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ACCURACY OF MODIFIED ALVARADO SCORE, ESKELINEN SCORE AND OHMANN SCORE IN DIAGNOSING ACUTE APPENDICITIS

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SUMMARY

Introduction: *By processing the data of a large number of patients with abdominal pain, diagnostic scores whose implementation attempts to facilitate acute appendicitis diagnostics were developed. Modified Alvarado score, Ohmann score and Eskelinen score are used as assistance when setting the diagnosis and making a decision to undertake surgery.*

Aim: *To assess accuracy of Alvarado score, Ohmann score and Eskelinen score in diagnosing acute appendicitis and to establish connection of total score of these scoring systems with histopathological degree of appendicitis.*

Subjects and methods: *A cross-sectional study was conducted at the Department of Surgery of University Clinical Hospital Mostar. The study included 70 patients who underwent appendectomy and were scored before surgery. All tested persons were examined by experienced surgeon who took anamnesis, physical status and ordered laboratory diagnostic tests. Appendicitis was excluded or confirmed by means of histopathological diagnostics, and the degree of appendicitis was determined.*

Results: *According to accuracy parameters (sensitivity, specificity, negative and positive predictive value), the score which was of highest value was Ohmann score, followed by Eskelinen score, while the lowest value was the one of modified Alvarado score. Total score in all three scoring systems follows the degree of appendicitis, but statistical significance was proven only for Ohmann and Eskelinen scores.*

Conclusion: *Ohmann and Eskelinen scores can be useful in diagnosing acute appendicitis, predicting the degree of appendicitis, as well as assistance when making decision to undertake an operative procedure. Modified Alvarado score in our subjects did not prove sufficient value. Diagnostics of acute appendicitis still must be led by contemporary algorithms in which diagnostic scoring is implemented.*

Key words: *appendicitis – diagnosis - sensitivity and specificity – pathology - predictive value of tests*

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INTRODUCTION

Acute appendicitis, one of the most common differential diagnoses in patients with abdominal pain who contact a surgeon, is caused, among other various factors, by pathogenic bacteria in intestines (Irvin 1989, Bhangu et al. 2015). Peak incidence of appendicitis is between age 10 and 20, and occurs approximately equally frequently in men and women (Buckius et al. 2012). The most widely accepted explanation for development of acute appendicitis is obstruction of appendix lumen by lymphoid follicles, feces parts, tumor, foreign bodies etc., due to which the necessary lumen drainage does not exist. This create conditions for the growth of bacteria followed by inflammation onset. The accumulated content together with the bacteria causes edema, distension and compromises circulation of inflamed appendix by creating ulcer. In the histopathological sense, on such appendix suppurative inflammation with neutrophilic infiltration of side wall in muscle layer can be seen, along with appendix lumen filled with pus, congestion of subserosal vessels and fibrinous exudation on the serous layer. This stage of acute appendicitis is called phlegmonous or suppurative appendicitis. If intraluminal pressure keeps increasing, appendix is destroyed in its full size and gangrenous stage of acute appendicitis onsets, which is manifested in histopathological sense as green hemorrhagic mucosal ulceration and necrosis which gradually permeates the entire thickness of the wall of the appendix (Mary 1994). When the contents from the gangrenous appendix pour out into the peritoneal cavity, the third stage of acute appendicitis i.e. perforation occurs. In rare cases, obstruction of lumen is solved spontaneously and the inflamed contents from the appendix is drained, which gives grounds to try to explain some forms of chronic appendicitis (Hassan et al. 2007, Sgourakis et al. 2008). Development of acute appendicitis cannot be predicted nor prevented, and appendectomy is the only justified treatment. Timely appendectomy minimizes morbidity and prevents mortality in these patients (Ditillo et al. 2006).

The usual clinical features of acute appendicitis start primarily as pain of continuous character in upper or central parts of abdomen. Pain is then transferred into the lower right quadrant and appears with typical

sensitivity and muscle spasm on palpation due to the stimulus of the parietal peritoneum of the front abdominal wall with inflamed appendix. Sometimes this sign might not appear at abnormal positions of appendix. Patient with acute appendicitis is disturbed because of pain, has nausea and/or vomiting and loss of appetite. Out of other signs of acute appendicitis, elevated body temperature which does not exceed 38.5˚C is present, but if it is higher, one must suspect of gangrene or perforation or of some other cause of disease. If inflammation continues to develop, in the moment when the inflamed appendix perforate, the so called lucid interval without pain appears. Soon after strong pain of the whole abdomen appears with developed signs of generalized hyperarousal of peritoneum in the sense of acute abdomen, which is a potentially fatal condition. At physical examination, the patient is tested with several various clinical tests, whose positive response suggests acute appendicitis (Di Saverio et al. 2016). Out of laboratory tests, leukocytosis is present, left shift of neutrophilic granulocytes and elevated C-reactive protein (CRP) concentration (Teo et al. 2015).

