA in children and evaluated signs, symptoms and blood exams. Material and methods: A retrospective study of children between the ages of 4 and 18 years referred to the emergency department for abdominal pain and submitted to appendectomy. Two groups were defined: those with histology-confirmed appendicitis and those without appendicitis. Univariate analysis was performed with logistic regression to compute odds ratio [CIs]c for each possible predictor. Results: The univariate analysis showed that six of the variables were significant predictors of appendicitis. These were leucocytes (OR=3.2 [2-5.1]), neutrophil (OR=3.6 [1.3-10.1]), AS (continuous variable) (OR=1.6 [1.3-2.1]), AS≥5 (OR=7.6 [2.9-19.9]), AS≥6 (OR=6.9 [2.5-18.7]) and AS≥7 (OR=5.6 [1.6-19.7]). All other recorded findings were not statistically significant. The negative appendectomy rate was estimated in 18%. It was an expected rate according to the information from other studies which reported a rate of 15-30%. Clinical findings when associated in a score, as the AS, can predict the risk of this clinical situation. Using three different cut-points (5, 6 and 7 points) of AS we observed positive and significantly associations, that remains even after adjustment for age and gender. Conclusion: Individually high leucocytes and neutrophil counts are associated with AA. Clinical story, signs and symptoms, as well, laboratory exams when grouped on a score can predict the risk of AA.

Keywords: acute appendicitis, negative appendicitis rate, Alvarado score
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Introduction

Acute appendicitis (AA) is the most common cause of emergent abdominal surgery in children [1-3]. The diagnosis of this condition is problematic in children because the symptoms can mimic other common causes of abdominal pain [4]. For this reason a high number of negative appendectomies (15-30%) have been described in different studies [5, 6].

The clinical challenge is to diagnose AA early enough to prevent perforation, abscess formation, peritonitis and in the same time minimizing the number of negative appendectomies.

Several studies have investigated alternatives or adjuncts to clinical diagnostic, namely diagnostic imaging and clinical scoring systems [7-13].

The Alvarado score (AS) is a clinical score to predict the risk of AA in children and evaluate signs, symptoms and blood exams.

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The purpose of this study was to evaluate the clinical predictors of AA and assess the accuracy of the AS as a diagnostic tool of AA by retrospectively applying different cut-points.

Material and methods

A retrospective study was conducted in the Paediatric Department of Braga Hospital between December 2008 and July 2010.

Children between the ages of 4 and 18 years referred to the emergency department for abdominal pain and submitted to appendectomy were eligible for enrolment in the study. Nonverbal children or children with previous appendectomy were excluded. Using electronic medical records of each patient a one-page data collection form was completed. It contained information about patient age, sex, date of the examination and the onset of symptoms, signs, blood exams and each of the eight AS components (Table I).

Table I. Alvarado Score

Parameters		Score
Symptoms	Migration of pain	1
	Anorexia	1
	Nausea/emesis	1
Signs	Tenderness in right lower quadrant	2
	Blumberg sign	1
	Pyrexia	1
Blood exams	Leukocytosis (≥10000/uL)	2
	Neutrophil (≥7500/uL)	1
Total Scores		10

In our department the medical records of each patient were collected by experienced surgeons. Decisions for laboratory or imaging investigations were totally dependent of the treating physician decision.

If children underwent an appendectomy the medical record was obtained and the pathology was reviewed. Appendicitis was defined as appendectomy with positive histology. A negative appendectomy was defined as an appendectomy with negative histology. Two groups were defined, those with histology-confirmed appendicitis and those without appendicitis.

Different clinical information were recorded, such as age, gender, fever (≥37.5ºc axillary), anorexia, blumberg sign, nausea/emesis, tenderness in right lower quadrant. The components of the AS were recorded.

Data were entered by one author into a Microsoft Access database. For each patient, information from the clinical process (signs, symptoms, surgical pathology) was collected and AS was calculated.

