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REVIEW ARTICLE

Optimization of Diagnosis of Acute Appendicitis in Pregnant Women

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Abstract

One of the most common diseases of abdominal surgery is acute appendicitis (AA). The urgency of the problem of early diagnosis of AA is justified by the fact that this pathology may occur during pregnancy, parturition, and the postpartum period, hiding acute surgical pathology under the mask of gynecological diseases. The review presents the main diagnostic techniques used by doctors of various specialties, since the diagnosis of AA in pregnant women presents significant difficulties and also analyzes the existing methods for diagnosing acute appendicitis for timely surgical treatment and preservation of pregnancy. Thus, despite a significant number of ways and methods, the diagnosis of appendicitis in pregnant women presents with different kind of challenges, especially with an increase in the duration of pregnancy. In timely combined diagnosis including various ways and methods which can prevent the development of severe complications, without harming the fetus, especially in the third trimester, the method of gradual compression is recommended, which consists the gradual compression of the muscles of the anterior abdominal wall on the right side. Overall, MRI technique is having the least side effects with best diagnostics results following with properly assessment of clinical and laboratorial findings.

Keywords Acute appendicitis · Pregnancy · Diagnosis · Complication

Introduction

The aim of the study was to analyze existing methods for diagnosing acute appendicitis for timely surgical treatment and preservation of pregnancy. Acute appendicitis (AA) is one of the common diseases of abdominal surgery [1]. The frequency of this pathology according to national and international researchers is 3-4 cases per 1000 people. AA is observed in all age groups, mainly in men aged 20-50 years and in women two times more often. AA in pregnant women provides a formidable pathology, as it threatens the health of the mother and the fetus; it can cause surgical, obstetric, extragenital, and perinatal complications during pregnancy, childbirth, and the postpartum period.

Despite the progress of medical science, the mortality rate from acute appendicitis is 0.2-0.3% of cases and remains stable for many years [2, 3]. In pregnant women, AA is the most common cause for surgical intervention, and it is observed from 0.03 to 5.2% of cases and can occur in any period of pregnancy [1, 3-6].

According to the literature, AA in pregnant women is most often observed in the first trimester from 9 to 32%, in second trimester 44 to 66%, less often in third trimester from 15 to 16%, and least in the postpartum period from 6 to 8% of cases [1, 7, and 8]. However, the opinion of scientists about the frequency of AA is ambiguous; the data obtained by Davoodabadi et al. (2016) indicate a high frequency of 66% of AA in the third trimester [9], while Noskov et al. (2017) believe that it can reach 49% [1].

It is believed that AA is most common in the first trimester and is detected in 49-50% of cases, and destructive forms occur more often in the third trimester and the postpartum period [1]. However, whatever the prevalence of AA in pregnant women is the high frequency of perinatal loss, reaching from 2 to 17% with uncomplicated form, 19.4-50% with

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perforation of the vermiform process (VP), and 90% with the development of diffuse peritonitis; all this makes doctors of various specialties to seek new diagnostic methods for timely surgical treatment [1-3, 8, 10]. Diagnosis of acute appendicitis during pregnancy and outside of pregnancy is based on the assessment of clinical and para-clinical symptoms, laboratory parameters, and instrumental research methods.

Pathogenesis

A conditionally pathogenic aerobic and anaerobic flora that grows in the intestine plays a significant role in AA, but in pregnant women, a physiological decrease in the intestinal motor function is observed, which creates conditions for the development and progression of the inflammatory process in the VP. In addition, the uterus, which expands during pregnancy, additionally leads to the displacement of the dome of the cecum in different directions, often upward and outward, forming various bends and causing VP stretch [2]. Increased progesterone secretion observed during pregnancy leads to the weakening of the automatic regulation of intestinal motor function, increasing intra-abdominal pressure, and impaired evacuation function, intestinal contents emptying processes and impaired blood circulation in intraparietal vessels [1, 2, 10].

Objectives

We have reviewed different articles from various journals from all over world (PubMed, elibrary.ru, etc.), about the different diagnostics approaches to acute appendicitis and various ways and methods which can prevent the development of severe complications which can lead to the death of mother and her fetus.

