Clinical Hospital Center Kosovska Mitrovica, Kosovska Mitrovica[1]
University of East Sarajevo, Bosnia and Herzegovina,
Faculty of Medicine in Foča[2]

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ACUTE APPENDICITIS – EXPERIENCES OF THE UNIVERSITY HOSPITAL IN FOČA, BOSNIA AND HERZEGOVINA

AKUTNI APENDICITIS – ISKUSTVA UNIVERZITETSKE BOLNICE U FOČI, BOSNA I HERCEGOVINA

Aleksandra MILENKOVIĆ[1], Radmil MARIĆ[2], Nenad LALOVIĆ[2], Ružica LUKIĆ[2], Alma PAŠALIĆ ALIHODŽIĆ[2] and Veljko MARIĆ[2]

Summary

Introduction. Acute appendicitis is the most common cause of the acute abdomen. Based on the idea that appendicitis is a progressive disease eventually leading to perforation, removal of the appendix is the gold standard of treatment. **Material and Methods.** The objective of the study is to determine if there is any difference in the occurrence of postoperative complications, and if hospitalization differs depending on the appendicitis surgery method used with the patients. A retrospective analysis was made using the data from the hospital sample of patients admitted to the University Hospital in Foca in the period from January 2019 to December 2021. **Results.** In the period that was retrospectively analyzed, 107 patients diagnosed with acute appendicitis were operated on. There was no statistically significant difference between the treated groups in relation to the degree of appendicitis, type and duration of symptoms, diagnostic procedures and the time that had elapsed from admission to surgery. The Alverado Score in the probable appendicitis group was 41.1%. The most common symptoms were palpation sensitivity in the inguinal region (84.1%), and pain in the right lower quadrant (69.1%), intraoperative findings of uncomplicated appendicitis 58%, and 25.2% intraoperative findings inconsistent with the pathohistological ones. **Conclusion.** Acute appendicitis is one of the most common emergency surgical conditions, which requires surgical intervention if not treated in time, and causes life-threatening consequences. Surgical treatment with selected techniques for faster establishment of the gastrointestinal tract function, shorter stay in the hospital, faster recovery and return to daily activities.

Key words: Appendicitis; Acute Disease; Appendectomy; Laparoscopy; Postoperative Complications; Treatment Outcome; Diagnostic Imaging

Sažetak

Uvod. Akutni apendicitis je najčešći uzrok akutnog abdomena. Na osnovu ideje da je apendicitis ireverzibilna progresivna bolest, koja na kraju uzrokuje perforaciju, apendektomija je zlatni standard lečenja. **Materijal i metode.** Cilj studije je da se utvrdi da li postoji razlika u pojavi postoperativnih komplikacija, kao i da li je hospitalizacija ista, u zavisnosti od metode operacije slepog creva kojoj su pacijenti bili podvrgnuti. Retrospektivna analiza je sprovedena na osnovu podataka bolničkog uzorka pacijenata koji su primljeni u Univerzitetsku bolnicu u Foči, u periodu od januara 2019. do decembra 2021. godine. **Rezultati.** U retrospektivno analiziranom periodu operisano je 107 pacijenata sa dijagnozom akutnog apendicitisa. Nije bilo statistički značajne razlike između lečenih grupa u odnosu na stepen upale slepog creva, vrstu i trajanje simptoma, kao ni u dijagnostičkim procedurama i ukupnom vremenu od prijema do operacije. Alverado Score u grupi verovatnog apendicitisa bio je 41,1%. Najčešći simptomi su palpatorna osetljivost u ingvinalnoj regiji i bolna osetljivost u desnom donjem kvadrantu 69,1%, intraoperativni nalaz reverzibilnog apendicitisa je 58%, a u 25,2% intraoperativnih nalaza se ne poklapa sa patohistološkim. **Zaključak.** Akutni apendicitis je jedno od najčešćih hitnih hirurških stanja, koje zahteva hiruršku intervenciju ako se ne leči na vreme, izaziva posledice opasne po život. Hirurška intervencija odabranim tehnikama omogućava efikasnije uspostavljanje funkcionisanja gastrointestinalnog trakta, kraću hospitalizaciju, brži oporavak i povratak svakodnevnim aktivnostima.