Acute appendicitis can be manifested in unclear clinical features, whose diagnosis and the decision to undertake the operative procedure must be led by the most contemporary algorithms. Besides the clinical examination, as assistance to set the diagnosis of acute appendicitis various radiological tests are used, and various scoring systems were created (Di Saverio et al. 2016). Alvarado score was developed after a retrospective observation of 305 patients who contacted surgeon due to abdominal pain with analysis of the most common laboratory indicators, signs and symptoms of acute appendicitis. The above mentioned parameters were listed into the scoring system as parameters with numerical value 1 or 2, and after processing the patient, these paramaters were summed up, so the lowest possible sum was 1 and the highest was 9. The author analyzed the obtained manner of scoring, regarding sensitivity, specificity and predictive value, and found that it can be useful in everyday clinical practice (Alvarado 1986). Modified Alvarado score does not include the left shift of neutrophilic granulocytes as one of the parameters and represents one of the most frequently used score nowadays, due to its simple application (Table 1). However, numerous falsely positive values in women were found (Sooriakumaran et al. 2005, Malik & Wani 1998). Eskelinen score was developed with an intention to be more specific for female population, and for the needs of its development, clinical data regarding acute abdominal pain in 1333 patients were analyzed retrospectively (Table 2). In Eskelinen scoring system relevant signs and symptoms were assigned numerical values in form of a factor which is multiplied by 2 if it is present or by 1 if it is not present. At the end, all values are added up, so theoretically the lowest possible score is 2.13 and the highest 67.6 (Eskelinen et al. 1994). By Ohmann score, an attempt was made to construct scoring that would reduce the number of negative appendectomies. In this score selected signs and symptoms have numerical values ranging from 1 to 4.5, which add up after processing the patients, so the lowest possible sum is 1 and the highest is 16 (Table 3). The author succeeded in proving that the use of this diagnostic score reduces the rate of negative appendectomies by 21%, and results in only 2% of unrecognized acute appendicitis (Ohmann et al. 1995).

The main objective of this study was to assess accuracy (specificity, sensitivity, positive and negative predictive value) of three scoring systems (modified Alvarado score, Ohmann score and Eskelinen score) in diagnosing acute appendicitis. A secondary objective was to establish connection between the total score of the above mentioned scoring systems and the histopathological degree of appendicitis.

SUBJECTS AND METHODS

Subjects

The patients with clinical features of acute appendicitis who were hospitalized and operated at the Department of Surgery of the University Clinical Hospital Mostar were included in this cross-sectional study. All patients were admitted for an examination by a surgeon because of abdominal pain in the lower right part, upon being examined by a primary health care physician. Those patients that underwent surgery after clinical processing were included in this study as subjects. Total number of subjects was 70. The study excluded those subjects who did not undergo surgery, subjects with inconclusive laboratory tests, subjects without histopathological test result and those who did not cooperate.

Methods

All subjects were examined by an experienced surgeon, who took anamnesis, physical status and ordered diagnostic tests. During examination general data were taken (age, gender), as well as anamnestic data crucial for the diagnostic scores (intensity, localization and quantity of pain, presence or absence of other symptoms, existence of nausea or vomiting, existence of anorexia). The main part of physical examination was palpation of abdomen, and the obtained data were also entered into diagnostic score: painful sensitivity of abdomen on palpation, existence of signs of peritoneal stimulus on palpation, positive Blumberg test (rebound tenderness). Body temperature was measured with mercury thermometer placed axillary. Measuring body temperature took 5 minutes and the obtained values were noted in Celsius degrees, and values above 37.3°C were listed as parameters in modified Alvarado score. Number of leucocytes was determined from full blood samples taken with anticoagulant K3-EDTA in auto-

mated hematology counter. The results were stated in number of leucocytes/L and leucocytes values above 10^9/L were listed as parameters in all three diagnostic scores (Alvarado 1986, Ohmann at al. 1995, Eskelinen et al. 1994). After preoperative processing, the patients underwent surgery and appendix as preparation was submerged into 10% formalin and submitted to the Department of Pathology. Appendix preparation was treated with standardized procedure and stained with hematoxylin and eosin, followed by observation through a microscope for the needs of histopathological diagnostics which excluded or confirmed appendicitis and the degree of inflammation was determined.

