

Severity of acute appendicitis based on laboratory data

Severidade da apendicite aguda baseada em dados laboratoriais

Dhara Giovanna Santin De Souza¹, Orli Franzon², André Luiz Parizi Mello³, Lorena Carolina Neto Tellez⁴, Vitória Henz De Negri⁵

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ABSTRACT: Objective: This study aims to predict the severity of acute appendicitis using routine laboratory tests, enabling earlier and more personalized diagnoses. Given the prevalence and diagnostic complexity of acute appendicitis, the goal is to help reduce perioperative morbidity and mortality associated with the condition. Methods: The research was conducted at the Regional Hospital of São José Dr. Homero de Miranda Gomes, involving 200 patients diagnosed with acute appendicitis and undergoing appendectomy between May 1, 2022, and January 31, 2023. Conducted prospectively, demographic data, laboratory tests (complete blood count, C-reactive protein (CRP), total cholesterol, albumin, and lactate), and the degree of appendicitis by transoperative evaluation were analyzed. Statistical analysis was performed using the Mann-Whitney U test for laboratory variable. Results: Among the 200 patients, 111 (55.5%) had uncomplicated appendicitis (grades 1 and 2), while 89 (44.5%) had complicated appendicitis (grades 3, 4, and 5). The analysis revealed statistically significant differences in variables such as white blood cells, neutrophils, eosinophils, lymphocytes, total cholesterol, albumin, and CRP between the groups of uncomplicated and complicated appendicitis. The ratios between neutrophils/lymphocytes (NLR), lymphocytes/monocytes (LMR), and albumin/CRP (ACR) also showed significant statistical differences. Conclusion: The results indicate that selected laboratory markers can be useful indicators in predicting the severity of acute appendicitis. These findings provide the basis for future investigations aimed at optimizing the clinical approach to appendicitis, contributing to more effective and personalized interventions.

KEY WORDS: Appendicitis; Appendectomy; Perioperative period; Indicators of morbidity and mortality.

RESUMO: Objetivo: O estudo visa prever a severidade da apendicite aguda por meio de exames laboratoriais rotineiros, oferecendo uma abordagem mais precoce e personalizada para o diagnóstico da doença. Dada a prevalência da apendicite aguda e a complexidade do seu diagnóstico, o objetivo é contribuir para a redução da morbimortalidade perioperatória associada a essa condição. Métodos: A pesquisa foi conduzida no Hospital Regional de São José Dr. Homero de Miranda Gomes, abrangendo 200 pacientes diagnosticados com apendicite aguda e submetidos à apendicectomia de 01 de maio de 2022 a 31 de janeiro de 2023. Realizado de forma prospectiva, foram analisados dados demográficos, exames laboratoriais (hemograma completo, proteína C reativa (PCR), colesterol total, albumina e lactato) e o grau de apendicite por avaliação transoperatória. A metodologia incluiu análise estatística utilizando o teste U de Mann-Whitney para variáveis laboratoriais. Resultados: Dos 200 pacientes incluídos, 111 (55,5%) apresentaram apendicites não complicadas (graus 1 e 2), enquanto 89 (44,5%) apresentaram apendicites complicadas (graus 3, 4 e 5). A análise revelou diferenças estatisticamente relevantes em variáveis como leucócitos, neutrófilos, eosinófilos, linfócitos, colesterol total, albumina e PCR entre os grupos de apendicites não complicadas e complicadas. As razões entre neutrófilos/linfócitos (NLR), linfócitos/monócitos (LMR) e albumina/PCR (ACR) também apresentaram diferenças estatísticas significativas. Conclusão: Os resultados indicam que marcadores laboratoriais selecionados podem ser indicadores úteis na predição da gravidade da apendicite aguda. Esses dados oferecem a base para futuras investigações visando otimizar a abordagem clínica da apendicite, contribuindo para intervenções mais eficazes e personalizadas.

PALAVRAS-CHAVE: Apendicite aguda; Marcadores laboratoriais; Severidade da doença; Morbimortalidade perioperatória.

¹ Cirurgiã geral - Hospital Regional Homero De Miranda Gomes, São José/SC, Brasil. ORCID: <https://orcid.org/0009-0000-1373-8555> E-mail: dhara_santin@gmail.com

² Cirurgião proctologista - Hospital Regional Homero De Miranda Gomes, São José/SC, Brasil. ORCID: <https://orcid.org/0009-0009-8230-7471> E-mail: orli_franzon@hotmail.com

³ Cirurgião do aparelho digestivo - Hospital Regional Homero De Miranda Gomes, São José/SC, Brasil. ORCID: <https://orcid.org/0000-0002-0162-1461> E-mail: contato@andreparizi.com.br