Diagnostic Modalities

The assessment of the clinical condition is simple and yet diagnostically valuable in the diagnosis of AA. In pregnant women, the condition of AA is characterized by a blurred clinical picture due to a variety of symptoms, which causes difficulties in establishing the diagnosis [2, 4, 6, 9]. Despite the fact that today more than 100 signs and symptoms of AA are described, unfortunately none of them has accurate meaning during pregnancy, childbirth, and the postpartum period, which creates a nonstandard emergency situation for doctors who solve the problem of appendicitis in pregnant women [4, 11].

Clinical Diagnosis

The clinical picture of AA in the first half of pregnancy is usually typical and does not differ from that without pregnancy [2, 3, 12], but classical signs and symptoms may be absent in pregnant women, especially in the third trimester [13]. The leading symptom in an AA clinic is pain, which can be of different localization and intensity [3], while the pain often begins at one point in the abdominal cavity and then migrates to the right iliac fossa and increases with coughing [5, 14]. The main clinical symptoms of the AA are presented in Table 1.

Kocher's Symptom The most reliable sign by which one can determine acute appendicitis is Kocher's syndrome. Among doctors even there is an expression: "Kocher does not lie." At half of the patients suffering from appendicitis, this attribute is revealed. Kocher says "pain from the epigastric region gradually migrates to the right iliac region."

Sitkowsky's Symptom With appendicitis, physicians still prefer this symptom in overwhelming numbers. The main reason is that it can be checked quickly and easily. The patient is asked to lie on his left side and describe his feelings. With this movement, the intestinal loops move, carrying the inflamed process behind them. Therefore, the patient with appendicitis will inevitably complain about the intensification of the pain syndrome.

Shchetkin-Blumberg Symptom The doctor slowly puts his hand on the front abdominal wall of the patient and gently, without pressure, presses. Then he abruptly removes his hand. If the patient felt a sharp pain, the Shchetkin-Blumberg symptom was confirmed. In the acute form of appendicitis, the patient will feel pain during this time in the iliac right region.

Bartolome-Michelson's Symptom It is an increase in pain during palpation of the patient in the position of the cecum on the left side.

Rozdolskogo's Symptom With percussion with a hammer or finger of the abdominal wall, soreness in the right iliac region in acute appendicitis is detected.

Resurrection's Symptom On a slightly stretched shirt, which is worn on the patient, quickly spend the edge of the palm on several areas in the abdomen. If, during these actions, the patient feels pain in the right iliac region, then he can diagnose appendicitis.

Volkovich-Kocher Sign The sign describes of acute appendicitis: pain, initially arising in the epigastric region (sometimes immediately below the xiphoid process), after a few hours localized in the right iliac fossa.

Table 1 Clinical symptoms of acute appendicitis

No	Clinical symptoms	Trimester of pregnancy			Symptom sensitivity (%)
		I	II	III	
1.	Kocher's symptom	+	+	+	40
2.	Sitkowsky's symptom	+	+	+	53.3
3.	Bartolome-Michelson's symptom	+	+	+	53.3
4.	Shchetkin-Blumberg's symptom	+	±	–	13.3
5.	Rozdolskogo's symptom	±			7.9
6.	Resurrection's symptom		±	±	68.8
7.	Kocher-Volkovich symptom	±			3

Most (more than 80%) surgeons are not aware of Rizwan's, Cheremskogo-Kushnirenko's and Brendo's symptoms, the identification of which is more informative in the second and third trimester of pregnancy [2, 3, 6]

Rizwan's Sign During a deep breath, pain in the right iliac region intensifies.

Cheremskogo-Kushnirenko's Sign The symptom shows a deep forced respiratory movement and cough, which causes increased pain in the right iliac region.

Brendo's Symptom Pain on the right is determined when pressing on the left rib of the pregnant women.

According to Reva (2015), the most frequent localization is considered the localization of pain in the right iliac region in 81.25% of cases, in the epigastric region in 25% of cases, and in the lower abdomen in 12.5% of cases. Less common and less frequent are pains in the right mesogastric region in 6.25% of cases, in the umbilical region, and on the right flank of the abdomen in 3.2% of cases [3]. Depending on the location of the appendicular process in relation to the caecum, the location is medially descending, most often - 71.9%, retrocecal - 21.9%, while in 81.2% of cases, patients complain of pain in the right iliac region and lower abdomen, at least - in the epigastric and paraumbilical areas. The lateral ascending and medial position occurs infrequently, equally in 3.1% of cases, with most patients also complaining of pain in the right iliac region and sometimes pain in the right mesogastric, paraumbilical, epigastric, and right flank of the abdomen [3].