With reference to histopathological finding, the subjects were divided into the following groups:

- The subjects that underwent surgery with diagnosis of acute appendicitis which was then excluded by histopathological finding (innocent appendix);
- The subjects with acute appendicitis to whom phlegmonous appendicitis was confirmed with histopathological finding;
- The subjects with acute appendicitis to whom gangrenous or perforated appendicitis was confirmed with histopathological result (the above mentioned stages cannot be differentiated on the basis of histopathological finding).

Statistical Methods

Depending on distribution of results in this research, chi square test (χ^2) was used for categorical variables, as well as Kruskall-Wallis and Mann-Whitney test for asymmetrically distributed results. After establishing the differences between groups with and without acute appendicitis, specific cut-off values in diagnostic scores were attempted to be established by having insight into ROC curves. Upon establishing cut-off values, compromise between sizes of sensitivity and specificity was attempted to be found. Levels of significance of $p<0.05$ were taken as statistically significant. SPSS statistical software, version 17 (SSPS Inc., Chicago, IL), as well as statistical version 7.0 (StatSoft Inc., Tulsa, OK, USA) were used for all statistical analyses.

RESULTS

No statistically significant differences in representation of the disease by gender were found in total sample ($\chi^2=2.800$; $p=0.094$). As expected, most patients in the sample were in age group from 10 to 30, while median age was 17.5±8.3. The youngest patient was 5 and the oldest 72.

Analysis of accuracy parameters for modified Alvarado score showed that sensitivity and specificity stand in inverse relation. Depending on the cut-off value, sensitivity ranges from 100% to 13.2%, and specificity from 0% to 88.2%. Positive predictive value for the observed range is between 75.7% and 81%, while negative predictive value ranges from 0% to 50% (Table 4).

Analysis of accuracy parameters for Ohmann score showed that sensitivity and specificity were almost completely in inverse relation. Depending on cut-off value, sensitivity ranges from 98.1% to 5.6% and specificity from 5.8% to 100%. Positive predictive value for Ohmann score for the whole range of the observed score sum from 9 to 16 is quite high and ranges from 76.4% to 100%. Negative predictive value for Ohmann score for the whole range of the observed score sum from 9 to 16 ranges from 64.2% to 25.3% (Table 5).

Analysis of accuracy parameters for Eskelinen score showed that sensitivity and specificity were also in inverse relation. For the set cut-off values, sensitivity ranges from 98.1% to 18.8% and specificity from 0% to 100%. Positive predictive value for all set values is quite high and ranges from 75% to 100%, whereas negative predictive value is low, as expected, and ranges from 0% to 47.8% (Table 6).

In total sample there were 24.3% subjects without inflammatory change on appendix, 35.7% had phlegmonous appendices and 40% gangrenous appendices (which included gangrenous perforated appendices, which represented 21% of total sample). There was no statistically significant difference in representation of various stages of appendicitis according to histopathological finding in relation to gender ($\chi^2=5.301$; $p=0.071$) (Table 7).

When comparing the histopathological finding of the subjects who underwent appendectomy with total scores in three examined scoring systems, it was proven that significant difference existed between histopathological finding and total score in Ohmann and Eskelinen score. In modified Alvarado score no statistically significant difference was found in the obtained total score in relation to histopathological finding, particularly between innocent appendix and phlegmonous appendices (Kruskal-Wallis test=3.970; $p=0.137$). In Ohmann score, statistically significant difference was found in the obtained total score in relation to histopathological findings (Kruskall-Wallis test=10.775; $p<0.005$). The subjects with gangrenous inflammation of appendix had average sum of scores 14.00±2.50 and differed significantly from the group of subjects with phlegmonous appendix inflammation who had the average total score 13.50±2.75 (Mann-Whitney U=100.000; $p=0.004$), as well as from the subjects without appendicitis, whose total score was 10.50±3.75 (Mann-Whitney U=116.500; $p=0.004$). As for Eskelinen score, statistically significant difference between total score in relation to histopathological findings was also found (Kruskall-Wallis test=11.533; $p=0.003$). The largest difference was found between the groups without appendicitis and the groups with gangrenous appendicitis (Mann-Whitney test U=106.5; $p=0.002$) (Table 8).

