Association for Academic Surgery

Utility of immature granulocyte percentage in pediatric appendicitis

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ABSTRACT

Background: Acute appendicitis is the most common cause of abdominal surgery in children. Adjuncts are used to help clinicians predict acute or perforated appendicitis, which may affect treatment decisions. Automated hematologic analyzers can perform more accurate automated differentials including immature granulocyte percentages (IG%). Elevated IG% has demonstrated improved accuracy for predicting sepsis in the neonatal population than traditional immature-to-total neutrophil count ratios. We intended to assess the additional discriminatory ability of IG% to traditionally assessed parameters in the differentiation between acute and perforated appendicitis.

Materials and methods: We identified all patients with appendicitis from July 2012−June 2013 by International Classification of Diseases-9 code. Charts were reviewed for relevant demographic, clinical, and outcome data, which were compared between acute and perforated appendicitis groups using Fisher exact and t-tests for categorical and continuous variables, respectively. We used an adjusted logistic regression model using clinical laboratory values to predict the odds of perforated appendicitis.

Results: A total of 251 patients were included in the analysis. Those with perforated appendicitis had a higher white blood cell count ($P = 0.0063$), C-reactive protein (CRP) ($P < 0.0001$), and IG% ($P = 0.0299$). In the adjusted model, only elevated CRP (odds ratio 3.46, 95% confidence interval 1.40−8.54) and presence of left shift (odds ratio 2.66, 95% confidence interval 1.09−6.46) were significant predictors of perforated appendicitis. The c-statistic of the final model was 0.70, suggesting fair discriminatory ability in predicting perforated appendicitis.

Conclusions: IG% did not provide any additional benefit to elevated CRP and presence of left shift in the differentiation between acute and perforated appendicitis.

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1. Introduction

Appendicitis is the most common reason for abdominal surgery in children in the United States [1]. Over 80,000 appendectomies are performed each year for pediatric appendicitis [2]. Children have higher rates of perforated appendicitis as compared with adults, ranging from 22%—52% depending on age and other variables [3]. Distinguishing acute from perforated appendicitis preoperatively may have a significant effect on the treatment plan. For acute appendicitis, treatment includes urgent appendectomy; however for complicated perforated appendicitis, many centers will administer intravenous antibiotics for a defined period after interval appendectomy [4]. Prior studies have shown that interval appendectomies assist in decreased hospitalization, complications, and cost when compared with the traditional emergency approach [5,6].

Many articles have focused on preoperative laboratory parameters, which may improve diagnostic accuracy in distinguishing acute from perforated appendicitis in conjunction with imaging modalities. White blood cell (WBC) counts with differential and C-reactive protein (CRP) levels are commonly obtained in children with suspected appendicitis. CRP has been shown to increase markedly after appendiceal perforation or abscess formation, making it a potential indicator of perforated appendicitis; however, WBC count is an early marker of appendiceal inflammation but cannot reliably distinguish acute from perforated appendicitis [7]. Recent literature has demonstrated that using automated hematologic analyzer counts can more accurately determine immature granulocyte percentage (IG%) in comparison with manually derived "band" counts or differentials, which underestimate IG% at low counts [8]. Lack of immature granulocytes has been shown to have a high negative predictive value, particularly in neonatal sepsis [9]. The purpose of this study was to determine if IG% would add additional discriminatory ability, in conjunction with traditionally used laboratory values, in differentiation of acute and perforated appendicitis in a pediatric population.

2. Materials and methods

After institutional review board approval (Protocol #: X130611004), pediatric patients (≤16 y of age) with appendicitis from July 2012—June 2013 were identified by International Classification of Diseases (ICD)-9 code, and a retrospective review was conducted. The following ICD-9 codes were included: appendicitis (541), appendicitis with perforation, peritonitis, or rupture (540.0), and acute appendicitis (540.9). Hospital records were further reviewed to select patients with acute or perforated appendicitis. We excluded patients with other diagnosed inflammatory conditions or significant comorbidities that might alter inflammatory markers. All operations were performed at Children's of Alabama. Perforated appendicitis was defined, based on previous studies, as the surgeon's interpretation based on operative findings, including a hole in the appendix, an intra-abdominal fecalith, or an intra-abdominal abscess [10]. Other variables were collected including demographic data (age, race, and gender) and laboratory values (WBC count, CRP, and presence of a left shift). IG% was determined by the Sysmex XE-2100 automated hematologic analyzer. The immature granulocyte measurement includes promyelocytes, myelocytes, and metamyelocytes, but not bands or blasts. This definition is consistent with previous studies [8,9]. Detection of immature granulocytes by Sysmex XE-2100 has shown a sensitivity, a specificity, and an efficiency of 92%, 81%, and 83%, respectively [11]. Left shift, or neutrophilia, was considered present if neutrophils were >75% of the WBC count, as described by a previous study [12]. Demographic and clinical characteristics were compared between acute and perforated appendicitis groups using Fischer exact and t-tests for categorical and continuous variables, respectively. Clinical laboratory variables were put into an adjusted logistic model to predict odds of perforated appendicitis.

3. Results

A total of 281 patients were initially identified based on ICD-9 codes. Thirty patients were excluded from the analysis: 14 for appendectomy for reasons other than appendicitis, 13 for incomplete data, and 3 for other inflammatory diagnoses that might affect laboratory parameters. A total of 251 patients were included in the analysis: 168 (67%) with acute appendicitis and 83 (33%) with perforated appendicitis. All patients included in the analysis underwent either immediate or interval appendectomy. Patient demographics are listed in Table 1. Collectively, the mean age was 11.1 y, and 62% were male. Most of the patients were Caucasian (52%). There were no significant differences in age, race, or sex between perforated and non-perforated groups.

Those with perforated appendicitis had higher mean WBC count ($P = 0.0063$), CRP ($P < 0.0001$), absolute neutrophil count (ANC) ($P = 0.005$), and IG% ($P = 0.0299$), as listed in Table 2. Additionally, those with perforated appendicitis were more likely to have a left shift present ($P = 0.0146$). Clinical laboratory variables were put into an adjusted logistic model predicting odds of perforated appendicitis (Table 3). In the adjusted model, only elevated CRP (odds ratio 3.46, 95% confidence interval 1.40—8.54) and presence of left shift (odds

Table 1 – Comparison of demographic characteristics of children with perforated and acute appendicitis.

Demographics	Perforated (N = 83)	Acute (N = 168)	P value[*]
Mean age (y)	10.8 ± 3.7	11.3 ± 3.3	0.2273
Race (%)			
Caucasian	55 (66.3)	127 (75.6)	0.3574
African American	17 (20.5)	24 (14.3)	
Hispanic	11 (13.3)	16 (9.5)	
Asian	0 (0.0)	1 (0.6)	
Sex (%)			
Male	51 (61.5)	104 (61.9)	1.0000
Female	32 (38.6)	64 (38.1)	

[*] Based on Fisher exact chi-square and t-test for categorical and continuous variables, respectively.