ORIGINAL CONTRIBUTION

Normal Total WBC and Operative Delay in Appendicitis

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Introduction

There are approximately 250,000 cases of appendicitis per year in the United States (1). Delay in diagnosis is associated with an increase risk of perforation and other complications (2). Failure to diagnose appendicitis, or to do so in a timely manner, is a common cause of malpractice litigation and settlements (3,4). The diagnosis of appendicitis remains challenging largely due to the often protean nature of presenting symptoms, variable history and physical findings, and broad list of non-operative diseases to be considered. Diagnosis remains largely dependent upon clinical assessment in conjunction with a variety of ancillary tests. Historically a complete blood count (CBC) with particular focus on white blood count (WBC) has been among the most commonly ordered laboratory tests. The data supporting or refuting a role for WBC is highly variable with some studies advocating a useful role while others suggesting little utility. Despite the lack of data supporting a clear role for WBC in the diagnosis of appendicitis, there is often a reluctance to commit to this diagnosis and operative intervention if the WBC is normal. The objective of this investigation was to determine if a normal total WBC was associated with a delay in operative intervention and, therefore, an increased rate of complications in patients presenting to an ED with a final diagnosis of *appendicitis*.

Methods

This study utilized a retrospective chart review design. The site was an urban, University ED with an annual census of *35,000* patients. During the period of review the ED was staffed by residents in Emergency Medicine, Family Medicine, Internal Medicine and Surgery. All care was supervised by faculty board certified in Emergency Medicine. Inclusion criteria encompassed all patients between the ages of 12 and 50 that were seen in the ED between 1989 and 1994 with a final hospital discharge diagnosis of appendicitis. All ED and inpatient records were reviewed along with operative and pathologic reports. Measures included age, gender, total WBC, presence of perforated appendix (PA) and time to operation (TO). Perforated appendix was defined on the basis of the pathologic report and included both gross and microscopic perforation. Time to operation was defined as the time from ED triage to skin incision in the operating room. Patients were segregated into three groups based upon total WBC. Group 1 total WBC *< 10,000*; group 2 *total WBC 10,000 to 11,999; group 3* total WBC > 11,999. These three groupings were empiric but determined prior to data analysis and chosen to reflect a normal WBC group 1, an equivocal WBC group 2, and an abnormal WBC group 3.

Statistical analysis included analysis of variance for the continuous variables of TO and age, and Chi Square analysis for the categorical variables of gender and PA.

This investigation was approved by the Medical Center's Human Subjects Committee.

Results

Two hundred and seventy-seven charts were identified of which 190 met all study inclusion criteria. Forty-five charts were either incomplete or unavailable for review and 42 others were excluded. Eighteen were excluded because appendectomy was performed incidental to another operative procedure and not because of presentation suggestive of appendicitis. Nineteen were excluded due to initial presentation from a site other than the ED. Three patients were eliminated due to percutaneous drainage of peri-appendiceal abscess and delayed appendectomy. One patient was a spouse of a surgical resident and excluded because of potential bias in the decision making process and another patient was excluded due to delay incurred as a consequence of parental consent issues.

Of the 190 patients included in the study, 112 were male and 78 were female. The mean age of the entire group was 26.5 years. Group 1 with total WBC < 10,000 included 8 males and 4 females with a mean age of 27.5 years. Group 2 with a total WBC *10,000 – 11,999* had a mean age of 27.5 years with 17 males and 10 females. Group 3 with a total WBC of > 11,999 had a mean age of 26.3 and consisted of 87 males and 64 females. There was no statistically significant difference between groups with respect to mean age or gender composition. The mean TO for group 1 was 1653 minutes, group 2 was 741 minutes and group 3 was 930 minutes (p=0.016). The rate of PA in group 1 was 50%, PA in group 2 was 26%, and PA in group 3 was 31 percent (p=0.001). All results are summarized in Table 1.

Discussion

There are a large number of tests that have been utilized by physicians to aid in the diagnosis of appendicitis. Helical computerized tomography (CT), ultrasound and technetium *labeled white blood cell scans have all been advocated as* useful adjuncts (5-10). Despite reports of very high sensitivity and specificity for several of these techniques, 98% sensitivity and specificity for helical CT and 98% sensitivity and 95% specificity for technetium labeled white cell scans, the WBC is still the most commonly ordered laboratory test in patients with suspected appendicitis. A review of several Emergency Medicine and Surgical texts identify the WBC as an important laboratory adjunct in the diagnosis of appendicitis, however there is no consistency with respect to how results should be utilized (11-15). The chapter on appendicitis in the text Principles of Surgery indicates that in the setting of a normal WBC with no left shift the diagnosis of appendicitis should be reconsidered (14). Emergency Medicine texts suggest that while an elevated WBC is commonly associated with *appendicitis, this test has poor specificity and low predictive* value. A review of the literature on the issue yields similarly divergent conclusions. Izbicki attempted to develop a scoring system to improve the diagnostic accuracy of appendicitis. This study suggested that among the predictive variables was a WBC greater than $11 \times 10^9/l$ (16). A study of 229 patients by

Eriksson concluded that if repeated WBC and C reactive protein measurement were normal, operation should be delayed (17). A study by Coleman found that in a cohort of 1919 patients with appendicitis, 11 percent of the patients had a normal WBC. They could find no difference in age, gender, or severity of disease in those with a normal WBC when compared to those with an elevated WBC (18). The results reported here are somewhat unique as they reveal an association between a normal initial WBC in the ED with a delay to operative intervention and an increased incidence of perforated appendicitis. While it cannot be concluded that the WBC was involved in the delay to operative intervention and that the delay was related to the higher rate of appendiceal perforation, the association is provocative. It is possible that a normal WBC as defined by a value of $< 10 \times 10^9/l$ caused the treating physicians to doubt the diagnosis of appendicitis and thereby delay surgical intervention.

There are some important limitations to this study that mitigate the power of any conclusions that can be drawn. This was a retrospective study and, as a result, many cases were excluded due to incomplete data collection and chart unavailability. The number of patients in group 1 was small. Only total WBC data was collected. It may be that total neutrophil count or a shift to immature neutrophils would have yielded different results. The WBC groupings were empiric. While these groupings were determined prior to data analysis it is possible that if different values were utilized results may have been different. Finally, this study was conducted during a time frame when helical computerized tomography of the abdomen was not commonly employed in the evaluation of suspected appendicitis. The findings may not have been the same in the current era of appendicitis evaluation.

Conclusion

In this group of 190 patients with appendicitis, a WBC $< 10 \times 10^9/l$ was associated with a significant delay in operative intervention and a higher rate of perforated appendix when compared to patients with WBC $> 10 \times 10^9/l$. If clinical signs are present it is prudent to still consider the diagnosis of appendicitis despite a normal total WBC.

Table 1

WBC	< 10,000 Group 1	10,000 – 11,999 Group 2	> 12,000 Group 3
Number	12	27	151
Male/Female ratio	8/4	17/10	87/64 P = NS
Mean Age (years)	27.5	27.5	26.3 P = NS
Mean Time to OR -TO- (minutes)	1653	741	930 P = 0.016
Perforation Rate -PA- (percent)	50	26	31 P = 0.001

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