Certain values of scoring points were then associated with the number of subjects who were divided according to histopathological finding into subjects with and without appendicitis. In modified Alvarado score the most frequent total score that was detected in patients with acute appendicitis was 8, for Ohmann score 12.5 to 15, and for Eskelinen score 58.85 to 63.35. For all three diagnostic scores, we established that the proportion of patients who had acute appendicitis was increasing in relation to the patients who did not have acute appendicitis starting from lower to higher values of total scores (Table 9, 10, 11).

Table1. Modified Alvarado score

Clinical/laboratory features	Value
Migration of pain into the lower right quadrant	1
Anorexia	1
Nausea, vomiting	1
Sensitivity in the lower right quadrant	2
Pain while decreasing pressure in the lower right quadrant	1
Elevated body temperature (≥37.3°C)	1
Leukocytosis ($\geq 10^9$/L)	2

Table 2. Eskelinen score

Signs/Symptoms	Criteria/scores	Factor
Soreness of abdominal wall	2 = lower right quadrant 1 = any other location	11.41
Rigidity of abdominal wall	2 = yes 1 = no	6.62
Number of leucocytes	2 ≥ 10^9/L 1 < 10^9/L	5.88
Rebound tenderness	2 = yes 1 = no	4.25
Pain upon arrival	2 = lower right quadrant 1 = any other location	3.51
Duration of pain	2 = longer than 48h 1 = shorter than 48h	2.13

Table 3. Ohmann Score

Clinical/laboratory features	Value
Palpation pain in the lower right quadrant	4.5
Rebound tenderness	2.5
Absence of urinary symptoms	2.0
Continuous pain	2.0
White blood cells count ≥ 10000/μIL	1.5
Age under 50 years	1.5
Migration of pain into the lower right quadrant	1.0
Unwilling muscle rigidity	1.0

Table 4. Values of specificity, sensitivity, positive and negative predictive value for modified Alvarado score

Cut-off value	Sensitivity	Specificity	Positive predictive value	Negative predictive value
≥4	100.0%	0.0%	75.7%	0.0%
≥5	92.7%	0.0%	74.2%	0.0%
≥6	90.5%	29.4%	80.0%	50.0%
≥7	79.2%	47.0%	79.2%	42.1%
≥8	56.6%	58.8%	81.0%	30.3%
≥9	13.2%	88.2%	77.7%	24.5%

Table 5. Values of specificity, sensitivity, positive and negative predictive value for Ohmann score

Cut-off value	Sensitivity	Specificity	Positive predictive value	Negative predictive value
≥9	98.1%	5.8%	76.4%	50.0%
≥10	92.4%	29.4%	80.3%	55.5%
≥11	90.5%	52.9%	85.7%	64.2%
≥12	86.7%	58.8%	86.7%	58.8%
≥13	64.1%	58.8%	82.9%	34.4%
≥14	52.8%	88.2%	93.3%	37.5%
≥15	37.7%	94.1%	95.2%	32.6%
≥16	5.6%	100%	100%	25.3%

Table 6. Values of specificity, sensitivity, positive and negative predictive value for Eskelinen score

Cut-off value	Sensitivity	Specificity	Positive predictive value	Negative predictive value
≥41	98.1%	0.0%	75.0%	0.0%
≥51	98.1%	0.0%	75.0%	0.0%
≥56	77.3%	64.7%	87.2%	47.8%
≥61	18.8%	100.0%	100.0%	28.3%

Table 7. Representation of appendicitis stages according to histopathological finding in relation to gender

Gender	Appendices number (%)		
	Innocent	Phlegmonous	Gangrenous
Men	7 (16.7%)	14 (33.3%)	21 (50.0%)
Women	10 (35.7%)	11 (39.3%)	7 (25.0%)

χ^2 test

Table 8. Comparison of total scores in relation to histopathological finding

Diagnostic score	Histopatology finding of appendix preparation			Kruskall-Wallis test	p
	Innocent	Phlegmonous	Gangrenous		
Modified Alvarado	7.00±3.00	7.00±2.00	8.00±1.00	3.970	0.137
Ohmann	10.50±3.75	13.50±2.75	14.00±2.50	10.775	0.005
Eskelinen	54.78±7.88	58.85±3.63	58.85±7.36	11.533	0.003

