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Acute appendicitis in pregnancy — do we treat correctly, or do we delay unnecessarily?

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ABSTRACT

Objectives: Acute appendicitis is the most common non-gynaecological indication for surgical intervention during pregnancy. The aim of this study was to compare perioperative and postoperative results of surgical treatment of acute appendicitis in the early and late stage of pregnancy.

Material and methods: This is a retrospective study focused on the evaluation of perioperative and postoperative results of appendectomy in pregnancy. The study included all pregnant patients who underwent laparoscopic or open appendectomy at the University Hospital Ostrava during the observed 10-year period (January 2012–December 2021). The patients were divided into two subgroups according to the stage of pregnancy in relation to the expected viability of the foetus (the viability limit was defined as the 23rd week of pregnancy).

Results: In the monitored 10-year period, a total of 25 pregnant patients underwent appendectomy. Comparing the two subgroups of patients, there were no statistically significant differences in any of the admission parameters. Laparoscopy was performed in 100% of the patients in the lower stage of pregnancy (< 23 g.w.) and in 61% of the subgroup of patients with more advanced pregnancy (> 23 g.w.); this difference was statistically significant (p = 0.039). Differences in subgroups regarding duration of surgery, risk of revision and 30-day postoperative morbidity were not statistically significant. In the subgroup of patients < 23 g.w., uncomplicated forms of appendicitis predominated (66%), whereas in the subgroup > 23 g.w., complicated forms predominated (69%); this difference was statistically significant (p = 0.026). When comparing the two subgroups of patients, there was a statistically significant difference in the length of hospitalization (p = 0.006). The mortality rate of the group was zero.

Conclusions: The results of the study confirm the fact that advanced pregnancy may be related to complicated forms of appendicitis. Therefore, early appendectomy is still the method of choice. In accordance with the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) recommendations, laparoscopic approach is preferred in pregnant patients, even in advanced pregnancy.

Keywords: acute appendicitis; appendectomy; laparoscopy; morbidity; mortality pregnancy

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INTRODUCTION

Acute appendicitis is the most common non-gynaecological indication for surgical intervention in pregnancy [1–4]. Up to 25% of non-gynaecologic surgeries in pregnancy are indicated specifically for acute appendicitis [5]. Less frequently, surgery in pregnancy is indicated for acute cholecystitis, ileus, symptomatic hernias or complications of non-specific intestinal inflammations [6]. The incidence of acute appendicitis in pregnant patients is given in the literature between 0.05–0.2% [1, 4, 7, 8]. It most commonly affects pregnant women between 20 and 30 years of age [4], and the highest incidence is in the second trimester of

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pregnancy, when it occurs in up to 76.2% according to some studies [1, 2, 4–6, 9].

Diagnosis is complicated by a very diverse and non-specific clinical presentation, change in appendix position, physiological leukocytosis and not least the limitations of imaging methods. Together with physiological changes in immunity with relative immunosuppression, late-diagnosed, complicated forms of acute appendicitis are associated with foetal loss in up to 36% of cases [4, 10]. On the contrary, the risk of foetal loss in uncomplicated forms is 1.5–5% [4, 6]. The prevalence of complicated, perforated appendicitis increases from 19% in the general population to 43–55% in pregnant women [7, 11, 12]. Perforated appendicitis is most commonly seen in the third trimester of pregnancy [5]. Thus, emphasis is placed on early diagnosis, as appendectomy performed within 24 hours of symptom onset isn't associated with higher rates of complicated forms [4, 13].

The aim of this study was to compare the perioperative and postoperative results of surgical treatment of acute appendicitis in early and later stages of pregnancy by analysing our group of patients.

METERIAL AND METHODS

A retrospective clinical study was performed to evaluate perioperative and postoperative results of appendectomy in pregnancy. The study included all pregnant patients who underwent laparoscopic or open appendectomy at the University Hospital Ostrava during the monitored 10-year period (January 2012–December 2021). Demographic and clinical data of the patients were obtained from the medical records available in the hospital information system.

All patients were examined by a gynaecologist and a surgeon and subsequently hospitalized at the surgical or gynaecological-obstetric clinic of the Ostrava University Hospital. Based on clinical and standard laboratory examination [leukocyte count and C reactive protein (CRP)], the diagnosis was supplemented by USG examination.