Ključne reči: apendicitis; akutno oboljenje; apendektomija; laparoskopija; postoperativne komplikacije; ishod lečenja; dijagnostički imidžing

Introduction

Acute appendicitis (AA) is among the most common causes of acute abdominal pain [1]. Acute appendicitis is one of the most common dilemmas surgeons encounter in the emergency room [2]. Luminal obstruction resulting from different causes is believed to be the underlying factor in the development of appendicitis. This obstruction causes an increase in mucus production and bacterial overgrowth, which in turn increases the tension within the appendiceal wall, leading to necrosis and, potentially, perforation [3]. Appendicoliths or fecaliths, known as "appendix stones", along with benign or malignant tumors, are among the various factors that can lead to the obstruction of the appendix lumen [4]. While acute appendicitis is a frequent cause of acute abdomen, there are many other clinical conditions that can resemble the symptoms of this acute surgical emergency. Consequently, misdiagnosis

Corresponding Author: Dr Aleksandra Milenkovic, Kliničko-bolnički centar Kosovska Mitrovica, 38220 Kosovska Mitrovica, Anri Dinana bb, E-mail: alexismilenkovic2512@gmail.com

Abbreviations

AA – acute appendicitis
RLQ – right lower quadrant
CRP – C-reactive protein
US – ultrasound examination
CT – computerized tomography
MRI – magnetic resonance imaging
WBC – white blood cells
ICD10 – International Classification of Diseases 10
CBC – complete blood count
MCV – mean corpuscular volume

may lead to unnecessary surgical explorations, which carry inherent risks of complications during and after the intervention [5]. Even with notable advancements in abdominal imaging [6], the risk of delayed diagnosis persists, magnifying the potential for complications and even fatal outcomes [7].

Clinical symptoms and signs suggestive of appendicitis include a history of central abdominal pain migrating to the right lower quadrant (RLQ), anorexia, fever, and nausea/vomiting. RLQ tenderness, along with classical signs of peritoneal irritation (e.g., rebound tenderness, guarding, rigidity, reflective pain), may be present on examination. Laboratory evaluations potentially useful for the diagnosis of appendicitis are white blood cell and granulocyte counts, the proportion of polymorphonuclear blood cells, procalcitonin, serum fibrinogen neutrophil-to-lymphocyte ratio and serum C-reactive protein (CRP). Given that many patients exhibit atypical symptoms, the utilization of laboratory or imaging tests becomes imperative in order to establish the diagnosis [8].

The ultrasound criteria for acute appendicitis include visualization of a non-peristaltic, non-compressible, tubular, blind-ending structure with a diameter of 6 mm or more in the right iliac fossa. An ultrasound (US) with graded compression has a sensitivity of 89% and specificity of 100%, and is a widely used technique for the diagnosis of acute appendicitis [9]. Computerized tomography (CT) has shown high sensitivity ranging from 90-100% and specificity ranging from 91-99% in diagnosing appendicitis. However, due to the potential risks associated with ionizing radiation, the use of CT scans in this context is restricted. Many healthcare professionals now reserve it for cases with atypical presentations or when there is a suspicion of cancer [10]. Magnetic resonance imaging (MRI) has demonstrated a high level of sensitivity (96%) and specificity (96%) in diagnosing acute appendicitis [11].

Various scoring systems, such as the Alvarado Score and Appendicitis Inflammatory Response, have been devised to assist clinicians in diagnosing acute appendicitis. However, it is important to note that scoring systems are unable to serve as the sole determining factor for an appendicitis diagnosis [12]. Maybe newer technologies like 99mTc-labeled monoclonal immunoglobulins (LeuTech) will help in the final diagnosis of acute appendicitis. LeuTech is a convenient, safe, rapid, and sensitive imaging test for the diagnosis of appendicitis, which reduces the risk of misdiagnosis and unnecessary appendectomies [13].

The objective of the paper and research was to take a closer look at acute appendicitis, to determine whether hospitalization is the same for all patients, and whether there is any difference in the appearance of postoperative complications, quality of life, and functioning of the gastrointestinal system, and daily activities, and that, because we only performed open appendectomy until 2014 to solve this urgent surgical condition.