Table 9. Distribution of inflamed and innocent appendix in modified Alvarado score

		Modified Alvarado score						Total
		4	5	6	7	8	9	
Histopathological finding	Innocent appendix	0	5	3	2	5	2	17
	Inflamed appendix	4	1	6	12	23	7	53
Total		4	6	9	14	28	9	70

Table 10. Distribution of inflamed and innocent appendix in Ohmann score

		Ohmann score				Total
		8.50-10.00	10.50-12.00	12.50-14.00	14.50-16.00	
Histopathological finding	Innocent appendix	6	4	6	1	17
	Inflamed appendix	4	7	21	21	53
Total		10	11	27	22	70

Table 11. Distribution of inflamed and innocent appendix in Eskelinen score

		Eskelinen score						Total
		33.80-48.72	50.85-53.97	54.60-56.73	57.47-60.98	63.35-65.47	64.09-67.60	
Histopathological finding	Innocent appendix	2	4	5	6	0	0	17
	Inflamed appendix	4	1	10	28	1	9	53
Total		6	5	15	34	1	9	70

DISCUSSION

Among our subjects, the highest incidence of appendicitis was found in the younger age group, which is in accordance with most of the results of numerous world's studies, and confirms that acute appendicitis is a disease of predominantly young population (Buckius et al. 2012, Ceresoli et al. 2016). However, children younger than 5 and adults older than 60 rarely have acute appendicitis, which is not exclusively so it can be a cause of clinical oversight which has perforation as its consequence (Marzuillo et al. 2015, Spangler et al. 2014).

By analyzing modified Alvarado, Ohmann and Eskelinen scores, in the context of assessment whether a patient has acute appendicitis, we found that none of the three tested scoring systems had high sensitivity and high specificity at the same time, but they were in inverse relation. If we want to exclude the disease, it would be best to use the score which is highly sensitive. Even though in all three scoring systems, as we observe higher number of scores decreases, we obtained cut-off values for which we can say are almost 100% sensitive: for modified Alvarado score that is the total score above 4, for Ohmann score above 9 and for Eskelinen score above 41. If total score is below the above mentioned, we can exclude the existence of acute appendicitis with high certainty. But, as already mentioned, due to low specificity at these cut-off values, by implementing the scores we would have a high number of false positive diagnoses of acute appendicitis. By taking cut-off values in all three scoring systems that will ensure high specificity, we can be sure of acute appendicitis diagnosis with high certainty. Those values for modified Alvarado score are 7 and above, for Ohmann score 13 and above, and for Eskelinen score 56 and above. Nevertheless, Ohmann and Eskelinen scores proved to be the most valuable because they have relatively high values of sensitivity and specificity in relation to modified Alvarado score. The best results of positive predictive values were obtained from Ohmann score, followed by Eskelinen score, while modified Alvarado score had relatively lower percentages of predictive values. In all three scoring systems, quite low negative predictive values were found, which does not completely solve the diagnostic dilemma after their application in diagnosing acute appendicitis, because the question remains: How sure can we be that our patient is really healthy if his total score is below the selected cut-off value? An interesting phenomenon is that negative predictive values in our subjects are the highest at cut-off values in modified Alvarado score ≥6, Ohmann score ≥11 and Eskelinen score ≥56, which is essentially the result of peak incidence of the above mentioned total score in patients with acute appendicitis and their higher proportion in relation to patients without appendicitis (Erdem et al. 2013). A study similar to ours, which was conducted by Horžić et al. dealt also with assessing these three diagnostic scores but on female population of 126 subjects. According to their results, modified Alvarado score is sensitive at cut-off value of 1 and specific in 100% as in our study, at cut-off value 7. Ohmann score is 100% sensitive at cut-off value of 4.5 and specific similarly as in our case, at values of total score 16. For hundred-percent values of sensitivity and specificity of Eskelinen score, authors had results identical with ours (Horžić et al. 2005). In review literature for modified Alvarado score it was concluded it had good accuracy in male population, inconsistent accuracy in children, and often overseen acute appendicitis in women. In our subjects, sensitivity in this score was 100% if we took cut-off value above 4, while world literature proposes sum of scores above 5 for all populations of patients (Ohle et al. 2011). As for Ohmann score, according to the results of prospective study by Tapel et al., it is stated that at cut-off value of 6.5 for this score there is no acute appendicitis oversight (Tepel et al. 2004). Sitter et al. researched the accuracy of diagnostic Eskelinen score on 2.359 subjects with acute appendicitis, and on the basis of their results, they suggested cut-off value of 57 points as the limit for setting the acute appendicitis diagnosis and thus reduced the number of negative appendectomies from 26.6% to 15.4% (Sitter et al. 2004).

