

Comparison of the Laparoscopic Appendicitis (LAPP) score with the Alvarado and Appendicitis Inflammatory Response(AIR) scores and computed tomography and pathology results

Hüseyin Fahri Martlı¹ , Hacı Bolat² 

1 Ankara Atatürk Sanatoryum Training and Research Hospital, Department of General Surgery, Ankara, Turkey

2 Niğde Ömer Halisdemir Training and Research Hospital, Department of General Surgery, Niğde, Turkey

Abstract

Background: Acute appendicitis is the most commonly encountered and operated group among general surgery emergency patients. Various scoring and algorithms are used in diagnosis and treatment. This study aimed to compare the Laparoscopic Appendicitis (LAPP) score, which is used to reduce negative appendectomy, according to the pathology and preoperative computed tomography results and investigate its correlation with other clinical scoring systems.

Methods: Patients who underwent appendectomy in our clinic between June 2020 and March 2021 were retrospectively reviewed. The obtained LAPP scores were compared with the preoperative imaging results, Alvarado score, appendicitis inflammatory response (AIR) score, and pathology results.

Results: The study included a total of 109 patients, of whom 22 (20.18%) had a pathology result that was not consistent with appendicitis. The LAPP score was determined as 1.41 for this 22 patients who underwent negative appendectomy ($p<0.001$), 2.45 for 74 patients with suppurative appendicitis ($p<0.001$), and 3.54 for 13 patients with gangrenous or perforated appendicitis ($p<0.001$).

Conclusions: The purpose of the LAPP score is to reduce the rate of negative appendectomy. Appendectomy is also performed in some patients who may have spontaneous resolution if they present to the hospital in the early period. We also consider that the frequency of familial Mediterranean fever in Turkey may be another reason for the high rate of negative appendectomy. In addition, the correlation of high Alvarado and AIR scores with a high LAPP score indicates that it is more reliable in the diagnosis of complicated appendicitis.

Keywords: Acute Appendicitis, Lapp Score, Alvarado Score

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Corresponding Author:

Hüseyin Fahri Martlı, Ankara Atatürk Sanatoryum Training and Research Hospital, General Surgery Department, Ankara, Turkey
E-mail: fahri_martli@hotmail.com



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INTRODUCTION

Acute appendicitis is one of the most common causes of acute abdomen in the world. Its prevalence in developed countries is 90-100 per 100,000(1). Appendectomy still constitutes the most common treatment method and gold standard for acute appendicitis(2). However, especially with the COVID-19 pandemic, the rate of non-operative treatment preference has increased, and it has become an important alternative in this area(3-5). Non-operative treatment is reported to fail in 8% of patients, while 20% present with recurrence within the first year, but it has been determined that antibiotic treatment does not increase morbidity and mortality, especially in uncomplicated appendicitis cases(6, 7). It can be predicted that organ-preserving treatment methods will be increasingly preferred due to the important role of the appendix in the preservation of the intestinal microbiota(7-9).

Negative appendectomy detects an important misdiagnosis. While this rate is approximately 9% in the Netherlands and European countries where the pilot Laparoscopic Appendicitis (Lapp) Score study was conducted(10), it is around 3-4% in the USA and South Korea, where computed tomography is used frequently for diagnostic purposes(11, 12). Hamminga et al. published a pilot study in 2012 using the perioperative LAPP score to prevent negative appendectomy in patients undergoing diagnostic laparoscopy for acute abdomen(13). The LAPP score was prepared based on findings suggesting inflammation in the perioperative appendix examination, both for the preliminary diagnosis of appendicitis and for operations performed for diagnostic purposes, and indicates appendectomy in patients with a score of at least 1(13, 14). The LAPP score questions the following: 1-) Is there necrosis or perforation in the appendix?, 2-) Is there any thickening of the appendix?, 3-) Is there any thickening in the appendix mesentery?, 4-) Is there vascular prominence in the appendix serosa?, and 5-) Is the appendix adhered to any organ or tissue? Each 'yes' answer is scored 1 point, and appendectomy is performed in patients with a total score of 1 and above. According to original study on the LAPP score study, the positive predictive value of the LAPP score was 99%, and the negative predictive value was 100%. In the validation study of the LAPP score conducted by Golpke et al., it was found that the rate of negative appendectomy was

lower in patients evaluated with the LAPP score than in cases where this score was not used(14). Therefore, the parameters in the LAPP score are also checked in open operations. Thus, it is clear that the validation of the LAPP score can also be performed in patients who have undergone open appendectomy. In this study, we aimed to compare the LAPP score according computed tomography (CT) and pathology results of patients who underwent appendectomy, and determine its correlation with the preoperative Alvarado and appendicitis inflammatory response (AIR) scores.

