Original Article

Diagnostic value of lactate levels in acute appendicitis

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Abstract

Objective: To assess the value of lactate measurements in addition to standard diagnostic measurement of white blood cell count (WBC) and C-reactive protein (CRP) in the accuracy of preoperative acute appendicitis (AA) diagnosis.

Methods: A total of thirty-six consecutive patients with histopathologically confirmed acute appendicitis were retrospectively included in the study. Fifteen volunteers were included as control group. Patient characteristics, preoperative ultrasonography (US) and laboratory assessment including WBC, C-reactive protein (CRP) and lactate values were collected. Receiver Operator Characterstics (ROC) curves for discriminant values and sensitivity, specificity, positive and negative predictive values (PPV,NPV) were calculated.

Results: The male/female ratio of groups 1 and 2 were 25/11 and 9/6 respectively. Mean age: 34.13±9.6 years. Area under ROC values for lactate were found significant and discriminant value was found to be 8 mg/dl. Specificity, sensitivity, PPV and NPV calculated for lactate were as follows: 53%, 80%, 77% and 57%.

Conclusions: Increased lactate levels as well as other inflammatory parameters should be considered as a diagnostic parameter in diagnosis of AA (JPMA 60:913; 2010).

Introduction

Acute appendicitis (AA) is one of the most common causes of the acute abdomen.[1,2] In spite of the widespread use of various advanced diagnostic tools, the diagnosis of appendicitis is not always easy to make. To support the diagnosis of appendicitis, leukocyte counting and CRP have been investigated in different studies.[3-5] It has also been reported that leukocytosis and elevated CRP levels support the diagnosis of AA.[6] The obstructed appendix is a good medium for bacterial proliferation and ischaemic injury of the appendix leads to an increase in lactate.[7] The purpose of this study was to investigate lactate levels in the diagnosis of AA.

Methods

All patients with suspicion of AA admitted to the emergency department of our hospital were evaluated. Patients were included in the study if diagnosis of appendicitis was confirmed histopathologically postoperatively. Routine preoperative work-up for acute appendicitis included WBC, CRP, arterial blood gas analysis and US evaluation. Data was collected retrospectively for confirmed cases of acute appendicitis. The cases with histopathological signs incompatible to AA were excluded. The control group included 15 voluntarily healthy individuals who participated in this study. They did not have any condition that would affect study parameters. Similar, studies were also performed in the control group. Leukocyte counting was performed in the Coulter MAXM haemocounter. CRP levels were measured nephalometrically (Beckman Image). Lactate levels were determined in blood gases analyser (Radiometer ABL800 flex).

Statistics:

Statistical evaluation was done by using the software package SPSS 15.0 and probability value of less than 0.05 was accepted as statistically significant. The results for lactate, WBC and CRP are given as the mean ± standard deviation (SD). Receiver operating characteristic (ROC) curves for lactate, WBC and CRP were constructed and discriminant values were determined.

Results

Thirty-six consecutive patients with histopathologically confirmed diagnosis of acute appendicitis were included in the study. The male to female ratio of groups 1 and 2 were 25/11 and 9/6 respectively. Mean age was 34.13±9.6 years. Laboratory examinations revealed a WBC of $12.5x10^3$±3.90, a CRP concentration of 12.74±7.92 mg/dl, and lactate level is 10.70±3.94 mg/dl in group 1 and a WBC of 6.59 $x10^3$±1.52, a CRP concentration of 5.53±1.5, and lactate level of 7.83±1.74 in group 2. All parameters were significantly higher in acute appendicitis group compared to the control group ($p<0.001$ for all parameters). US was found positive in 52.8% (19) of the patients with acute appendicitis.

ROC curves for lactate, WBC and CRP were drawn and AUC was found significant for all parameters (Figure). The discriminant values were determined as 8 mg/dl, 7.1 x

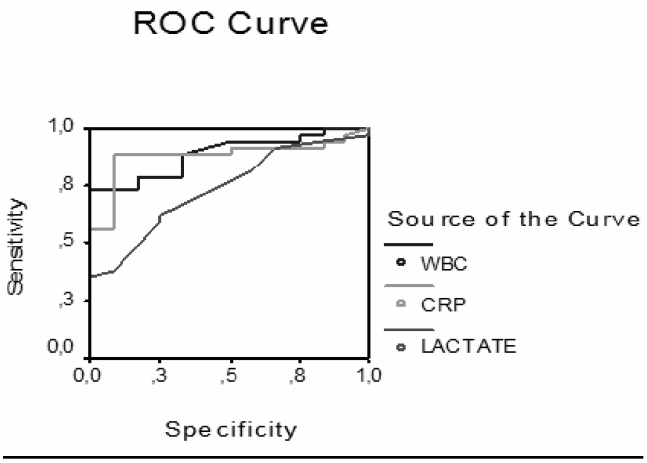

Figure: ROC Curve for WBC, CRP and Lactate levels.

