CURRENT STATE OF ACUTE APPENDICITIS DIAGNOSIS

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The advantages and disadvantages of current techniques of clinical laboratory and instrumental study in acute appendicitis have been considered. There have been shown prospective directions in the development of diagnostic methods. The possibilities of integral diagnosis of acute appendicitis have been presented in detail.

Key words: acute appendicitis; integral diagnosis of appendicitis; "negative" appendectomy; acute appendicitis diagnostic score.

The incidence of acute appendicitis (AA) in the total population accounts for to 0.1–0.6% with a steady downward trend [1–3]. The improvement of the diagnostic methods makes a great contribution to it. The diagnostic errors result in "unreasonable" operations as well as in delayed surgical care, their frequency being 2.3–34.5% [3–9]. The interest in the preoperative diagnosis of AA forms does not wane. Videolaparoscopy is a sufficiently effective technique; however, it is an invasive procedure. Laparoscopy under local anesthesia does not provide enough information. Current methods of diagnosis are based on costly forms of instrumental and laboratory studies, often requiring the involvement of top experts and specific equipment. The present review was aimed at reflecting up-to-date trends in the development of AA diagnosis, assess the existing methods in terms of efficiency and optimality.

Clinical and laboratory study

The AA clinical diagnosis is traditionally primary [5, 10–13]. However, the true efficiency of many of the 'specific' appendicular symptoms is not adequate [14, 15]. These routine clinical laboratory tests do not have anything specifically associated with AA. The known techniques of differential laboratory diagnosis based on determining a patient's degree of intoxication at various indices (Ya.Ya. Kalf–Kalif's leukocyte index of intoxication (1941), V.A Shalygina's index of erythrocyte aggregation (1997), T.Sh. Khabirova's an index of neutrophils response (2000) provide little information. There are some reports that a leukocyte count is also of no practical significance in AA diagnosis and, moreover, does not allow to suggest its form [16].

C-reactive protein (CRP) study in the range of "subclinical" values, i.e. up to 10 mg/L, is of a particular interest. CRP level of over 5 mg/L may be the evidence of destructive appendicitis and is an indication for surgical treatment 16–19]. However, various aspects unrelated directly to acute surgical pathology can lead to false-positive results. The rate of a CRP increase (CRPv) distinguishes a bacterial inflammation from a non-bacterial one. Thus, CRPv over 1.08 mg/L/h indicates a bacterial inflammatory reaction. The sensitivity, specificity and accuracy of the method are 75.0–98.0%, 66.0–87.0%, 72.0–96.0%, respectively. A comprehensive study such as a "triple test" (CRP, leukocyte count and neutrophil count) increases the sensitivity (94.4%) and prognostic value (98.7%) of the method [20]. A semi-quantitative method for determining CRP is cheap and fast to be applied but less accurate in comparison with a quantitative one.

Current immunochemical techniques for AA diagnosis have not been widely used so far, remaining theoretical and applied methods in some clinics. They are as follows: a comprehensive immunological study [21, 22] determining the level of metal-proteins in biological fluids [23], the use of a polymerase chain reaction in order to indicate and identify viruses [24], calprotectin tests (S100A8/A9) [25, 26], E-selectin [27], serum YKL-40 [28], D-lactate [29], 5-hydroxyindole acetic acid level [30] and urine alpha-2-glycoprotein [21]. The common shortcomings of these methods are high costs and long-term performance of immunochemical tests.

AA Integral Diagnosis

Since the end of the past century the Alvarado scoring system used for AA diagnosis has been widespread worldwide [31]. It is based on the determining of an index of acute appendicitis (IAA) by summing up the points of 8 signs: migration of pain, anorexia, vomiting (nausea), tenderness in the right iliac fossa, positive Shotkin–Blumberg's symptom, elevated temperature, leukocytosis, left shift in leukocyte count. The diagnostic accuracy is 82.7–90.0%, and "negative" appendectomy while using