Material and Methods

A retrospective survey was conducted in this study by collecting data from a total of 107 patients. The subjects were individuals ranging in age from 4 to 66 who were admitted to the Hospital in Foca between January 2019, and December 2021 with a diagnosis of acute appendicitis (ICD-10 codes from K35 to K35.9) and underwent surgery afterwards. After the surgical procedures, all the removed appendices were examined through pathological analysis to establish the final histological diagnosis. After the pathohistological analysis of the resected appendices, the patients were divided into three groups. The first pathohistological group were patients with normal appendix or catarrhal appendicitis; the second group were patients with uncomplicated appendicitis – phlegmonous appendicitis; while the third group were patients with complicated appendicitis – gangrenous and/or perforated appendicitis.

The observation characteristics in our study encompassed a range of factors, including demographic characteristics such as age and gender. We also assessed the presence of symptoms such as gastric complaints and pain migration. Clinical signs such as an increase in body temperature and pain sensitivity in the RLQ were documented. In order to establish an adequate diagnosis of acute appendicitis and reduce the number of negative appendectomies, different prognostic scores are used for the clinical evaluation of acute appendicitis. In our study, we used the Alvarado Score, a diagnostic scoring system based on the scoring symptoms, physical and laboratory findings, which is suitable for rapid diagnosis in the early stages of inflammation. The Alvarado score has a sensitivity and specificity of 99 and 43% respectively to rule out the diagnosis of AA when <5 and a sensitivity of 82% and specificity of 81% if <7 [14]. Score greater than 6 points indicates acute appendicitis, and less than 6 suggests the absence of appendicitis (1-4 points suspected uncertain diagnosis; 5-6 possible acute appendicitis; 7-9 probable acute appendicitis). There is no sign, symptom, or laboratory test that is 100% reliable in the diagnosis of acute appendicitis.

Laboratory parameters such as absolute and relative leukocyte count, differential blood count, neutrophil-lymphocyte ratio, and CRP concentration were analyzed. Urinalysis was conducted to assess any abnormalities. Additionally, we utilized radiological imaging methods such as US) In situations where the clinical diagnosis was uncertain, or laboratory or ultrasound findings ambiguous, we used CT and MRI. Finally, pathohistological findings were analyzed to determine the degree of inflammation of the appendix.

We used descriptive statistical methods to summarize and present the data. Data is visualized with use of graphs and tables. For numerical data, we calculated mean values, standard deviations, and maximum and minimum values, while frequencies were computed for categorical data. We used the Chi-square test to compare the categorical variables. All of the mentioned tests were two tailed. Statistical significance was set up at $p \leq 0.05$.

Results

In the above analyzed period, 107 patients aged 4 – 66 underwent surgery due to the diagnosis of acute appendicitis. 89 (83.2%) patients were operated with the laparoscopic technique and 18 (16.8%) with the open method. There was no difference between the treated groups in regard to the degree of appendicitis, type and duration of symptoms, the diagnostic procedures and the time that had elapsed from admission to surgery. There was no statistically significant difference in the frequency of the appendicitis type between genders (χ^2=0.47, df=2, $p > 0.05$). The distribution of appendicitis types according to gender is shown in **Graph 1**.

In terms of age and gender distribution, the largest number of operated patients is in the age group 11-60 years, 62 (58%); a slightly smaller number is in the 4-10 years old group, 32 (29.9%); while the fewest patients were in the age group 61-66 years, 13 (12.1%). In all three age groups, there is a slight predominance of male patients, 54 (50.4%) **(Graph 2)**.

Our results show that score 1-4 points (uncertain diagnosis of acute appendicitis) had 32.7% patients. Score of 5-6 points (potential acute appendicitis) had 26.2% patients and the highest percentage of the patients (41.1%) had score of 7-10 points (likely acute appendicitis). Distribution of stages of appendicitis based on the Alvarado Score diagnostic system is presented in **Table 1**.

Palpable pain sensitivity of the right inguinal region was registered in 82 (76.6%) patients while nausea and vomiting were present in 45 (42.1%). Moreover, there was a statistically significant difference in frequencies of these symptoms between different types of appendicitis, (χ^2=29.4, df=2, $p \leq 0.05$ and χ^2=8.93, df=2, $p \leq 0.05$) respectively. There was no statistically significant difference between other mentioned symptoms in patients with appendicitis. The absolute and percentage representation of individual symptoms and clinical signs in the total number of patients by group is shown in **Table 1**.