During pregnancy, pain in the right lower quadrant of the abdomen is the most common symptom and is observed in almost all trimesters of pregnancy [5, 15], but pain being the only diagnostically valuable indicator can be observed from 86 to 100% of cases in the first trimester, from 80 to 85% in the second trimester, and from 60 to 85% in the third trimester; a typical picture is present only in 50-60% of cases. It should be noted that pain in the right lower quadrant can be observed in the absence of appendicitis [7, 9], causing gynecological, somatic diseases of various organs and systems (gastrointestinal tract, urinary system, injury). The clinical Dyelafua triad, which includes the main local signs of AA in the form of pain in the right iliac region, local tension, and pain, with long gestation periods, is not always clearly identified [2]. Most often, the pain begins in the umbilical region and then migrates to the right lower quadrant due to the progression of the inflammatory process [16].

Sometimes, pregnant women feel pain which irradiates to the rectal area or to the vagina especially often in the first trimester [17], but with retrocecal location, rectal or vaginal examination causes an increase in pain [16]. In the second to third trimester, pain due to enlargement of the uterus, and the shifting of the caecum closer to the liver, is more often localized in the right mesogastric region and right hypochondrium in 21.8% of cases [6, 7, 15]. With the location of the VP in the pelvic region, pain can cause an increase in the frequency of urination, dysuria, tenesmus [16, 18]. In approximately one third of patients, pain may be localized outside the right lower quadrant of the abdominal cavity.

The presence of pain in the left lower quadrant is of rare manifestation and in most of its cases is a congenital developmental anomaly, so it is necessary to take into account that VP can be located anywhere in the abdominal cavity [19]. AA is difficult to identify in pregnant women and due to the vagueness and pseudoclassical signs and symptoms characteristic of extragenital diseases. The main symptoms of AA such as vomiting, anorexia, nausea, pyrexia (fever), tachycardia, and pain in the right lower quadrant [2, 4, 9] can be observed in pregnant women, being common symptoms in surgical, gynecological, and somatic pathology [2, 7]. Nausea and vomiting in 80%, abnormal stool 72%, and loss of appetite 84% of cases can occur with early pregnancy toxicosis. Complaints of abdominal pain radiating to the right or left lumbar region in 100% of cases can occur with the threat of abortion, ovarian apoplexy, uterine myoma, spontaneous abortion, and renal colic [11, 14, 20, 21]. Other symptoms in the form of heartburn, intestinal disorders, and flatulence can also be observed with atypical location of VP.

Scoring System for Diagnosis

In European countries, the Alvarado scale is used to diagnose AA, evaluating 8 signs of the disease (Table 2).

Laboratory Indicators

When assessing laboratory parameters, it must be remembered that leukocytosis in pregnant women is physiological in nature; therefore, this indicator should be given importance when the number of leukocytes exceeds 10,000 mL^3. It must be remembered that the main thing is not leukocytosis itself but its change in dynamics. The presence of leukocytosis and a neutrophilic left shift in the leukocyte formula, as well as lymphocytopenia, indicates AA. By the severity of leukocytosis, one can judge the depth of morphological changes in the Vermiform appendix.

Imaging Diagnostics

Ultrasound

One of the modern noninvasive methods for the diagnosis of AA in pregnant women is ultrasound (US). It increases the accuracy of diagnosis during pregnancy up to 83% [10]. However, during pregnancy, especially in the third trimester, it may be difficult to visualize the VP; therefore, a method of gradual compression is recommended. This method is based on the gradual compression of the muscles of the anterior abdominal wall in the right side. This method provides sensitivity up to 67-86% and specificity 76-88% when imaging in nonpregnant women and provides sensitivity up to 67 -100% and specificity 83-96% in pregnant women [13]. The use of ultrasound depends largely on the operator's experience and may be difficult due to intestinal gas and obesity [4]. The level of uncertain results during ultrasound can be 88-97% in women with a period of more than 16 weeks of gestation [7].