When the diagnosis of acute appendicitis was suspected or confirmed, the patients were indicated for surgery. Again, based on multidisciplinary consensus (surgeon, gynaecologist, anaesthesiologist), laparoscopic or open approach was chosen for the surgery under general anaesthesia. The pregnant patient's preference was also accepted in the decision-making process. In the case of the laparoscopic approach, the operation was performed at a capnoperitoneum of 12 mm Hg and trocars for both the optics and the working instruments were positioned according to the height of the uterine fundus. Appendectomy was performed using endoloops followed by plunging of the appendix stump with purse string suture, clips (Hem-o-lok) or stapler. In the case of open surgery, the abdominal cavity was accessed through an McBurney's incision, also known as grid iron incision or para-rectal incision and after standard appendectomy, the stump was plunged with purse and Z string suture. In both methods, drainage of the abdominal cavity was decided individually.

After the surgery, the patients were admitted to the intensive care unit of the gynaecological-obstetric clinic or to the standard ward via the recovery room, depending on their clinical condition and peri-operative findings.

Basic demographic (age and American Society of Anesthesiologists [ASA] classification) and clinical data were observed and subsequently evaluated. Patients were divided into 2 subgroups according to the stage of pregnancy in relation to predicted foetal viability [14]. Viability is defined as the ability of the human foetus to survive outside the uterus. In the perinatology centre of the Ostrava University Hospital, the 23rd week is generally accepted as the limit of foetal viability within the so-called grey zone between 22 weeks + 0 days and 25 weeks + 0 days.

The first subgroup included patients up to 23 weeks of pregnancy, the second subgroup included patients from 23 weeks of pregnancy onwards. Para-clinical parameters evaluated in both groups were absolute leukocyte count, CRP value and USG finding. Furthermore, the time interval between the onset of symptoms and surgery, the duration of surgery, and the proportion of negative appendectomies were evaluated. Perioperative finding was divided into three subgroups, negative finding on appendix, uncomplicated acute appendicitis and complicated acute appendicitis (presence of abscess, circumscribed or diffuse peritonitis). From other parameters, the length of hospital stays and postoperative complications according to the Clavien-Dindo classification were monitored [15].

The obtained data were evaluated by descriptive statistics methods. Median, minimum and maximum were used to describe the numerical variables. Absolute frequency supplemented by relative frequency (%) was used to describe categorical variables. For comparison of the analysed groups, the Mann-Whitney test or Fisher's exact test was used. All analyses were performed using R software (version 4.2.1) with a significance level of 0.05.

RESULTS

A total of 25 pregnant patients underwent appendectomy at the Department of Surgery and Gynaecology and Obstetrics, Ostrava University Hospital in the ten-year period under study.

Preoperative characteristics of the evaluated group of patients are presented in Table 1.

Table 1. Demographic and clinical data of patients in the study

	Median (Min–Max) or n (%)[a]			
	Overall (n = 25)	**g.w. < 23 (n = 12)**	**g.w. > 23 (n = 13)**	**p[b]**
Age [years]	28 (19–41)	26 (25-37)	29 (19-41)	0.311
Symptoms duration				> 0.999
< 24 h	15 (60)	7 (58)	8 (61.)	
24 h–48 h	9 (36)	5 (42)	4 (31)	
> 48 h	1 (4)	–	1 (8)	
Leukocyte count [109/L]	14.0 (8.0–34.0)	12.7 (9.1–21.8)	15.5 (8.0–34.0)	0.149
CRP [mg/L]	25.0 (3.7–259.0)	20.8 (4.0–259.0)	76.0 (3.7–219.1)	0.650
Ultrasonography[c]				
Sensitivity [%]	65.0 (40.8–84.6)	62.5 (24.5–91.5)	66.7 (34.9–90.1)	> 0.999
Specificity [%]	50.0 (1.3–98.7)	0.0 (–)	100.0 (–)	–
ASA				0.593
I–II	22 (88.0%)	10 (83.3%)	12 (92.3%)	
III	3 (12.0%)	2 (16.7%)	1 (7.7%)	
IV–V	–	–	–	