The potential negative appendectomy rate was calculated as the number of false positives divided by the number of patients taken to the operating room for an appendectomy.

We identified patients who underwent preoperative ultrasonography (US) and the final, written report of the exam was reviewed. The US diagnosis was based on the detection of a blind-ending, non-compressible tubular structure with a maximal diameter greater than 6 mm, with or without an appendicolith, and no peristaltic activity.

SPSS 16.0 software was used for all statistical analysis. A P value <0.05 was considered statistically significant.

The differences between means with 95% CIs were calculated. For the comparison of continuous data and categorical data Student t test and Qui-square test were used, respectively.

Univariate analysis was performed with logistic regression to compute odds ratio [CIs] for each possible predictor.

Results

A total of 192 patients were identified based on the appendectomies records, including 111 males and 81 females. The mean age was 12 years (standard deviation [SD] ± 4).

Of these patients, 157 (82%) had pathology-proven appendicitis. The patients with and without appendicitis were similar, with the exception of C – reactive protein level and leucocytes and neutrophil counts, that were higher in the former group (Table II).

Table II. Characteristics in patients with and without appendicitis

Variable	Diagnosis	Mean	*SD*	*P*
Age (years)	NA (negative appendectomy)	12,3	4,1	0.074
	AA (Acute Appendicitis)	12,3	3,9	
Time of onset of symptoms (hours)	NA	40,3	45,9	0.374
	AA	30,9	31,7	
Leukocyte (count/uL)	NA	9864	4369	0.001
	AA	15320	5586	
Neutrophil (count/uL)	NA	6444	4109	0.001
	AA	12160	5235	
CRP (mg/L)	NA	15,4	28,7	0.001
	AA	52,0	66,7	
Alvarado score (AS)	NA	4,5	2,2	0.002
	AA	6,1	1,7	
Variable	**Diagnosis**	**Proportion (%)**		***P***
Male gender	NA (negative appendectomy)	10,7		
	AA (Acute Appendicitis)	89.3		0.052
Migration of pain	NA	7.1		0.352
	AA	92.9		
Anorexia	NA	14,0		0.675
	AA	86,0		
Nausea/emesis	NA	12.1		0.118
	AA	87.9		
Tenderness in RLQ	NA	15.8		0.913
	AA	84.2		
Blumberg sign	NA	19.6		0.391
	AA	80.4		
Pyrexia	NA	14.9		0.844
	AA	85.1		
Leukocytosis (≥10000/uL)	NA	7.2		0.001
	AA	92.8		
Neutrophil (≥7500/uL)	NA	7.5		0.001
	AA	92.5		
Alvarado score ≥ 5	NA	8.7		0.001
	AA	91.3		
Alvarado score ≥ 6	NA	6.5		0.001
	AA	93.5		
Alvarado score ≥ 7	NA	5.1		0.004
	AA	94.9		

Table III. Univariate analyses (Odds ratio estimates)

	Appendicitis	
	No (reference)	Yes
	OR	*OR* [95%CI]
Leukocytosis (≥10000/uL)	1	3.2 [2-5.1]
model 1	1	3 [1.9-5]
Neutrophil (≥7500/uL)	1	3.6 [1.3-101]
model 1	1	3.3 [1.2-10]
Alvarado score (AS)	1	1.6 [1.3-2.1]
model 1	1	1.5 [1.2-2.1]
Alvarado score ≥ 5	1	7.6 [2.9-19.9]
model 1	1	6.9 [2.5-18.8]
Alvarado score ≥ 6	1	6.9 [2.5-18.7]
model 1	1	6.1 [2.2-17.2]
Alvarado score ≥ 7	1	5.6 [1.6-19.7]
model 1	1	5.2 [1.5-18.1]

model 1 - age and gender adjustment

Thirty seven patients had leucocytes count greater than 18000/uL. In 36 (97%) of these 37 patients had pathology-proven appendicitis. Ten patients with WBC≥18000/uL had perforation and two had appendiceal abscess. In the patient with negative appendectomy a mesenteric lymphadenitis diagnosis was made.

