

Clinical Science

# Diagnostic markers in acute appendicitis



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## Abstract

**BACKGROUND:** An adequate medical history combined with clinical examination is usually enough to make the diagnosis of acute appendicitis. The aim of this study was to determine the value of elevated white cell count (WCC), C-reactive protein (CRP), and bilirubin as diagnostic markers of acute appendicitis.

**METHODS:** A retrospective analysis was carried out on consecutive patients who underwent appendectomy over a 3-year period. All data including patients' age, sex, blood test results, and appendix histology were summarized. Sensitivities, specificities, positive, and negative predictive values of WCC, CRP, and bilirubin were calculated separately or in combination for all patients.

**RESULTS:** A total of 447 patients were included. There is a significant difference in the results between patients with negative and positive appendicitis with regards to CRP (32 vs 73;  $P < .001$ ), mean total WCC (10.9 vs 14.0;  $P < .001$ ), and the mean levels of bilirubin (10.9 vs 17.2;  $P < .001$ ).

**CONCLUSIONS:** The diagnosis of appendicitis remains multifactorial and blood tests may help to guide the surgeon in the decision making.

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Acute appendicitis is one of the most common surgical emergencies and appendectomy remains among the most frequently performed emergency operations worldwide.<sup>1-3</sup>

An adequate medical history combined with clinical examination to elicit common physical signs associated with localized peritonitis is usually enough to make the diagnosis of acute appendicitis. However, the diagnosis of appendicitis is not always straight forward especially in female patients as a gynecological pathology may mimic acute appendicitis. Moreover, the variability in

appendicular locations such as in hidden or retrocecal appendicitis may not allow patients to exhibit enough peritoneal signs to support the diagnosis of acute appendicitis.<sup>4</sup> To date, reliable specific marker of acute appendicitis has not yet been identified. Despite advances in technology and investigation modalities, the rate of negative appendectomies remains between 15% and 50%.<sup>5</sup>

Several Scoring systems have been developed to aid in the diagnosis of acute appendicitis (Alvaredo,<sup>6</sup> Lintula<sup>7</sup> and RIPASA<sup>8</sup>). However, these systems have their own limitations and are mainly used in children and have not shown to be accurate in the adult female population.<sup>6</sup>

In practice, the diagnosis of acute appendicitis is supported by the presence of elevated inflammatory markers, that is, white cell count (WCC) and C-reactive protein (CRP). However, some studies have shown that neither of these markers is diagnostic nor specific for acute appendicitis.<sup>9</sup>

The authors declare no conflicts of interest.

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**Table 1** Patients according to sex and appendix histology result

	Positive for appendicitis	Negative for appendicitis	Total
Men	248	19	267 (59.7%)
Women	138	42	180 (40.3%)
Total	386	61	447

Recently, serum bilirubin has been found to play a useful role in the diagnosis of perforated appendicitis with a sensitivity of 70% and specificity of 86%.<sup>10</sup> The diagnostic accuracy of appendicitis based on hyperbilirubinemia remains uncertain.

The aim of our study is to determine the value of elevated WCC, CRP, and bilirubin as diagnostic markers of acute appendicitis.

## Patients and Methods

A retrospective analysis of collected data was carried out on all consecutive patients who underwent appendectomy at our institution over a 3-year period (from January 2007 to April 2010). Patients were identified from our research and audit department using the search terms “appendicitis,” “appendectomy,” and “laparoscopic appendectomy.” All data including patients’ age, sex, blood test results (WCC, differential leukocytes count, CRP, and liver function tests including bilirubin), and appendix histology results were obtained from our audit department and hospital computerized record system (NMPATH). All collected data were fed into and summarized on an EXCEL spreadsheet (Microsoft Excel 2007, Redmond, WA). All patients’ identifying data were stored on a secure password protected computer, access of which was provided by the hospital login.

Appendectomy was performed conventionally or laparoscopically. There was no age cut off. Patients with incomplete blood test results (WCC, CRP, or liver function tests) and patients with known liver disease, Gilbert’s syndrome, or with persistently elevated liver function tests were excluded from the study.

Blood test results were deemed positive if they were above the upper limits of the hospital’s laboratory values. Hyperbilirubinemia is thus defined as bilirubin levels of greater than 15  $\mu\text{mol/L}$ . Leukocytosis is defined as WCC of greater than  $11 \times 10^9/\text{L}$ , and CRP was considered elevated if levels were more than 10 mg/L.

Patients were classified into 3 groups according to appendix histology result. The first group (control group) contains patients with negative appendectomy, that is, normal appendix on histology. The second group has patients with appendicitis proven on histology without evidence of perforation, while patients with evidence of appendicular perforation form the third group.

Data were analyzed using SPSS version 19.0 (SPSS, Inc, Chicago, IL). Continuous variables were expressed as mean and standard deviation or range and median. Sensitivities, specificities, positive predictive value (PPV), and negative predictive value (NPV) of WCC, CRP, and bilirubin were calculated separately or in combination for all patients. One-way analysis of variance test was used to analyze difference between means of variables among patients’ groups. Results were considered statistically significant when *P* value was of less than or equal to .05.

## Results

Between January 2007 and April 2010, appendectomy was performed in 567 patients. By applying exclusion criteria, 120 patients were excluded (73 patients had positive appendicitis). A total of 447 patients were included in the study, of which 267 were men and 180 were women. Mean age was 27.1 years (range: 5 to 83 years). The total number of children (age < 16 years) was 76 (17%). The number of patients with negative appendectomy (control group) was 61 (13.6%), of which 42 were women (Table 1).

The total number of patients who had appendicitis was 386, of which 18.1% ( $n = 70$ ) had histology confirming perforated appendicitis.

WCC was elevated in 52.6% of men, while it was elevated in 40.5% in women in the negative appendectomy group. For patients with appendicitis, WCC was elevated in 79.4% of men and 63% of women. In the perforated appendicitis group, WCC was elevated in 82.4% of men and 61% of women (Table 2).

**Table 2** Summary of percentages of positives laboratory results including WCC, CRP and bilirubin according to gender and appendix histology results

Criterion	Sex	Negative %	Positive %	Perforated %
WCC	Male	52.6	79.4	82.4
	Female	40.5	63	61.1
CRP	Male	47.4	78.2	92.2
	Female	40.5	73.2	94.4
Bilirubin	Male	26.3	54.4	60.8
	Female	16.7	29.7	50

CRP = C-reactive protein; WCC = white cell count.

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