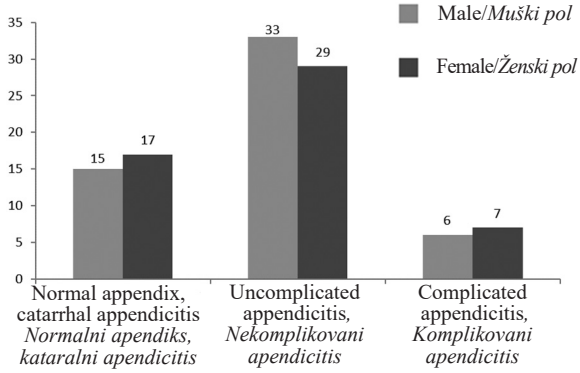
Out of the total of 107 patients, 32 (29.9%) had an intraoperative finding of catarrhal appendicitis. Uncomplicated appendicitis was present in 62 (58%) patients and complicated appendicitis was found in 13 (12.1%). Out of the 107 patients, 27 (25.2%) intraoperative findings did not match the pathohistological findings. Thus, in our study, an unexpectedly large difference in intraoperative and pathohistological findings became the key reason for numerical unevenness. Within the group of catarrhal appendicitis, 11 cases (34.3%) exhibited intraoperative findings that were underestimated in comparison to the group of uncomplicated appendicitis where 4 cases (6.4%) had underestimated intraoperative findings, while in 7 cases (11.3%), the intraoperative findings were overestimated. Among the patients with complicated appendicitis, intraoperative findings were overestimated in 5 cases (38.4%). These findings suggest that there were variations in accurate assessment of the severity of appendicitis during surgery, with both underestimation

Table 1. Representation of symptoms and clinical signs in the formed groups of patients
Tabela 1. *Prikaz simptoma i kliničkih znakova u formiranim grupama pacijenata*

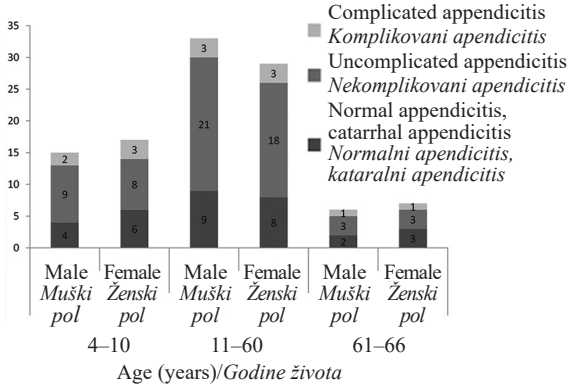
	Catarrhal appendicitis *Kataralni apendicitis* N/*Br.* = 32	Uncomplicated appendicitis *Nekomplikovani apendicitis* N/*Br.* = 62	Complicated appendicitis *Komplikovani apendicitis* N/*Br.* = 13	Chi-square χ^2	p value *p vrednost*
	N/*Br.* (%)	N/*Br.* (%)	N/*Br.* (%)		
Loss of appetite/*Gubitak apetita*	15 (46.9)	24 (38.7)	9 (69.2)	5.625	> 0.05
Nausea and vomiting/*Mučnina i povraćanje*	13 (40.6)	24 (38.7)	8 (61.5)	8.93	≤ 0.05
Migration abdominal pain *Migratorni abdominalni bol*	4 (12.5)	6 (9.7)	2 (15.4)		
Palpable pain sensitivity *Bolna osetljivost na palpaciju*	20 (62.5)	50 (80.6)	12 (92.3)	29.4	≤ 0.05
Increased body temperature *Porast telesne temperature* (> 38° C)	15 (46.9)	14 (22.6)	10 (76.9)	1.08	> 0.05
Sharp pain in the right lower quadrant of the abdomen caused by cough/*Oštar bol u donjem desnom kvadrantu abdomena uzrokovan kašljem*	14 (43.8)	13 (21.0)	7 (53.8)		
Leukocytosis/*Leukocitoza* >10,000	12.6 (6–22)	14.6 (4–26)	15.2 (2–29)		
Neutrophils "turning" left *„Skretanje" neutrofila u levo*	72 (56–92)	82 (51–89)	88 (55–92)		

Table 2. Frequency of operative and pathohistological findings
Tabela 2. *Učestalost operativnog i patohistoloških nalaza*

Findings *Nalazi*	Intraoperative *Intraoperativno*	Pathohistological *Patohistološki*
Catarrhal appendicitis/*Kataralni apendicitis*	32	30
Uncomplicated appendicitis/*Nekomplikovani apendicitis*	62	60
Complicated appendicitis/*Komplikovani apendicitis*	13	17