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Table 1

Mathematical differential diagnostic table

Symptom	Difference in axillary and rectal temperature of less than 0.5°C				Difference in axillary and rectal temperature of more than 0.5°C			
	Onset of pain							
	not in the right iliac region		in the right iliac region		not in the right iliac region		in the right iliac region	
	Yes	No	Yes	No	Yes	No	Yes	No
No similar episodes in the past	8	–1	6	–3	9	0	7	–2
Nausea, vomiting	12	–3	10	–5	13	–2	11	–4
Muscle tension in the right iliac area	9	3	7	1	10	4	8	2
Shotkin's sign	12	3	10	1	13	4	11	2
Leukocytosis	9	–3	7	–5	10	–2	8	–4
LII more than 3,5	13	–3	11	–5	14	–2	12	–4
Body temperature above 37,0°C	11	5	9	3	12	6	10	4
Tachycardia — 90 and above	5	–3	3	–5	6	–2	4	–4
Rovsing's sign	5	1	3	–1	6	2	4	0
Dry or coated tongue	3	0	1	0	4	0	2	0

Hereinafter: LII — leukocyte index of intoxication.

it amounts to 14.3–17.5% [11, 31]. The score's being based exclusively on clinical and laboratory findings is its shortcoming. IAA for doubtful AA often shows the values of "AA is unlikely". The sensitivity of the score of 5–7 ("AA is possible") is only 58–88%. The AA diagnostic accuracy goes up to 92–98% when performing computed tomography (CT) with the score of 7–8 [32–34]. Modifications of the score including additional research methods are suggested [2, 11, 35].

The Alvarado-modified diagnostic scoring system for AA was developed and implemented into clinical practice in the I.M. Sechenov Moscow Medical Academy (Russia) [2]. A key point of the method is to perform ultrasound imaging of the vermiform appendix at the IAA values corresponding to "AA is probable". The sensitivity, specificity, accuracy, prognostic value of positive and negative results are 87.0, 96.7, 94.0 and 89.2%, respectively. "In'ffective" appendectomies were performed in 12.3% of cases. A method for AA diagnosis in children was developed and implemented. It is based on determining a clinical index by summing up the scores of 6 symptoms: nausea (2 points), specificity of the local pain in the right lower abdominal quadrant (2 points), migration of pain (1 point), walking with difficulty (1 point), a peritoneal irritation symptom or pain at percussion (2 points), neutrophil count of over $6{,}75 \cdot 10^3$/ml (6 points). Patients with an index lower than 5 are unlikely to develop AA. The sensitivity of the score is 96.3% [36].

An original score for AA diagnosis was developed in the RIPAS Hospital in Brunei [9]. It takes into account a patient's sex, age, duration of the disease, clinical and laboratory signs of AA (pain in the right iliac area, migration of pain, nausea, vomiting, local defense, peritoneal signs, Rovsing's sign, fever, leukocytosis, changes in the urine test). The sensitivity, specificity, and accuracy are 97.0, 82.0 and 92.0%, respectively. "Unreasonable" appendectomies are performed in 19.4% of cases, and the predicted rate of "negative" appendectomy is 13.5%.

The key points of diagnostic research in the mathematical differential diagnostic table of AA (Table 1) developed by Russian scientists (Saratov) [37] are the difference in axillary and rectal temperature and the anatomical abdominal area of the onset of pain. According to the authors, the method improves AA diagnosis and enables to predict a histological form of the vermiform appendix with 95–96% probability. The disadvantages of this method are its being unhandy and labor-consuming. The total score of 41 or more indicates destructive appendicitis. With a score of less than 35 a follow-up and further observation to clarify the diagnosis is indicated. With a score of 35–41 laparoscopy is indicated.

We have developed a differential diagnostic and treatment algorithm. Its main link is the determination of the IAA according to a score (See Table 2) in which the score values of the signs depending on their "weight" significance

Table 2

The score of acute appendicitis diagnosis

Sign	Score
Leukocytosis (leukocyte count over $8.8 \cdot 10^9$/L)	1
LII (by Kalf–Kalif) over 1.6	2
CRP level of ⩾5 mg/L	2
Body temperature of ⩾37.0°C	10
Kocher–Volkovich's symptom	10
Shotkin's symptom	2
Local guarding	7
Presence of two or more of appendicular symptoms	7

are calculated mathematically and rounded to the nearest integer.