Table: Sensitivity, Specificity, Positive Predictive Values (PPV) and Negative Predictive Values (NPV) for all parameters.

Spesifity	(%)	Sensitivity (%)	PPV (%)	NPV (%)
Lactate	53	80	77	57
WBC	66	86	83	71
CRP	93	83	96	73
USG	100	60	100	55

WBC= White Blood Count. CRP= C-Reactive Protein. USG= Ultrasonogram.

10^3 and 7.4 U/L respectively. For these cut-off values when AUC were calculated WBC (AUC=0.886, p<0.001) had the highest diagnostic value and CRP (AUC=0.868, p<0.001) and lactate levels (AUC=0.719, p=0.028) followed. Specificity, sensitivity, PPV and NPV calculated for lactate were as follows: 53%, 80%, 77% and 57%. These values for other parameters are presented in Table.

Discusion

In this study, patients with AA had significantly higher lactate levels than the control group and ROC analysis revealed lactate had discriminant value for AA. These results suggest that the measurement of lactate levels may be a useful adjunct to clinical and radiological findings in diagnosis of AA.

AA is the most common acute surgical infection seen in emergency department. Appendectomy remains the most frequently performed emergency abdominal surgical procedure.[8] Early diagnosis of AA is important for reducing morbidity rates. AA remains a difficult diagnosis.[9] Despite many advances in diagnostic system, AA is still a diagnostic dilemma at times.[10]

Determining the optimum algorithm for diagnostic procedure in suspected AA may not only reduce the number of unnecessary operations, but also the frequency of complications, and may contribute measurably to reducing the costs of treating patients with acute abdominal conditions. The diagnosis of appendicitis is not always straight forward. The indication for operation is usually based on a combination of clinical and laboratory findings.[11-13] The rate of correct diagnosis has been reported as 80% using physical examination and leukocyte counting. The rate of correct diagnosis has remained lower than 90% despite utilization of US, computerized tomography (CT), and scintigraphy. Although, CT can be useful in diagnosis, it is not a routine diagnostic tool in our department when appendicitis is suspected. This management conforms with the literature.[14] (Because a significant amount of radiation exposure may occur due to CT scans performed for the diagnosis of AA in the emergency department. Ultrasound (US) eliminates radiation risk but has a sensitivity inferior to that of CT.[15] In this study, abdomen US as an adjunct to physical examination was performed in 43 patients. Only 19 (52.8%) of the patients with AA could be diagnosed with US, in the remaining patients, ultrasonographic evaluation was reported to be normal. These results indicate that US scans may offer a lower diagnostic yield for appendicitis.

Once obstruction occurs, appendix is a good medium for bacterial proliferation, and ischaemic injury leads to an increase in lactate levels.[7] In our study, we demonstrated positive relationship between blood lactate levels and AA. Therefore, we conclude that lactate might be a simple and reliable diagnostic marker for AA. WBC and CRP levels are commonly used to support the clinical diagnosis of AA. The use of these diagnostic labarotary measurements with the addition of lactate in suspicion of AA can enhance the accuracy of diagnosis. A recent study showed that patients experiencing lower abdominal pain, with normal WBC and CRP values, are unlikely to have acute appendicitis and can be safely sent home.[6]

Another recent study suggested that normal values of both WBC and CRP were very unlikely in pathologically confirmed appendicitis and inflammatory markers might be helpful in diagnosis of AA.[3,16,17] We believe that lactate level analysis would support these results.

None of these markers, including lactate levels are specific to AA, and all can be elevated in many clinical conditions. They may not play a major role in differential diagnosis, but when there are clinical findings suggestive of acute appendicitis they may aid to strongly support the diagnosis of AA.

Conclusion

Lactate is a reliable marker of inflammation in patients presenting with suspected AA. Our data highlight the importance of an elevated CRP and WBC in patients with suspected diagnosis of AA in addition to lactate measurements.

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