⁴ Cirurgiã geral - Hospital Regional Homero De Miranda Gomes, São José/SC, Brasil. ORCID: <https://orcid.org/0009-0009-8376-5298> E-mail: lorenacnt@hotmail.com

⁵ Médica generalista formada na Universidade do Sul de Santa Catarina, Palhoça/ SC, Brasil. ORCID: <https://orcid.org/0000-0001-6789-0747> E-mail: vitoria.negri23@gmail.com

Correspondence: Vitória Henz De Negri, e-mail: vitoria.negri23@gmail.com

INTRODUCTION

Acute appendicitis is one of the most common causes of abdominal pain and the most frequent cause of inflammatory acute abdomen. Its incidence is higher in young men, but the disease occurs in both sexes and all age groups. Its pathogenesis, in most cases, is related to obstruction of the appendix lumen, causing local inflammation, but in some cases, it presents due to primary bacterial infection at the site. It can range from mild cases to progressing with perforation, abscesses, and generalized peritonitis, being a significant cause of morbidity and mortality in the population when diagnosed in more advanced stages. The most accepted treatment today is surgical, through appendectomy, which can be performed either via open surgery or laparoscopically.

The diagnosis of the disease remains challenging, especially in women, and involves clinical criteria, laboratory tests, and imaging findings. Various scoring systems in the literature attempt to indicate a higher or lower diagnostic probability based on the medical history, physical examination, and the use of inflammatory markers. However, in most cases, imaging exams, especially computed tomography (CT), are still necessary. Although CT is a diagnostic method with very high sensitivity and specificity, it has some disadvantages, such as radiation exposure, which translates to a 0.2% increase in the risk of developing neoplasms with a single examination. Furthermore, it adds costs to the healthcare service and increases the patient's hospital stay.

Given all the above, this study aimed to predict the severity of acute appendicitis through laboratory tests that are easily accessible in the vast majority of services, enabling earlier diagnosis and management, thus reducing perioperative morbidity and mortality associated with the disease.

METHODOLOGY

The study included all patients admitted to the Regional Hospital of São José Dr. Homero de Miranda Gomes with a diagnosis of acute appendicitis from May 1, 2022, to January 31, 2023, who underwent emergency open or laparoscopic appendectomy, were over 15 years old, and of both sexes. Patients whose admission laboratory tests did not include the following measurements were excluded: complete blood count, C-reactive protein, total cholesterol, albumin, and lactate. In the end, the study sample comprised 200 patients.

The study was approved by the Research Ethics Committee (CEP) of the institution under CAAE 58148222.0.0000.0113. The evaluation was prospective, and data were collected through the patients' electronic medical records. The variables of interest were recorded by the researchers in a Windows Excel spreadsheet for statistical analysis using the IBM Statistical Package for the Social Sciences (SPSS) software.

The following were analyzed: sex (male/female), age (years), hospital admission laboratory tests: absolute value of total leukocytes (cells/mm³), differential leukocyte count - relative (%) and absolute (cells/mm³), platelets (cells/mm³), C-reactive protein (CRP) (mg/L), total cholesterol (mg/dL), lactate (mmol/L), serum albumin (g/dL), and the degree of appendicitis based on intraoperative evaluation. Additionally, the ratios of neutrophils/lymphocytes (NLR), lymphocytes/monocytes (LMR), and albumin/CRP (ACR) were studied. These parameters were selected because they are considered low-cost, routinely accessible tests in hospital settings and are well-established in the literature for assessing the inflammatory state. Therefore, they were evaluated for their applicability in diagnosing and predicting the severity of acute appendicitis.

Acute appendicitis was classified based on intraoperative findings according to the surgical descriptions proposed by Gomes and Nunes in 2006, as follows: grade 0 – normal appendix; 1 – hyperemia and edema; 2 – fibrinous exudate; 3 – segmental necrosis; 4A – abscess; 4B – regional peritonitis; 4C – necrosis at the base of the appendix; 5 – diffuse peritonitis. Subsequently, the severity was categorized into non-complicated appendicitis (grades 1 and 2) and complicated appendicitis (grades 3, 4, and 5).

Regarding the laboratory tests, their measures of central tendency (mean) and dispersion (standard deviation) were studied, and the Mann-Whitney U test was used to assess the equality of medians, since the study design aimed to compare small, independent, unrelated samples in which normal distribution could not be assumed.

RESULTS

When analyzing the patients included in the present study in relation to demographic characteristics, out of the 200 patients, 89 (44.5%) were female and 111 (55.5%) were male. Additionally, the average age of the participants was 34 years, with a median of 32 years for females and 30 years for males, both with a standard deviation of 14 years (Table 1).

Regarding the phase of the disease, it was divided by severity degree, where grades 1 and 2 represent non-complicated appendicitis, accounting for 111 (55.5%) cases. The complicated cases, which include grades 3, 4, and 5, corresponded to 89 (44.5%) patients. Grade 2 predominated, with 92 (46%) cases, followed by grade 4 with 48 (24%) cases (Table 1).