MATERIALS AND METHODS

In the study, 337 patients who underwent appendectomy at Nigde Omer Halisdemir University Training and Research Hospital between June 2020 and March 2021 were screened. This study was approved by the clinical research ethics committee of the Niğde Ömer Halis Demir University (Date: 23.12.2021 number: 2021/105). From the retrospectively screened patient files, a total of 108 patients with known preoperative Alvarado and AIR scores, complete anamnesis, and detailed perioperative findings were included in the sample. The patients' Alvarado, AIR and LAPP scores of the patients were compared with the preoperative radiological examination and pathology results of the appendectomy material. In addition, the correlation of LAPP score with the Alvarado and AIR scores was examined.

The exclusion criteria were determined as an age below 18 years and lack of informative operation notes, anamnesis or epicrisis. The patients' whole blood count, c-reactive protein, liver function, and kidney function were studied preoperatively. Preoperative ultrasonography or CT was performed in all patients. CT was performed in patients who could not be diagnosed or had suspected acute abdomen despite normal ultrasonographic findings. Patients with any intra-abdominal pathology other than perioperative appendicitis were not included in the study.

SPSS v. 25 was used for statistical analyses. While analyzing the study data, in addition to descriptive statistical methods (mean, standard deviation, median, frequency, ratio, minimum and maximum values), the distribution of the data was evaluated with the Shapiro-Wilk test. Student's t-test was used to compare two groups with normally distributed quantitative data. One-

way analysis of variance was used conducted for the comparison of three or more groups in terms of normally distributed quantitative data. The significance level was accepted as $p < 0.05$.

RESULTS

The pathology result of 22 patients (20.18%) with a retrospective LAPP score of at least 1 or higher was not consistent with appendicitis. In the remaining 87 (79.82%) patients, the pathology result was reported as appendicitis. When evaluated according to the pathology results, the mean LAPP score was 1.41 ± 0.67 for the 22 patients without appendicitis, 2.45 ± 1.07 for the 74

patients with appendicitis, and 3.54 ± 1.27 for the 13 patients with perforated-gangrene-plastron ($p < 0.001$) (Table 1). In Tukey's post hoc analysis test, there was a significant difference between the non-appendicitis group and the suppurative appendicitis group ($p < 0.001$), and between the non-appendicitis group and the complicated appendicitis group ($p < 0.001$), but no difference was found between complicated appendicitis and suppurative appendicitis $p > 0.05$. Accordingly, the patients that underwent negative appendectomy had a lower LAPP score, those with appendicitis had a higher LAPP score, and those with complicated appendicitis had a higher LAPP score, which were all at statistically significant levels.

Table 1. Comparison of the Laparoscopic Appendicitis (LAPP)score according to the pathology results

Pathology Result	n	LAPP Score (Mean \pm SD)	Min-Max (LAPP Score)	P
Not appendicitis	22	1.41 ± 0.67	1-3	
Acute appendicitis	74	2.45 ± 1.07	1-5	0.001
Gangrenous-perforate appendicitis	13	3.54 ± 1.27	1-5	

One-way analysis of variance, * $p < 0.05$, ** $p < 0.01$

When compared according to the preoperative CT results, the mean LAPP score was 2.46 ± 1.18 for the 88 patients with CT findings consistent with appendicitis and $1.59 \pm$

0.71 ($p < 0.001$) for the 21 patients with non-appendicitis or normal findings (Table 2).