Normal vermiform process (VP) during ultrasound cannot be identified; morphological changes cannot be detected in the ultrasound picture, due to the increased thickness of walls, the presence of a narrow lumen, the elasticity of easily compressible walls, and the pronounced organ mobility. In destructive forms of acute appendicitis due to inflammatory infiltration and thickening of the walls of the VP and retention of fluid in the lumen, it becomes possible to visualize it with ultrasound. Today, many authors propose to identify direct and indirect signs of AA. Direct ultrasound signs include increasing the contrast of structures, increasing the diameter, thickening of the walls of VP, and lack of peristaltic appendix activity; with dosed compression, the rigidity of the Vermiform appendix is observed. Indirect signs of AA include thickening of the dome of the cecum; enlarged regional lymph nodes; increased echogenicity of tissues around the cecum and VP (infiltration of its mesentery); increasing the contrast of structures in the projection of VP (cecum, distal small intestine, surrounding tissues); gas outside the intestinal lumen (sign of perforation); the absence, weakening, or strengthening of peristaltic in the terminal part of the small intestine; an increase in the diameter of the distal ileum; thickening of the wall in the area of the ileocecal junction; the presence of friable infiltrate in the area of the dome of the cecum; free fluid in the right iliac region and in the pelvis; and soreness in the projection of the supposed location of VP with ultrasound; with dopplerometry, an increase in diastolic blood flow is observed with a simultaneous decrease in the resistance index (to 0.54) in the appendicular artery. All this allows you to increase the reliability of diagnosis during pregnancy to 83% [11]. However, it must be remembered that indirect ultrasound signs of AA in pregnant women are not pathognomonic and specific signs, since they can also be observed with other acute inflammatory diseases of the abdominal cavity. Therefore, during pregnancy, especially in the third trimester, the method of gradual compression is recommended, which consists in the gradual compression of the muscles of the anterior abdominal wall on the right side.

Table 2 Alvarado scale

No	Signs	Points
1.	Kocher's symptom	1
2.	Nausea, vomiting	1
3.	Loss of appetite	1
4.	Soreness in the right iliac region	2
5.	Shchetkin-Blumberg symptom in the right iliac region	1
6.	Increase body temperature > 37.3 °C	1
7.	Leukocytosis > 10.5 × 109/l	2
8.	Leukocyte shift to the left	1
9.	Total	10

If the score is from 0 to 4, then the risk of having acute appendicitis does not exceed 5%, and patients can be left in the hospital under medical supervision. If the number of points is from 5 to 7, then the risk of acute appendicitis is already 40–50%, and such patients need to re-evaluate their condition after 2 h or perform diagnostic laparoscopy. Indicators from 8 to 10 points are grounds to assume that the risk of acute appendicitis is more than 80% and emergency surgery is indicated for such patients [2]

Magnetic Resonance Imaging (MRI)

Another effective method for diagnosing AA is the use of magnetic resonance imaging (MRI). MRI, being the most accurate method, is capable of providing accuracy in the diagnosis of AA in pregnant women 70-94% [9]. MRI today is the golden standard for accurate diagnosis of appendicitis in

pregnant women after an inconclusive ultrasound [4, 7, 11, 21], as MRI visualizes the appendix with 100% sensitivity and 98% specificity [4]. A feature of MRI is the absence of ionizing radiation and side effects for the mother and fetus [4, 7, 11]; however, when MRI is used during pregnancy, especially in the first trimester, special care must be taken, especially in patients suffering from claustrophobia [11]. Contraindications for MRI are as follows: the presence of a pregnant pacemaker or other electronic devices, and contrast agents containing gadolinium [7]. The predictive value of a positive prognosis result for MRI is 90.4%, and a negative predictive value is 99.5% if the appendix can be identified [4]. The sensitivity in detecting AA with MRI is 90-100% and specificity 94-98% [7].

However, according to some authors, there is concern about the adverse effects of acoustic noise on the fetus, but no specific adverse effects of MRI on fetal development have been reported to date [4]. Intravenously administered gadolinium agents penetrate the placenta and can damage the fetus, so their use during pregnancy should be limited and absolutely contraindicated [4, 7, 11]. MRI without the use of intravenous gadolinium can be performed at any stage of pregnancy (the quality of evidence is low; the strength of the recommendation is strong) [7]. A prerequisite for an MRI is to consult with a radiologist before performing the procedure. Contraindications for MRI are as follows: pregnant woman with pacemaker or any other electronic devices and contrast agents containing gadolinium.