Results of the univariate analysis showed that six of the variables were significant predictors of appendicitis. These were leucocytes (OR=3.2 [2-5.1]), neutrophil (OR=3.6 [1.3-10.1]), AS (continuous variable) (OR=1.6 [1.3-2.1]), AS≥5 (OR=7.6 [2.9-19.9]), AS≥6 (OR=6.9 [2.5-18.7]) and AS≥7 (OR=5.6 [1.6-19.7]). All other recorded findings were not statistically significant.

To adjust for potentially confounding variables an adjustment for age and gender was performed. All predictors remain statistically significant (Table III).

US was performed in 37 (19%) patients and its results were true-positive for appendicitis in 26 of these patients and false-negative in 8. In the 11 patients with a US and did not have a final diagnosis of appendicitis, a true-negative US-based diagnosis was made in 3 and no false-positive US-based diagnosis was made.

Perforated appendicitis was diagnosed in 21 of 192 patients, including 4 with appendiceal abscess, so the perforation rate was 11%. In all of these 21 patients, a correct diagnosis of appendicitis was made with US.

Discussion

The paediatrics guidelines for AA diagnosis are based on clinical story and physical exam findings [14-16]. Curiously in our study all the clinical (signs and symptoms) findings were not significantly associated with the AA.

Nonetheless, when theses clinical findings were associated in a score, as the AS, they can predict the risk of this clinical situation. Using three different cut-points (5, 6 and 7 points) of AS we observed positive and significantly associations, that remains even after adjustment for age and gender.

Several studies have reported the utility of the AS to predict the AA and the sensitivity and sensibility using different cut-points [7, 17].

The AS must be used in routine paediatric practices and particularly when he AA diagnosis is uncertain to improve the distinction between to those who do or not have appendicitis, or primarily who need to stay in the emergency room for clinical surveillance.

The negative appendectomy rate was estimated in 18%. It was an expected rate according to the information from other studies which reported a rate of 15-30% [6].

Despite this expected result it was important to determine the predictors of AA to minimizing the negative appendectomy rate.

Using this approach the negative appendectomy rate would have decreased.

In this retrospective study of 191 children taken to the operating room for appendectomies the possible predictors of AA were investigated.

Both clinical and analytical parameters were studied but only leucocytes and neutrophil were significantly associated with the AA diagnosis. Other studies have already reported these associations [18-20] . A low-grade leucocytosis is commonly present in patients with AA. Nonetheless, a white blood cell (WBC) counts greater than 18000/uL is not generally seen in the initial phase, but is not uncommon after perforation and abscess formation. C- reactive protein was not statistically associated with AA, a expect result according to the references [21, 22].

US generally is the primary imaging performed in children suspected of having AA because it is relatively quick to perform and does not involve the use of ionizing radiation. But it is also highly operator dependent and there may be difficulty in identifying appendicitis when there is pain, gas and perforation.

The overall sensitivity of US in our study was 70%. Higher sensitivity value would have been expected if the exam had been performed by a limited number of experienced specialists, as they have been in other studies [23, 24].

The generally accepted, relatively high negative appendectomy rate has often been considered to be preferable to the complications of perforation. So, it is normal a higher negative appendectomy rate (18%) than perforation rate (11%). A range in the paediatric population, from 23 to 73%, has been reported [25].
Limitations of our study include its retrospective design and patient information recorded bias.

In conclusion, beside US can be valuable in the AA diagnosis ours findings suggest that only analytical parameters predict AA. The signs and symptoms are important settings for de AA diagnosis when they are grouped on a score. In this case using AS and a cut-point of 5, a 6-fold increases risk of AA was estimated.

We recommend the adoption of the Alvarado Score into the clinical practice.

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