



## Laparoscopic Appendectomy in the Third Trimester Pregnancy: Approach Challenge

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### Abstract

**Introduction:** Acute appendicitis is the most common non-obstetric surgical emergency during pregnancy. Symptoms of acute appendicitis during pregnancy are usually the same as for other patients, however, due the physiologic and anatomic changes throughout pregnancy, the diagnosis may be challenging. In the presence of a high clinical suspicion and no clear results on imaging exams, laparoscopic exploratory surgery can be an option.

**Case Report:** We present the case of a 35-year-old woman with 31 weeks of pregnancy, admitted in the emergency department with a history of right lower quadrant abdominal pain, leukocytosis and increased CRP. An US was made and suggested the diagnosis of appendicitis. Thus, a laparoscopic appendectomy, with left lateral decubitus, was performed. The surgery and postoperative period had no complications, both for the mother and the fetus.

**Conclusion:** Accurate and timely diagnosis and prompt treatment, decrease maternal and fetal morbidity and mortality. There is no place for conservative approach. More recent literature suggests that, with some precautions, and technical expertise/experience, laparoscopy can be performed without complications in all three trimesters, with the same benefits of minimally invasive surgery.

### Introduction

Acute appendicitis is the most common non-obstetric surgical emergency during pregnancy, with a variable incidence, and rates ranging from 1.8 to 41/10000 pregnancies [1-5] and between 1/635 to 1/500 pregnancies per year [2]. Still, the incidence of appendicitis in pregnancy appears identical to the non-pregnant population [2].

Acute appendicitis and symptomatic gallstone disease are the most common surgical emergencies during pregnancy, and occur in 0.04% to 0.2% of all pregnancies [7]. The first represents about 25% of non-obstetric surgical procedures performed during pregnancy [5-8]. Other causes of non-obstetric surgical procedures include ovarian torsion, splenic disorders, symptomatic hernias, complications of inflammatory bowel diseases, acute pancreatitis, intestinal obstruction and trauma [5].

Complicated acute appendicitis can occur in 1/700 to 1/1500 of all live birth pregnancies, at any time during pregnancy, usually in women aged younger than 30 years [4]. These cases can be as high as 43%, compared with 19% in the general population [9].

The mortality associated with acute appendicitis declined over the years and rarely occurs nowadays [3], however a delay in diagnosis increases the risk of complications and mortality in both mother and fetus [10]. According to literature, the most feared complications are fetal death, preterm birth and maternal death [1,6]. Fetal loss and infant mortality are usually associated with complicated disease, such as perforated appendicitis [3,6], with an incidence between 20% to 25%, compared with 1.5% to 7% in cases of uncomplicated appendicitis [1,3,11]. The preterm delivery rate has been reported to be between 7.5% and 30% and is more common in women with perforated appendicitis [1,3,10]. Maternal morbidity can be as high as 42% in complicated appendicitis, with mortality rates that can reach 4% in advanced cases of gestation and perforation of appendix, [3,11].

### Case Presentation

The authors present a case of a 35-year-old pregnant woman with 31 weeks of gestation who went to the emergency department due to an abdominal pain located in the right iliac fossa, associated with nausea and anorexia, starting 2 days prior, and without improvement with analgesics. The patient denied fever or other symptoms. At observation, we found pain and tenderness in the right

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Figure 1: Left lateral decubitus position.

lower abdominal quadrant.