Computed Tomography (CT)

Computed tomography (CT) also allows to diagnose AA; CT with contrast has a diagnostic accuracy of 91-95% and a specificity of 90%-95%. For abdominal pain in a pregnant woman, CT can be used for diagnosis [4]. A modern protocol of multidetective CT suggests low radiation doses and prudent use during pregnancy. Radiation effects on the fetus with pelvic CT can be 2 rad but can reach 5 rad when a full CT of the abdomen and pelvis is performed. This dose of radiation is considered safe but can affect teratogenesis and can increase the risk of developing malignant neoplasms of pediatric hematology [4, 7, 11]. CT protocols and doses vary by hospital, and physicians should be aware of the radiation exposure to the fetus and, if possible, minimize it. Contraindication for widespread use of CT in pregnant women is ionizing radiation, so the use of this method has limited especially in the first trimester [5, 9].

Diagnostic Laparoscopy

Diagnostic laparoscopy (DLP) is a method that is considered minimally invasive and safe, but its implementation is justified when clinical, laboratory, and instrumental methods are impossible, especially when it is impossible to exclude AA in the first and second trimester of pregnancy. DLP is a method of choice; its implementation is justified with long-term dynamic observation of pregnant women, when the development of severe infectious complications is fraught with the development of complications dangerous for the mother and fetus [18, 22]. The use of DLP for long gestation period is limited with insufficient information content of the method, difficulty of examining the abdominal cavity and technical difficulties; risk of damage to the uterus in pregnancy and the development of fetal hypoxia [4].

DLP of acute appendicitis shows acute appendicitis are hyperemia of the serous cover of the appendix with fibrin, infiltration of the mesenteric, and appendix tissues; pronounced injection of the vessels of the parietal peritoneum in the right iliac region and the lateral canal; and in complicated forms, the presence of a turbid purulent effusion in abdominal cavity, hyperemia of the parietal peritoneum along the right lateral canal, and infiltration of the wall of the dome of the cecum [2, 11]. The disadvantages of laparoscopy include the risk of damage to the pregnant uterus by the trocar or Veress needle.

Implication

Thus, despite a significant number of ways and methods, the diagnosis of appendicitis in pregnant women presents significant difficulties, especially with an increase in the duration of pregnancy. The timely combined diagnosis includes various ways and methods which can prevent the development of severe complications, preserve the pregnancy, and improve the result and outcome of pregnancy, childbirth, and the postpartum period for the mother and fetus.

False-positive diagnoses and subsequent surgeries put pregnant women at unnecessary risk. A large retrospective study demonstrated evidence of a fetal loss rate of 4% and early delivery rate of 10% for negative appendectomies. Given the risks associated with delayed diagnosis, the current practice when acute appendicitis is highly suspected is to perform an immediate appendectomy because any delay in surgery could lead to a ruptured appendix and increased fetal mortality [4]. However, in some cases, choice of antibiotic treatment can be helpful before surgical intervention in first, second, and third trimester also, antibiotics such as metronidazole 0.5 g intravenously 3 times per day and ceftriaxone 1 g once a day intravenously.

Conclusion

When a pregnant patient is admitted to the Emergency Department with symptoms indicative of appendicitis,

ultrasound is recommended as the first line of diagnosis. However, due to the difficulty in viewing the appendix in pregnancy using ultrasound, MRI is considered as the best tool for diagnosis, with least side effects also following with the clinical signs for diagnosis, with the laboratory findings. For better diagnosis of AA, one should be very particular with the health and condition of the mother and fetus, carefully assessment of the clinical symptoms should be performed, and then only recommendation for the further techniques of diagnosis and treatment should be done. It is important to quickly ascertain a correct diagnosis as delayed appendectomies can lead to ruptures and subsequently higher fetal mortality rates. Standard of care after acute appendicitis is diagnosed in a pregnant patient is surgical consultation for an emergency appendectomy, as efficacy and safety of nonoperative management with antibiotics of choice in pregnant patients' remain to be elucidated.

Compliance with Ethical Standards

Conflict of Interest The article is dedicated to the welfare for public health and awareness. The purpose of writing this article is to provide adequate and necessary knowledge to the readers, the whole data and text are taken from the various online sources and journals such as elibrary.ru, PubMed, etc. Our motive is to spread knowledge and awareness among the readership through our article with the consent of ethics committee. The article is not financially aided by anyone or any community.

Human and Animal Rights Any living being human or animal is not harmed in the process of writing this article.

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