Table 2. Comparison of the LAPP score according to the preoperative tomography results

CT Result	n	LAPP Score	Min-Max	P
Consistent with appendicitis	88	2.46 ± 1.18	1-5	0.001
Inconsistent with appendicitis	21	1.59 ± 0.71	1-3	

One-way analysis of variance, * $p < 0.05$, ** $p < 0.01$

The comparison of the Alvarado and AIR scores according to the patients' pathology results revealed that the mean Alvarado and AIR scores were 5.43 ± 1.44 and 5.82 ± 1.97 respectively for the 22 patients who underwent negative appendectomy; 6.8 ± 1.52 ($p < 0.05$), and 6.82 ± 2.16 , for the 74 patients with appendicitis; and 6.85 ± 1.57 ($p < 0.05$) and 8.08 ± 1.85 respectively for the 13 patients with advanced infection. After Tukey's test; While the Alvarado score was significantly different between complicated appendicitis and nonappendicitis, and between suppurative appendicitis

and nonappendicitis ($p < 0.001$ and $p < 0.05$, respectively), it did not make a significant difference between complicated appendicitis and suppurative appendicitis ($p > 0.05$). A significant difference was found between suppurative appendicitis groups ($p < 0.05$), between non-appendicitis and complicated appendicitis groups ($p < 0.05$), and between complicated appendicitis and non-appendicitis groups ($p < 0.05$) (Tables 3 and 4). For the 88 patients with appendicitis-consistent preoperative CT findings, the mean Alvarado and AIR scores were determined as $6.66 \pm$

1.52 ($p < 0.05$) and 6.76 ± 2.11 ($p > 0.05$), respectively. The mean Alvarado score was 5.65 ± 2.41 ($p < 0.05$) and the mean AIR score was 6.35 ± 2.34 ($p > 0.05$) for the 21 patients without appendicitis findings on CT. While a statistical relationship was defined between the Alvarado score and

CT results, no significant relationship was found between the AIR score and CT results. Lastly, a highly significant positive correlation was observed between the high LAPP, high Alvarado and AIR scores (Tables 5 and 6).

Table 3. Comparison of the preoperative Alvarado score according to the pathology results

Pathology Result	n	Alvarado Score	Min-Max	P
Not appendicitis	22	5.45 ± 1.44	3-8	
Acute appendicitis	74	6.8 ± 1.52	4-9	0.001
Gangrenous-perforated appendicitis	13	6.85 ± 1.57	4-9	

One-way analysis of variance, * $p < 0.05$, ** $p < 0.01$

Table 4. Comparison of the preoperative Appendicitis Inflammatory Response (AIR) Score according to the pathology results

Pathology Result	n	AIR Score	Min-Max	P
Not appendicitis	22	5.82 ± 1.97	2-9	
Acute appendicitis	74	6.82 ± 2.16	2-12	0.001
Gangrenous-perforated appendicitis	13	8.08 ± 1.85	4-10	

One-way analysis of variance, * $p < 0.05$, ** $p < 0.01$

Table 5: Correlation analysis for the relationship between the LAPP score and the preoperative Alvarado score

		LAPP Score	Preoperative Alvarado Score
LAPP Score	r	1	0.363**
	p		0.000
Preoperative Alvarado Score	r	0.363**	1
	p		

Spearman's correlation test, * $p < 0.05$, ** $p < 0.01$

Table 6: Correlation analysis for the relationship between the LAPP score and the preoperative AIR score

		LAPP Score	Preoperative Alvarado Score
LAPP Score	r	1	0.363**
	p		0.000
Preoperative Alvarado Score	r	0.363**	1
	p	0.000	

Spearman's correlation test, * $p < 0.05$, ** $p < 0.01$

DISCUSSION

The most important goal of using the LAPP score is to reduce the rate of negative appendectomy(14). Parameters included in the LAPP score are findings in favor of inflammation in the perioperative examination of the appendix, which surgeons expect to see when diagnosing preoperative appendicitis. The use of the LAPP score can be considered as a method for systematizing the perioperative appendix examination. However, there are two important questions in this process: First, is the LAPP score is compatible with other preoperative scoring systems and preoperative CT and postoperative pathology results? Second, are the parameters included in the LAPP score sufficient to make an operation decision?