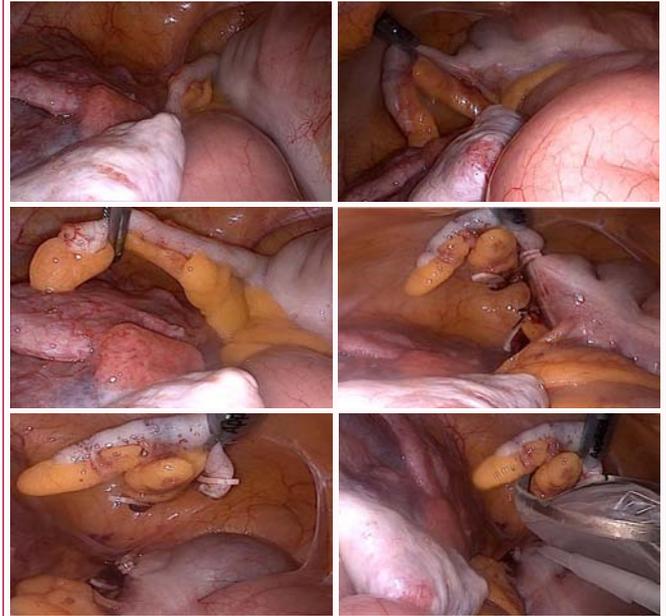
Blood tests revealed leukocytosis of 15.200/L and an elevation of C-Reactive Protein (CRP) of 2.05 mg/dL without other alterations. The Ultrasound (US) demonstrated an evolutive pregnancy in the third trimester, and a structure compatible with the ileocecal appendix with parietal prominence and increased caliber, evaluated at 8 mm to 9 mm, although not achieving adequate visualization of its terminal portion; a small amount of abdominal fluid in this topography, with hyperechogenicity of the fat. The diagnostic hypothesis of acute appendicitis was posed.

Both patient and fetus were evaluated by obstetrics, with US and cardiotocography, showing no alterations suggestive of obstetric or fetal complications. Decision was made for laparoscopic appendectomy. Prior to anesthetic induction, antibiotic therapy with amoxicillin and clavulanic acid was administered.

The patient was placed on the table in a left lateral decubitus position with her left and right arm placed on an armrest (Figure 1). The first 10 mm trocar was inserted 3 cm to 4 cm above the uterine fundus in the right midclavicular line with optical trocar technique. Two other ports (10 mm and 5 mm) were placed, one in the right iliac fossa (5 mm) and the other in the right upper quadrant (10 mm), after an inspection of the abdominal cavity and once the appendix was found (Figure 9). The procedure was performed under general anesthesia and maintained a continuous end-tidal CO<sub>2</sub> monitoring within the physiological range. The pneumoperitoneum was achieved by CO<sub>2</sub> insufflation (10 mmHg to 12 mmHg). We found this positioning very convenient for this case, because it allowed the uterus to drop forward, moving away from the area where the appendix was located. We found the appendix in its usual position, showing acute phlegmonous appendicitis.

The appendicular artery and stump were ligated with Hem-o-lok® and the specimen was placed in a retrieval bag® for removal through the 10 mm midline port. The abdominal fascia of the 10 mm ports was closed with absorbable thread and the skin was closed using staples (Figures 2-8).

According to the patient's obstetric history and the risk of preterm delivery, indomethacin was administered rectally.



Figures 2-8: Laparoscopic appendectomy procedure.

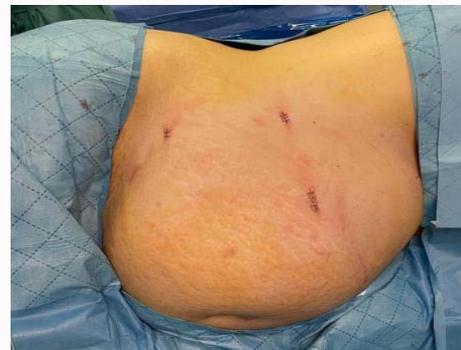


Figure 9: Incisions for trocar placement.

The patient was reevaluated after surgery by the obstetrics team and no complications after the procedure were verified to the patient nor the fetus. The postoperative period was uneventful, and she was discharged on the 2<sup>nd</sup> postoperative day. The patient completed the 5 days course of antibiotics.

## Discussion

Acute appendicitis can occur at any time during pregnancy [5]; however, some studies indicate that the incidence is higher in the second trimester (1 in 1000 pregnancies) [1,3,5,6,12].

A delay in the diagnosis and treatment increases the risk of an appendix perforation, which is associated with an increased maternal and fetal morbidity [5,11,12]. Literature reveals a statistically significant relationship between the duration of symptoms prior to surgery and the intraoperative findings, revealing three times increase

of appendiceal perforations when symptom duration was equal or greater than 48 h [5]. So, a prompt diagnosis of acute appendicitis during pregnancy is recommended and management with the suitable surgical intervention should not be delayed for over 24 h [12]. Non-operative management with antibiotics alone is associated with higher incidence of complications when compared to appendectomy.