Graph 1. Distribution of appendicitis types according to gender
Grafikon 1. *Distribucija tipova apendicitisa prema polu*

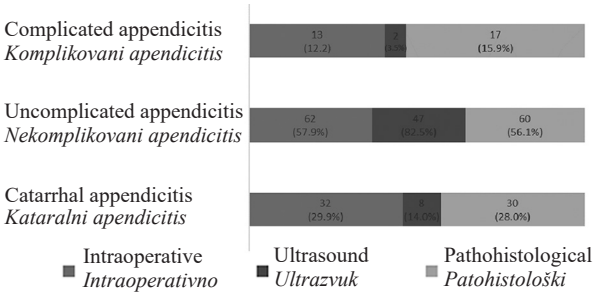


Graph 2. Distribution of appendicitis degree by patients' demographic characteristics
Grafikon 2. *Distribucija stepena apendicitisa prema demografskim karakteristikama pacijenta*

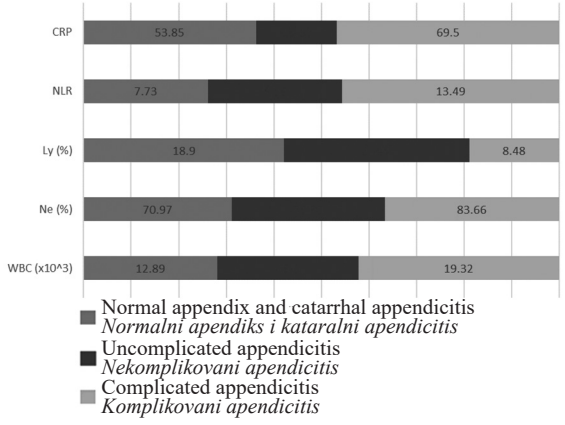
and overestimation occurring in different subgroups of patients **(Table 2)**.

Ultrasonographic examination of the abdomen has proved to be a valuable tool for diagnosing acute appendicitis and ruling out other potential differential diagnoses. It helps decrease the number of negative appendectomies, thus enhancing diagnostic accuracy. An US finding of a normal appendix is sufficient to rule out the diagnosis of appendicitis, and if positive, it should be interpreted with other clinical findings in order to make a decision about the surgery. Over 76.7% were used in the diagnosis of uncomplicated appendicitis, and extremely little in the case of complicated and catarrhal appendicitis. Results of ultrasonographic findings and their correlation with intraoperative and pathohistological findings are shown in **Graph 3**.

Standard laboratory parameters were monitored: absolute number of leukocytes, percentage of neutrophils and lymphocytes, neutrophil-lymphocyte ratio, along with CRP. These parameters were determined from the preoperative venous blood sample. The lowest preoperative values of the neutrophil-lymphocyte ratio were present in the group of catarrhal appendicitis. CRP was performed in 72 (67.3%) operated patients with suspicion of acute appendicitis. The lowest preoperative CRP values were in the uncomplicated appendicitis group (25.11), where they differed only from the complicated appendicitis group (69.50). CRP value in the catarrhal appendicitis group was 53.85. The difference between the groups of catarrhal and complicated appendicitis is shown in **Graph 4**.



Graph 3. Distribution of severity of appendicitis by intraoperative, ultrasound and pathohistological findings
Grafikon 3. *Distribucija stepena apendicitisa prema intraoperativnom, ultrazvučnom i patohistološkom nalazu*



Graph 4. Routine lab tests in the formed pathohistological groups of patients
Grafikon 4. *Rutinske laboratorijske analize u formiranim patohistološkim grupama pacijenata*

Discussion

Acute appendicitis is one of the most common clinical challenges for emergency surgeons, because of its diagnostic processing. The clinical presentation of acute appendicitis may vary a lot, from mild symptoms like moderate abdominal pain or fever, to most severe scenarios, such as diffuse peritonitis and sepsis. The most frequent clinical sign is right lower quadrant abdominal pain. However, these symptoms are not specific for acute appendicitis as they can be present in other septic conditions [15].

Diagnostic and therapy treatment of acute appendicitis have significantly developed in recent years. Laparoscopy, US, CT, MRI and laboratory diagnostics have advanced technically [16]. Our institution`s guidelines do not include abdominal CT and MRI for the diagnosis of acute appendicitis except for unclear pathological conditions. While the clinical diagnosis of appendicitis may be straightforward in patients with common signs and symptoms, atypical presentations can result in delays in treatment, unnecessary hospital admissions for observation, and unnecessary surgery [17].