Results of our study showed that no statistically significant difference in representation of inflammation existed, neither in the level of acute appendicitis in relation to gender. A large retrospective study from 2012 on 3.736 subjects obtained results according to which men are more prone to acute appendicitis, and women have a proven innocent appendix after appendectomy. A reason of this phenomenon is probably a higher possibility of differentially diagnostic dilemmas regarding the disease in the lower right quadrant in women when compared with men, and therefore, more frequent appendectomy (Teo et al. 2015).

While comparing the amount of the obtained total scores with the degree of appendicitis according to the histopathological finding, it was found that the total score in all three scoring systems follows the degree of appendicitis, but statistical significance was proved for Eskelinen and Ohmann scores, while for modified Alvarado score it was not proven. There are not many similar studies for comparison, which dealt with the analysis of diagnostic scores for acute appendicitis this way. The most similar study, the one by Horžić et al., interestingly, has results contrary to ours; where modified Alvarado score differentiated healthy from phlegmonous and gangrenous appendices, but not Ohmann and Eskelinen scores. We found that modified Alvarado score on our subjects did not differentiate innocent from phlegmonous appendices. Ohmann score on our subjects demarcated innocent appendices from phlegmonous ones at total score value 9, and it also differentiated phlegmonous from gangrenous appendices well. When researching Eskelinen score, we established

that it differentiated innocent appendices from inflamed ones well, but also that differentiation between phlegmonous and gangrenous appendices was not good. In each case, in all three analyses of diagnostic scores, it was found that the patients with innocent appendix had the lowest total scores, while the highest score in all three scorings was found in gangrenous, i.e. perforated appendicitis (Horžić et al 2005).

When taking data which we will then add into the three above mentioned diagnostic scoring systems, we are required to observe each parameter as if it was or was not there, which is particularly difficult when assessing symptoms. Quality or quantity of those symptoms are not taken into consideration, neither is patient's ability to explain them as accurately as possible. For example, one of the basic parameters is migration of pain into the lower right quadrant, which is entered into all three scoring systems, and it is quite difficult to take it anamnestically from small children or from uncooperative patients who are not sure about „where the pain first began". The parameter of elevated body temperature might also be disputable, because patients can sometimes be afebrile, because they took antipyretic therapy on their own, which also has analgesic effect. It is therefore up to the assessor to interpret the obtained anamnestic data and to add them to diagnostic scoring. All three diagnostic scoring systems seem very good in ideal conditions when we have „the perfect example" of acute appendicitis, but are difficult to be applied when atypical clinical features appear (Hassan et al. 2007, Guidry & Poole 1994, Kraemer et al. 1999). In addition, due to relatively small population, we did not succeed in analyzing whether one of the three diagnostic scoring systems was more accurate for a certain age group or gender. All three scorings, along with other diagnostic aids in diagnosing acute appendicitis can be of great assistance. Not in the long run should we rely on diagnostic scoring as a sole parameter when setting the diagnosis and making crucial clinical decisions, particularly because positive and negative predictive values do not have a satisfactory interrelation (Tepel et al. 2004, Sitter et al. 2004, Ohle et al. 2011).

CONCLUSION

Eskelinen and Ohmann scores can be useful when diagnosing acute appendicitis, predicting the degree of appendicitis, as well as assistance when making a decision to undertake a surgical procedure. Modified Alvarado score did not show sufficient value on our subjects. All three scoring systems should not be the only parameters on the basis of which a conclusion is made on the existence of acute appendicitis in patients with abdominal pain, but a comprehensive assessment of each case is necessary, led by contemporary algorithms in which diagnostic scores are also implemented.

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Contribution of individual authors:

Pejana Rastović: Design of the study, subjects recruitment, literature searches, statistical analysis, analysis and interpretation of data, writing the manuscript;
Zoran Trninić: Design of the study, interpretation of data;
Gordan Galić: Subjects recruitment;
Zdrinko Brekalo: Subjects recruitment;
Josip Lesko: Writing the manuscript;
Marko Pavlović: Writing the manuscript, literature searches, analysis and interpretation of data.
All authors participated in the final revision of the manuscript and approved it.

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