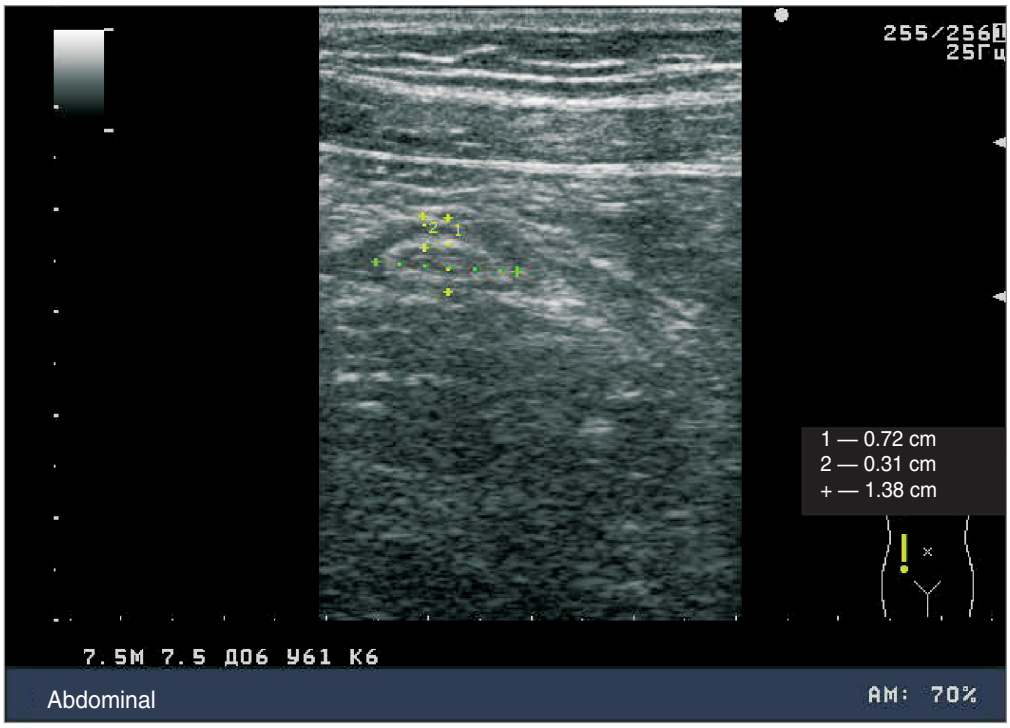
The interpretation of the results is as follows: “AA is improbable”, if IAA is up to 16 points and including; “AA is probable”, if IAA ranges from 17 to 29 points; “AA patient” if IAA is 30 points and more. Characteristics of the score: sensitivity is 95.0%, specificity is 100%, overall accuracy is 97.5%, false-negative response is 5.0%, false-positive response is 0%, positive predictive value is 95.2%. The algorithm is valid for the facilities with a various therapeutic and diagnostic potential. In case of IAA being “AA is probable”, mandatory hospitalization with active observation and ultrasound scanning of the appendix is indicated. If the sonographic signs of AA are missing or ultrasound scanning of the appendix is not possible, dynamic observation with the determination of IAA repeated every 2 hours must be provided. Video laparoscopy is indicated in case of IAA rise or persisting doubts about the diagnosis. If IAA value is “a patient has AA”, a diagnostic laparoscopy transferring into a treatment one is advisable to confirm the diagnosis.