Timely intervention remains the focus of management in the prevention of progression from uncomplicated to complicated appendicitis. Nonetheless, complications like perforation with intra-abdominal abscess formation, peritonitis, and abdominal sepsis represent severe forms of acute appendicitis. These complications might be associated with severe morbidity or mortality. The probability of perforation has shown to increase after a delayed or missed diagnosis of uncomplicated appendicitis [18].

On the contrary, surgical removal of a normal appendix exposes patients to unnecessary anesthesia and surgical complications. Many diseases resemble acute appendicitis presentations. Therefore, more effort should be made towards decreasing the appendectomy rate and its complications for patients and hospitals. Rather than immediately proceeding with surgery, a more comprehensive evaluation can be pursued, including careful observation of symptoms, running additional diagnostic tests, and considering alternative diagnoses. This approach aims to minimizing the unnecessary removal of a healthy appendix and reducing the associated risks and complications of surgery [19].

Recently published papers report a wide variation in the early appendectomy rate, ranging from 3% to 25%, mostly affecting women [20].

Excision of the appendix not only decreases the risk of life-threatening complications including perforation and sepsis, but also allows for histopathology examination, which is the gold standard for confirming the diagnosis of acute appendicitis, irrespective of the intraoperative findings [21]. The reliability of intraoperative assessment in our study was 74.8%. The dilemma and a question in the case of negative intraoperative finding of appendicitis is whether appendectomy should be performed due to potential inflammation in the future, which is the opinion of some authors [22], or whether the appendix should be left in situ.

From the results of our research, it is possible to see that the neutrophil-to-lymphocyte ratio values are the lowest in catarrhal appendicitis (7.73) while the highest values are found in complicated appendicitis (13.49). Neutrophils play an important role in acute appendicitis, they are the primary responders during acute inflammation, they have the ability to phagocytose and their number increases proportionally to inflammation. During inflammation, the longevity of neutrophils increases significantly by severalfold as they become activated. This ensures the continued presence of primed neutrophils at the site of infection [23]. In a more complicated form of acute appendicitis the appearance of lymphopenia is possible, the pathohistological mechanism of which has not been fully elucidated [24]. According to these facts, an increase in the neutrophil-lymphocyte ratio is expected especially in a complicated form of acute appendicitis as a result of an increase in neutrophils and decrease in the number of lymphocytes.

C-reactive protein is considered one of the most important inflammatory markers [25]. Our patients with complicated forms of the disease had a multiple higher CRP value (48-270 mg/L), though not in the non-perforated form of disease. This speaks of CRP as a good marker of perforation, but not about the form of the disease without perforation. As reported in various studies, white blood cells (WBC) and CRP are the most significant laboratory markers to be considered in the case of acute appendicitis [26]. A WBC cut-off >10.000/ml has sensitivity range between 65 and 85% and specificity range between 32 and 82%, and CRP values >10 mg/L have sensitivity range between 65 and 85% and specificity range between 59 and 73% [27].

Both laparoscopic and open appendectomy are safe and effective techniques for the treatment of suspected acute appendicitis. Both techniques are associated with good clinical outcomes and few complications [28]. The benefits of laparoscopic approach include reduced incidence of surgical site infections, shorter postoperative stay, less pain, reduced incidence of incisional hernias, and faster postoperative recovery and return to everyday activities, along with better cosmesis [29, 30]. In our study, the type of operative technique was determined according to the surgeon`s preference and the patient`s wish. The open technique required hospitalization for six days after the operation, and the laparoscopic appendectomy for three days.

Conclusion

Acute appendicitis is an urgent surgical condition due to its localization in the abdomen, and includes a wide range of differential diseases. The clinical scoring system is not the only clinically reliable indicator of positive findings in acute appendicitis, but it has a high predictive value to negative appendectomies. Despite the high prevalence of acute appendicitis, diagnosis is challenging because many appendicitis symptoms are nonspecific and patients may have atypical clinical presentation. The frequency of minimally invasive surgery in the treatment of acute appendicitis in our coun-

try is 83.2% and it is reflected in the faster establishment of the gastrointestinal tract function, shorter hospitalization, i.e., three days, faster recovery, and return to daily activities and better quality of life.

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