In this study, the pathology result of the 22 patients with at least one LAPP score point was not consistent with appendicitis. The preoperative CT findings were consistent with appendicitis in 12 of these patients and indicated suspicion in the remaining 10. The mean LAPP score of these 22 patients was 1.41 (min-max: 1-3), and the indication for surgery was determined according to the parameters in the LAPP score. In a multicenter validation study by Gelpke et al., 300 patients underwent appendectomy, and the pathology result of 14 was a normal appendix. All these 14 cases presented with appendicitis findings on preoperative CT. Gelpke et al. reported that the use of the LAPP score reduced the rate of negative appendectomy to 4.7%(14). In our study, despite the use of the parameters in the LAPP score, the rate of negative appendectomy was 20%. The mean Alvarado and AIR scores of these patients were 5.45 (min-max: 3-8) and 5.82 (min-max: 2-9), which did not favor a diagnosis of appendicitis. Similarly, in the study of Gelpke et al., the Alvarado score was found to be low and evaluated as an important limitation of the study by Niu et al.(14, 15). The patients who underwent surgery due to both CT findings and severe clinical condition during the follow-up were operated on because they had at least 1 point or more in the LAPP score, but the pathology result of these patients was not consistent with appendicitis. It is suggested that in the pathophysiology of appendicitis, first lumen obstruction and subsequently inflammation develop, and inflammation starts primarily from the lumen, with mucosal inflammation being an early sign of appendicitis(16). As a treatment method, the endoscopic

opening of obstruction provides a similar improvement to appendectomy and causes less morbidity(17). The development of diagnostic methods and easier access to healthcare facilities can explain negative appendectomy since surgery is also performed in cases of spontaneously resorbed appendicitis. Another reason for the high rate of negative appendectomy despite the use of the LAPP score in Turkey may be the common occurrence of familial Mediterranean fever (FMF) in the general population(18-20). Since diffuse peritonitis occurs in FMF, the vascularity of the appendix and the wall thickness of the appendix and its meso may appear to be increased, thus mimicking appendicitis in the perioperative examination. The low Alvarado and AIR scores of the patients may also be a supporting finding.

With the current pandemic, non-operative appendicitis treatment has become increasingly preferred(21-23). Non-operative treatment can be undertaken with antibiotics, and spontaneous resolution may be observed with supportive treatment(7). Studies showing spontaneous resolution without antibiotics have obtained similar results with patient groups treated with antibiotics in uncomplicated appendicitis, although the level of evidence is low(24, 25). Patients with appendicitis who do not present to hospital and do not undergo radiological imaging are also likely to have spontaneous resolution. In Turkey, access to health services is much easier than in many other countries. According to the data of the Turkish Ministry of Health shared in Twitter account, there were 2.9 million emergency or elective outpatient clinic presentations in Turkey on December 21, 2021, which, in 30 days, would reach 90 million, the total population of the country. The patients with a negative appendectomy despite at least one LAPP score point can be explained by the admission of patients that would have spontaneous resolution to the hospital. In addition, Mock et al. reported that the rate of negative appendectomy was higher in groups with a low socioeconomic status(26). This is supported by the patient profile of Turkey and Nigde region.

When the LAPP score was compared with the Alvarado and AIR scores, a positive and significant correlation was found between them. In a validation study conducted by Gelpke et al. using the Alvarado score, the mean LAPP score was reported to be 6 in the patient group(14). In our study, both the Alvarado and AIR scores were found to be low in

patients who underwent negative appendectomy, which would have excluded the diagnosis of appendicitis. In complicated appendicitis cases, the Alvarado, AIR and LAPP scores were all found to be high, supporting the significant relationship between these scores.

Gomes et al. conducted a similar study and performed perioperative grading(27); however, they reported that although the LAPP score identified advanced infection, it was not detailed enough for non-complicated appendicitis, and therefore it was considered to be more useful in the evaluation of uncomplicated appendicitis.

The current study was conducted retrospectively, which may have resulted in incomplete information in surgical notes and patient anamnesis and epicrisis in some cases, resulting in limitations. Since the LAPP scores had not been determined based on perioperative findings, scoring was performed retrospectively by examining the operation notes. Most operations were performed with the open technique. Although this contradicts the name of the score, the diagnosis of perioperative appendicitis was made using the same parameters in open surgery. Other limitations can be considered as the small number of patients and single-center design.

CONCLUSION

The LAPP score parameters represent the systematic version of the perioperative appendix examination. Despite the LAPP score point in the perioperative examination, the pathology result not being consistent with appendicitis can be explained by conditions specific to Turkey or appendectomy being also performed in patients that would have had spontaneous resolution. The use of the LAPP score does not reduce the rate of negative appendectomy in patients with a low score, and therefore these patients should be further evaluated with clinical and laboratory findings, while surgery can be safely performed in patients with a high LAPP score. The use of the LAPP score will be beneficial in the systematization of the perioperative examination and the decision-making of the surgeon as a rational parameter. It may be useful to validate the LAPP score parameters separately and increase or decrease the scores of the parameters.

Declarations

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