[a]Median, minimum and maximum, or absolute and relative frequency (%); [b]p value Mann-Whitney test, or Fisher exact test; [c]Sonography was not performed in three patients (all from the g.w. < 23 group). These patients were not included in this partial analysis. A 95% confidence interval is given for sensitivity and specificity; g.w. — gestational week; CRP — C Reactive Protein; ASA — American Society of Anesthesiologists Classification

When comparing the two subgroups of patients, there were no statistically significant differences in age (p = 0.311), allocation to ASA classification (p = 0.593), or duration of complaints (p > 999). There were also no statistically significant differences in the input CRP values (p = 0.650), leukocyte count (p = 0.149) or sonographic findings (p > 0.999) between the two subgroups. The majority of patients, 22/25 (88%) were assigned to the group ASA I. The duration of symptoms was less than 24 hours in 15/25 patients (60%) of patients, and only one patient (4%) had a duration of more than 48 hours. The leukocyte count was 14.0 × 109/L (8.0–34.0) and the CRP value was 25.0 mg/L (3.7–259.0). The sensitivity of sonographic examination was 65%, the specificity was 50%.

20/25 (80%) of pregnant patients underwent laparoscopic appendectomy, 5/25 patients (20%) underwent open appendectomy. In 1/25 patient (4%), the laparoscopic procedure had to be converted. This patient was principally included in the laparoscopic subgroup (intention to treat). While laparoscopy was performed in 100% of patients in the lower stage of pregnancy (g.w. < 23), it was performed in 8/13 patients (61%) of the subgroup of patients with more advanced pregnancy (g.w. > 23). This difference was statistically (p = 0.039). The operation duration did not differ significantly between subgroups (p = 0.091). Surgical revision was indicated in only one patient in the subgroup with pregnancy longer than 23 weeks.

Histopathological finding was negative for inflammation in 3/25 of patients (12%) (one of these patients was diagnosed with carcinoid). The uncomplicated form of acute appendicitis was diagnosed in 11/25 patients (44%) and one of the complicated forms of appendicitis in the same percentage 44%. When comparing both defined subgroups, statistically significant differences (p = 0.026) were found in the representation of the different forms of appendicitis (Tab. 2). While in the subgroup of patients up to 23 weeks of pregnancy, uncomplicated forms of appendicitis predominated in 8/12 patients (66%), in the subgroup of patients from 23 weeks onwards, even with early diagnosis, complicated forms of appendicitis predominated in 9/13 patients (69%).

The median length of hospital stay was 5 days. When comparing both subgroups of patients, there was a statistically significant difference in the length of hospital stay, with a longer hospital stay in the group of patients with more advanced stage of pregnancy (g.w. > 23) (p = 0.006). Postoperative complications occurred in 4 patients (16%), of which one was assessed as mild and three as severe (Tab. 2). Comparing the two subgroups, there was no statistically significant difference in 30-day postoperative morbidity (p = 0.096), although complications occurred only in the subgroup of patients pregnant for more than 23 weeks. The mortality rate of the group was zero.

Table 2. Perioperative and postoperative results of patients in the study

	Median (Min–Max) or n (%)[a]			
	Overall (n = 25)	**g.w. < 23 (n = 12)**	**g.w. >23 (n = 13)**	**p[b]**
Operation duration [min]	41 (20–85)	38 (20–60)	49 (31–85)	0.091
Length of hospital stay [days]	5 (2–20)	3 (2–7)	5 (4–20)	0.006
Type of surgery				0.039
Laparoscopy	20 (80)	12 (100)	8 (61)	
Laparotomy	5 (20)	–	5 (39)	
Conversion				> 0.999
Yes	1 (4)	–	1 (8)	
No	24 (96)	12 (100)	12 (92)	
Intraoperative finding				0.026
Appendix simplex	3 (12)	2 (17)	1 (8)	
Non–complicated appendicitis	11 (44)	8 (66)	3 (23)	
Complicated appendicitis	11 (44)	2 (17)	9 (69)	
The need for operational revision				> 0.999
Yes	1 (4)	–	1 (8)	
No	24 (96)	12 (100)	12 (92)	
Classification Clavien–Dindo				0.152
0	21 (84)	12 (100)	9 (69)	
1–2	1 (4)	–	1 (8)	
3–4	3 (12)	–	3 (23)	
5 (postoperative mortality)	–	–	–	
30-day postoperative morbidity	4 (16)	–	4 (31)	0.096