Although the symptoms of acute appendicitis in pregnant women are generally very similar to non-pregnant patients (pain in the right lower quadrant pain, nausea, vomiting, anorexia, rebound tenderness and fever), the diagnosis can be more challenging in these group of patients [1,3,11,12]. This may be particularly difficult, considering obstetric and non-obstetric diagnoses that may cause an acute abdomen in pregnancy [2,5]. The pregnancy state may also be associated with physiologic leukocytosis, and there is a major reluctance in the use of Computer Tomography (CT) [1,5,12], which can also make the diagnosis harder. That is more noticeable in the third trimester of pregnancy because the abdominal pain can be milder or atypically localized (more lateral and higher in the upper right side of the abdomen) as the corpulence of the uterus causes displacement and lateral rotation of the appendix [3,12].

The accuracy of imaging exams in the diagnosis of appendicitis during pregnancy is low [10]. An abdominal Ultrasound (US) can be done, though this exam is often inconclusive and CT scanning, which is the preferred exam, can't be done due to the radiation exposure in pregnancy [10,12]. Magnetic Resonance Imaging (MRI) has a high sensitivity for appendicitis (97% to 100%) and should be an option when the US is inconclusive. However, this imaging technique has a high cost, limited availability, and a high learning curve.

Due to the difficulty in the diagnosis combined with the lower threshold in opting for a surgical intervention, the number of negative appendicitis detected in the Operating Room (OR) is higher in this population. Approximately 23% to 30% of appendectomies performed during pregnancy show normal appendices in comparison with 18% in non-pregnant patients [2,5,11,13]. A diagnostic laparoscopy followed by a laparoscopic appendectomy in cases of inflammation seems a logical strategy to reduce unnecessary appendectomies [10]. Nevertheless, the appendix can appear normal in a macroscopic view and pathologically altered in a microscopic view. Thus, when no other causes are found during laparoscopy, an appendectomy is usually performed [13].

A negative appendectomy is not an entirely risk-free intervention in a pregnant woman, and the chances of misdiagnosis and preterm delivery need to be carefully balanced against the risks of perforation from a delayed diagnosis [2,11]. So, therefore, it is easily understandable that the decision to perform the surgery is often difficult to make in a pregnant woman, given its impact on the pregnancy outcome and the conditions of the surgery itself [5,7].

Laparoscopic Appendectomy (LA) was first performed in 1983 and has emerged as the gold standard of the surgical approaches, with several advantages such as: Less pain and less fetal depression caused by pain medication, less maternal hypoventilation, less risk of postoperative maternal hypertension, thromboembolic risk reduction because of early mobilization, earlier discharge from hospital and return to daily activities and fewer wound infections [1-3,5,7,10,14]. Notwithstanding, the laparoscopic approach seems to be related to a slight increase in the risk of fetal loss at the time of delivery [1,3].

The effects of pneumoperitoneum are a major consideration

in regards to laparoscopic surgery during pregnancy [1,6]. The underlying pathophysiology is the increase in intra-abdominal pressure to induce pneumoperitoneum that reduces venous return and consequently cardiac output, thus resulting in maternal hypotension and hypoxia [1,6]. As a result, fetal acidosis will occur and may increase with the use of carbon dioxide in pneumoperitoneum [1,6]. Nonetheless, some studies show that in a pregnant animal model, the fetus was not adversely affected when the pneumoperitoneal pressure was elevated to 10 mmHg to 12 mmHg for less than 30 min [1,2,6]. The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) guidelines recommend insufflation pressures of 10 mmHg to 15 mmHg for pregnant women [1].

In fact, literature shows that the use of laparoscopy during pregnancy is not only a relatively safe choice but also an effective therapeutic option for an appendectomy, with no deleterious effects to either mother or child [3,5,14-19].

A systematic review compared these two approaches and no significant differences were observed between these groups with regard to preterm delivery, birth weight, Apgar scores, operative time or intra-abdominal abscess formation after surgery [1]. Some authors believe that a laparoscopic approach has more effective access and visualization of the appendix, thus reducing surgical complications [1]. In another study, the incidence of preterm delivery in pregnancies above 37 completed weeks, was significantly higher in the open appendectomy group (8%) vs. the laparoscopic group (2%). However, a number of factors may limit the impact of this result [2]. The literature revealed that laparoscopy would be a useful tool, providing the benefits of minimally invasive surgery in all cases, inclusive in pregnant women [5,18].