Concerning laboratory data, statistically significant differences were found in the following variables: neutrophils, eosinophils, lymphocytes, total cholesterol, albumin, and C-reactive protein (CRP). Statistical differences were also observed between the non-complicated and complicated appendicitis groups in the ratios of neutrophils/lymphocytes (NLR), lymphocytes/monocytes (LMR), and albumin/CRP (ACR) (Table 2).

TABLE 1 – Epidemiology and Clinical-Surgical Parameters

Variables (n= 200)	n	(%)
Sex		
Female	89	44,5%
Male	111	55,5%
Age Range – Mens and Median by sex		
Mean: 34 ± standard deviation of 14 years	-	-
Male Median: 30 years	-	-
Female Median: 32 years	-	-
Severity grade		
Non - complicated	111	55,5%
Grade 1	19	9,5%
Grade 2	92	46%
Complicated	89	44,5%
Grade 3	27	13,5%
Grade 4	48	24%
Grade 5	14	7%

TABLE 2 – Comparison of laboratory parameters between groups

Parameters	Groups	n	Mean	Median	Lower 95.0% CI for median	Upper 95.0% CI for median	Standard deviation	p-value
MCV	Non - complicated	111	87,57	87,96	86,97	88,67	3,51	0,355
	Complicated	89	86,95	87,01	86,19	88,32	4,56	
MCH	Non - complicated	111	29,95	30,17	29,84	30,46	1,41	0,260
	Complicated	89	29,71	29,92	29,38	30,17	1,89	
MCHM	Non - complicated	111	34,20	34,13	33,94	34,53	1,12	0,760
	Complicated	89	34,16	34,26	33,93	34,53	1,11	
MPV	Non - complicated	111	10,23	10,10	10,00	10,40	0,97	0,452
	Complicated	89	10,16	10,10	9,90	10,40	0,87	
Leukogram	Non - complicated	111	12375	12190	11310	13440	4188	0,015
	Complicated	89	14136	13440	12330	14390	4520	
Neutrophils	Non - complicated	111	9312,76	9461,50	8056,44	10672,20	3984,61	0,001
	Complicated	89	11436,95	10912,05	9957,20	12014,96	4150,43	
Eosinophils	Non - complicated	111	90,33	57,12	44,94	82,14	94,76	0,000
	Complicated	89	56,09	22,96	13,92	42,00	86,26	
Lymphocytes	Non - complicated	111	1926,29	1904,76	1765,75	2028,60	738,45	0,000
	Complicated	89	1416,08	1309,48	1144,78	1486,65	752,56	
Monocytes	Non - complicated	111	890,93	838,14	758,40	908,04	383,41	0,130
	Complicated	89	1015,84	927,42	801,59	1119,95	546,95	
Platelets	Non - complicated	111	249775	247000	236000	263000	58784	0,993
	Complicated	89	249045	246000	239000	271000	63105	
Total Cholesterol	Non - complicated	111	162	158	149	164	39	0,001
	Complicated	89	143	136	129	149	40	
Albumin	Non - complicated	111	4,29	4,30	4,30	4,40	0,45	0,000
	Complicated	89	3,99	4,00	3,90	4,20	0,44	
C Reactive Protein (CRP)	Non - complicated	111	55,52	37,76	26,52	54,70	55,54	0,000
	Complicated	89	161,53	143,81	111,07	187,45	114,24	
Lactic acid measurement	Non - complicated	111	1,58	1,40	1,30	1,70	0,72	0,236
	Complicated	89	1,75	1,50	1,40	1,80	1,04	
Neutrophil/ Lymphocyte (NLR)	Non - complicated	111	5,92	4,67	3,66	5,37	4,62	0,000
	Complicated	89	10,80	8,82	7,60	10,17	8,10	
Lymphocyte/ Monocyte ratio (LMR)	Non - complicated	111	2,46	2,38	2,12	2,53	1,16	0,000
	Complicated	89	1,70	1,29	1,17	1,71	1,28	
Albumin/CRP ratio (ACR)	Non - complicated	111	0,27	0,12	0,08	0,17	0,50	0,000
	Complicated	89	0,07	0,03	0,02	0,04	0,10	

DISCUSSION

A prospective study aimed to evaluate the influence of laboratory test results on the diagnosis of the severity of acute appendicitis by analyzing the complete blood count, inflammatory markers, and relevant ratios between the evaluated variables.

For the study population, it was observed that the epidemiology of acute appendicitis is very similar to what is found in the literature, with the disease in Brazil having an incidence ranging from 57.3% to 59.03% in men, and the average age of diagnosis being 35.35 years.