Instrumental study

Currently, the usefulness of routine ultrasound imaging of the vermiform appendix is being debated [1, 5, 7, 8, 38, 39]. The undeniable advantages of the method are its non-invasiveness, availability, a possibility to perform a study dynamically, absence of radiation exposure to the patient and the staff. The sensitivity of the method is 80.7–95.6%, specificity is 47.0–99.1%, the overall accuracy is 71.0–98.0%. The information value increases with color Doppler and power mapping of the blood flow. At the same time, at the positive ultrasound decision, the unchanged appendix is removed in 6.7% of cases [1]. This method is the most informative in complicated AA [1, 5, 38–41]. 3.5–10 MHz linear and convex probes are usually used to perform the study. The sonographic sign of AA is a blind-ended tubular structure at the point of maximum tenderness with the outer diameter of 6 mm which is aperistaltic and can not be compressed, with wall hyperemia in the initial stages of inflammation at the color Doppler study, the wall being 2 mm thick, and often contains fecal bolus. At cross–scanning the tubular structure resembles a “target”, “cockade”, the wall thickness of the stromal component of the appendix being 5 mm or more (See the figure). The ultrastructure of the appendix at sonography is differentiated better than at CT scanning, which enables to predict the AA form better preoperatively [10]. The main disadvantage of the method is that the results depend considerably on the expert’s qualifications.

The X-ray method of testing in AA has supporting significance. Indirect signs of appendicitis at plain abdominal radiography are observed in less than half number of cases [7]. These include: appendicolitis shadows observed in 20–33.0% of children and in 10.0% of adults, isolated stretching of the terminal ileum loops with fluid levels, but gas in the appendix may be present in healthy subjects, too. Irrigoscopy is more informative with appendicular infiltrate, colonoscopic appendicography presents interest in the diagnosis of chronic appendicitis.

The CT accuracy in AA diagnosis is of 94.0–100% [33, 36–38], and in that event “negative” appendectomies



Patient Zh., 21, has undergone a cross scanning of the vermiform appendix. He shows “a target” symptom. The anterior-posterior diameter of the part of the appendix is 0.72 cm, its width is 1.38 cm and wall thickness — 0.31 cm. The accumulation of the fluid is observed around the appendix (from the personal files)

make up 3–8.0% [32, 40–43]. The appropriateness of this study in complicated AA and doubtful cases is practically not disputable, and the usefulness of routine CT is actively discussed. It is believed that this method does not reliably reduce the rate of "undue" appendectomy [8, 33, 40–41].

Currently, hardware-based methods based on radiophysical and electric effects in the inflamed tissues are investigated. Trans-resonant functional topography, deep microwave radiotermography, electromyography, the mathematical analysis of heart rate variations provide indirect findings of the appendix involvement into the pathological process. [21, 44, 45].

The issues of AA laparoscopic diagnosis are substantially represented in modern literature. The accuracy of the method is quite high, it is 92.0–95.8%, sensitivity is 92.0–98.7%, specificity is 91.1% [1, 12]. Laparoscopy is the final step in AA diagnosis, when all the non-invasive methods have been used, but the diagnosis yet being doubtful. An advantage is its easy transformation into a therapeutic surgical aid [6]. It is videolaparoscopy that allows providing a comprehensive revision of the abdominal cavity [8, 12, 46]. Diagnostic errors occur in 1.7–3.0% of cases, and the study gives little information in 6.6–8.5% of cases because of the anatomical features [5, 7, 42]. In case of a difficulty in catarrhal appendicitis verification dynamic laparoscopy is required. Video laparoscopy allowed reducing the rate of diagnostic errors significantly in most clinics [8, 12] and catarrhal AA was excluded in some others [47–49].

The use of diagnostic laparoscopy enables to reduce the rate of appendectomies for acute appendicitis, which leads to the reduction of suppurative septic complications, as well as to a marked economic effect.

Thus, the following main provisions can characterize the current state of AA diagnosis: 1) the diagnostic criteria for AA are polymorphic, no specific sign has been found, 2) there is a steady trend to a less aggressive surgical approach due to the introduction of additional research techniques; 3) the economic aspects of modern medicine leave the most promising methods for AA diagnosis within the scope of theory and application use.

At the present time the radiologic studies are undoubtedly a priority, being highly informative and non-invasive. Laparoscopy reduced the number of diagnostic errors, though has not excluded them completely. We must not forget that an adequate diagnosis in this method is only achieved with the use of anesthesia and endovideosurgical techniques. With a low therapeutic diagnostic potential of a medical facility the integrated approach can optimize AA diagnosis.

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