Nonetheless, complications can occur, and these can affect both the mother and/or the fetus [5]. In literature, there are also some limitations of the use of laparoscopic appendectomy such as diffuse peritonitis, advanced pregnancy with markedly enlarged uterus, or lack of experience of the surgeon or operating team [8]. Thus, the surgeon's experience is an important determinant of a successful maternal-fetal outcome [14].

Many studies in recent years have demonstrated that surgery is common in the second trimester, but few studies with a large number of patients have applied laparoscopic techniques in the third trimester [3]. This is probably due to the fact that the enlarged uterus and a large fetus in the third trimester are two factors to be considered during the choice to perform a laparoscopic surgery in pregnant women [3]. The fundus of the uterus will be at the level of the pelvis bone at 12 weeks, at the umbilical level at 20 weeks and in the third trimester it is very large, so the space in the abdomen is limited [3]. Therefore, it is understandable that the laparoscopy approach during the last months of pregnancy may be associated with increased risks in organ lesion due to the enlarged uterus with a high conversion rate and a prolonged operative and pneumoperitoneum time [2,3,5].

Some authors suggested the 28<sup>th</sup> week of gestation as the maximum cut-off limit for laparoscopy when performing an appendectomy. However, a gestational age limit has not been officially established [5,10]. In late pregnancies, identifying the appendix during open surgery may be troublesome, as the appendix is pushed upwards or laterally by the uterus and the manipulation and traction of the uterus necessary to find the appendix increases the risk of a premature delivery [10]. Direct incision at the McBurney's

point could cause a lot of problems in the third trimester and it can be too low to reach the appendix [10]. On the other hand, in laparoscopy surgery, the appendix is easily localized and additional incisions may be planned accordingly, reducing the risk of uterine irritability due to manipulation and traction. Another benefit of the laparoscopic appendectomy is, in case of a normal appendix, it's easier to search the abdominal cavity for other causes for the symptoms [10].

No conclusive evidence exists on the optimal treatment strategy for appendicitis in the third trimester, partly due to the technical difficulties and the risks of maternal and fetal complications [20]. For these reasons, it's important for this technique to be performed by experienced surgeons with high skills in the laparoscopic technique to minimize the anesthetic and surgical times and thus reduce its risks [3]. More recent studies have already started to show its feasibility and safety in all trimesters of pregnancy [1-3,5,7,19-21].

The question is: What is the best approach in laparoscopic appendectomy in the third trimester?

### Position

Most laparoscopic appendectomies are performed in a supine position, even in pregnant women. However, there are some disadvantages in this positioning [3]. The gravid uterus places pressure on the inferior vena cava, resulting in venous compression which may cause a decrease in venous return and cardiac output [3,21]. Also, the vision is limited, and the camera scope touches the uterus and can cause complications with the fetus and a preterm labor [3]. Siding to the left (70° or 90°), the uterus falls downwards, widening the surgical field, increasing cardiac output by 20%, and venous drainage from the lower limbs, reducing the risk of deep vein thrombosis [3]. It also reduces the compression of the vena cava and aorta, and reducing pneumoperitoneal pressures and thus increasing the blood supply to the uterus. That avoids hypoxia of the fetus and the risk of premature labor [3,10].

The SAGES recommend that all gravid patients beyond the first trimester should be placed in the left lateral or partial left lateral decubitus position to minimize compression of the vena cava [21].

### Incisions

There is no consensus regarding the best technique to access the abdominal cavity in laparoscopic appendectomy, with complications described with all entry techniques [5].

In the last months of pregnancy, there is a higher risk of damaging the uterus and blood vessels of the uterine wall and the fetus by trocar puncture, with a significant bleeding risk to both mother and fetus [3]. Some authors and current SAGES guidelines recommend the use of the Veress needle, the Hasson's technique or the optical trocar technique, placing the trocar near the right rib in order to avoid hitting the uterus [2,3,10,21]. These techniques can be used with safety and effectiveness, as long as the initial access site to the abdomen is made taking into account the height of the uterine fundus and the abdominal wall is pulled upwards during entry [5,21]. Literature describes a rate of entry complications of 0% in the Hasson's open entry and 2.8% with the Veress needle [2,10].