The relationship between the absolute value of the leukogram and the disease severity was established, with values above 14,136 p/mm³ showing an association with complications found during surgery. Other authors describe similar findings in the literature, corroborating the present study. For example, Elgamal et al. (2019) also found a directly proportional relationship between the variables of interest with statistical significance ($p=0.03$) and showed that values above 14,010 were related to complicated acute appendicitis. In contrast, Melo et al. (2020) found that values above 14,141 were associated with suppurative appendicitis.

The differential of the leukogram plays an important role as an inflammatory marker in various clinical conditions, including acute inflammatory processes. Its main components – neutrophils, eosinophils, and lymphocytes – also showed statistical relevance in this study. When evaluated together with other clinical-laboratory markers, they allow for a more comprehensive assessment of the patient's health status, providing valuable information about the type of inflammatory response.

In this study, a statistically significant correlation was found between lower cholesterol values and signs of disease severity. This association suggests a possible interaction between lipid profiles and the inflammatory response. Although cholesterol is not traditionally considered an inflammatory marker, as its molecule is necessary for the integrity of cell membranes and the presence of inflammation can lead to a reduction in its hepatic synthesis, patients with lower levels of this marker can be identified as a higher-risk group for complications such as abscesses, perforation, or peritonitis. Nevertheless, it is important to assess other factors such as pre-existing conditions, genetics, and lifestyle, which alter serum cholesterol levels, and perform further analyses to confirm the association and better understand the causal relationship found in this study.

Regarding albumin, the significant correlation found also indicated that lower values of this laboratory marker were associated with signs of complications in the disease. According to the cohort and meta-analysis by Hajibandeh et al. (2020), it was proven that albumin values decrease during abdominal sepsis and predict preoperatively the presence and nature of intraperitoneal contamination in patients with acute abdomen, as well as being an indicator of postoperative morbidity and mortality. Thus, providing this data objectively in clinical practice assists in the management of these patients, and its routine incorporation in surgical emergency protocols may be considered.

C-Reactive Protein (CRP) plays a crucial role as a systemic indicator of inflammation, contributing to the clinical approach and monitoring of patients with acute appendicitis and other inflammatory conditions. In this analysis, it was found that the higher its value, the greater the degree of complications, with values above 161.53 suggesting the presence of some adversity in the course of the disease. Melo et al. (2020) also found this positive correlation, where higher CRP values were associated with the histological severity of acute appendicitis. Elgamal et al. (2019) showed that patients with acute appendicitis, regardless of severity, had elevated CRP ($p<0.001$), and this marker has a negative predictive value of 97-100% for diagnosing the disease in question. Dinç et al. (2021) found significantly elevated values in uncomplicated disease, also corroborating the present study's findings of a directly proportional relationship between CRP values and the severity of the disease.

For the ratios between the laboratory markers, it was observed that: NLR values above 10.80, LMR values below 1.70, and ACR values below 0.07 may be indicative of complicated acute appendicitis.

Regarding NLR, it was observed that the higher the ratio, the greater the degree of complication of the disease, with a worse prognosis for the patient. This fact is also observed in other studies that assessed this marker in patients with sepsis, such as in Lin et al. (2022), who found that NLR is an independent predictor of mortality.

In a study similar to the one conducted at the Regional Hospital of São José, but in a retrospective manner, Mori et al. (2022) evaluated preoperative NLR in patients with acute appendicitis and concluded that it is the most useful indicator for predicting postoperative complications, particularly infectious ones. Moreover, Wautier et al. (2022) showed that in other conditions involving systemic inflammation, such as neoplasms, the findings of the present study were corroborated, where worse outcomes were observed in patients with higher ratios.

For LMR, reduced values indicated exacerbated disease. In the case of ACR, Dinç et al. (2021) also observed a similar finding to the present study, where the lower the ratio value, the higher the degree of severity of the disease. This is because, as previously observed, patients with more complicated appendicitis are those who had lower albumin values and higher CRP values, which justifies the inverse proportional relationship observed in the variable in question.

The study's limitations refer to the fact that it was an observational study with an opportunistic sample. Thus, it was only possible to infer that for similar populations, similar results can be expected, but a random sample would be necessary for the data to be extrapolated to the general population. It is therefore suggested that new studies on this topic be conducted to enrich the data obtained.

CONCLUSION

In general, it was observed that the data obtained in this study were consistent with what is expected in the literature, in addition to allowing the inclusion of new variables in the assessment of patients with suspected acute appendicitis in

surgical emergencies. The use of laboratory markers and their relationships in diagnostic evaluation can predict the degree of severity of the disease with accuracy, enabling early and effective therapeutic interventions, thus improving the prognosis of these patients.

Based on the results found, it is recommended that the laboratory analyses studied should be considered for routine use

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