In the third trimester, the typical approach is different from the standard laparoscopic appendectomy, in terms of incisions [17]. Preoperative imaging is important to decide the location of laparoscopic incisions [17]. The first 10 mm trocar is the most challenging to place and should be inserted supra-umbilically into

the midline between the umbilicus and sternum (depending on the location of the uterus). Its introduction should be adjusted to the fundus height and placed cranially 3 cm to 4 cm above the highest level of the fundus uteri, to avoid touching it [2,3,10]. The placement of the next two trocars is relatively easy and flexible depending on the size of the uterus [3]. In summary, port site locations should be adapted to the gestational time [2].

### Pneumoperitoneum

Many studies and SAGES guidelines recommend a pneumoperitoneum pressure between 10 mmHg to 15 mmHg in pregnant women to prevent fetal morbidity [2,3,10,21]. In fact, the left position and with good muscle relaxation, maintaining the intra-abdominal pressure at 8 mmHg to 10 mmHg is sufficient for this approach [3].

Pneumoperitoneum lowers the cardiac output and increases systemic and pulmonary vascular resistance, leading to a rise in blood pressure. In the presence of maternal and fetal hypoxia, acidosis may develop, which in turn can be corrected by hyperventilation [2,21]. Therefore, a capnogram is important to measure the end-tidal CO<sub>2</sub>, monitoring the mother directly and the fetus indirectly, and thus preventing the fetal acidosis which can be high from CO<sub>2</sub> absorption [2,21].

### Operative time

In some studies, laparoscopic appendectomy is associated with a mean operating time of 51 min, with a median of 46 min. This is better than the previous reports which describe times reaching 60 min in the non-pregnant population [2]. The surgeon's expertise may contribute to reduce surgical time [2].

### Perioperative management

Perioperative management is fundamental and starting wide-spectrum antibiotics covering gram-positive, gram-negative and anaerobic bacteria is of the most importance [12]. Antibiotic therapy alone may be effective in some patients with uncomplicated appendicitis but it's not an option in pregnant women [6,12].

A perioperative obstetric consultation and fetal monitoring is recommended, with fetal heart monitoring pre and postoperatively [2,11,21]. The intraoperative fetal heart rate monitoring is to be the most accurate method to detect fetal distress during laparoscopy [21].

Tocolytics should not be used prophylactically in pregnant women undergoing surgery, but should be considered perioperatively when signs of preterm labor are present [2,11,12,21]. In literature, there is no significant difference in the rate of preterm delivery among women receiving prophylactic tocolytics (0%) and those who didn't receive tocolysis (3.8%) (p=0.59) [2].

Pregnancy is a known hypercoagulable state with a 0.1% to 0.2% incidence of deep venous thrombosis [21]. In addition, the pneumoperitoneum with CO<sub>2</sub> may increase the risk of this event by predisposing to venous stasis [21]. Prophylaxis for deep venous thrombosis in the pregnant women can be done in intra and postoperatively with pneumatic compression devices and promoting an early postoperative ambulation [2,11,21]. In contrast, there is no data regarding the use of prophylactic unfractionated or low molecular weight heparin for in these patients [11,21].

Cesarean section should not be performed during the third trimester in women with a perforated appendix and diffuse peritonitis

since the intraperitoneal spread of infectious material to the uterus is a high risk for uterine incisional dehiscence [12].

## Conclusion

The diagnosis of acute appendicitis remains challenging in pregnant women and urgent surgical treatment in these patients is extremely important to reduce the incidence of maternal and/or fetal complications [5,8].

The laparoscopic approach is safe and effective in all trimesters of pregnancy, with low risk of postoperative complications [1,5,7,15,]. Laparoscopic appendectomy during the third trimester could be associated with problems such as a high conversion rate or a prolonged operative and pneumoperitoneum time, thus, the left tilt patient position or a total left lateral decubitus is a good and feasible technique to optimize the outcomes of surgery [3,20]. Other aspects were optimized to reduce complications in these patients' creating guidelines for the introduction of trocars, pneumoperitoneal pressure, anesthesiological measures and position of the pregnant patient [10].

In sum, the key to success lies in an early diagnosis and treatment, and skilled surgeons and anesthetists [3,20]. More randomized, large-scale and well-designed trials on pregnant women are needed to clarify the present findings [1].

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