[a]Median, minimum and maximum, or absolute and relative frequency (%); [b]p value of Mann–Whitney test, or Fisher exact test; g.w. — gestational week

DISCUSSION

Acute appendicitis is the most common non-gynaecological and non-obstetric pathology during pregnancy that requires urgent surgical intervention. The main problem is the wide differential diagnosis, which leads to a correct diagnosis in 85% in the first trimester but only 30% in the third trimester [16]. Non-specific symptoms such as nausea, vomiting, pain in the lower abdomen, over the symphysis, pulling pains in the right lower abdomen and groin or tenesmus are usually present. Anatomical changes with change in the position of the appendix and its greater distance from the abdominal wall with increasing stage of pregnancy alter the clinical picture and decrease the sensitivity of clinical examination. Pain may also be related to the right upper quadrant or to the back. Only 53% of patients have symptoms typical of acute appendicitis, *i.e.* periumbilical pains with subsequent shift to the right lower abdomen [11]. Therefore, a careful clinical examination is emphasized, and it's important to know all the physiological and anatomical changes accompanying each trimester.

Another non-specific finding is a physiological leukocytosis, which occurs in up to 81% of pregnant women [4]. However, even a normal leukocyte value doesn't exclude acute appendicitis. The neutrophil count or neutrophil-to-lymphocyte ratio is of greater diagnostic value, especially if there's a leftward shift in the white blood cell counts with a neutrophil count > 70% [4].

In pregnant women with suspected acute appendicitis, ultrasound is the first choice of imaging modalities with a literature reported sensitivity of 67–100% and specificity of 83–96% [4, 9, 10, 16]. However, a negative sonographic finding doesn't rule out acute appendicitis if the finding at clinical examination is highly suspicious of this diagnosis [8].

In case of borderline finding on sonography, some authors recommend performing magnetic resonance imaging (MRI) with a sensitivity of 91.8% and specificity of 97.9% [3, 4, 9, 11, 16, 17]. Magnetic resonance imaging without the use of intravenous contrast medium is considered the gold standard for confirming or excluding the diagnosis of acute appendicitis in pregnant women with unclear sonographic

finding [7]. According to some studies, the use of MRI can lead to a reduction of negative appendectomies by up to 50% [1, 18, 19]. For completeness, laparoscopy can also be used to make the diagnosis, with the caveat that the risk of late diagnosis must always be considered against the potential complications of negative laparoscopy. Except in urgent trauma situations, Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) doesn't recommend CT scanning in pregnancy [9, 17].

Based on published studies as well as the analysis of our data, it can be concluded that the accuracy of diagnosis decreases and the risk of complicated forms of appendicitis increases with the stage of pregnancy [1]. In the case of perforated appendicitis, increased intra-abdominal pressure, increased abdominal volume and the inability to confine the infection with omentum lead to an easier development of generalized peritonitis [1]. Therefore, the aim is to make an accurate and timely diagnosis in order, on the one hand, to minimize the number of perforated appendicitis and, on the other hand, to minimize the number of negative appendectomies, of which 23–37% have been described compared to the general population, where they are represented in 14–18% [1, 11, 16, 18]. The number of perforations rises to 66% if the symptomatology lasts more than 24 hours [3]. A multidisciplinary approach with careful foetal monitoring is preferred in the diagnostic process.

Works have also been published that discuss non-operative treatment with antibiotic therapy [3, 7, 19, 20]. The main risk of this treatment is failure, where primary uncomplicated appendicitis may progress to a complicated form with local or diffuse peritonitis, sepsis and the need for much more aggressive subsequent surgical treatment. Other risks include the possibility of recurrent appendicitis, the development of antibiotic resistance and undiagnosed appendiceal neoplasm [19]. However, due to the higher risk of perforation and its associated morbidity, risk of preterm labour and foetal loss, early appendectomy still remains the gold standard and first method of choice.

Based on the studies performed, it can be concluded that laparoscopic appendectomy is currently the method of choice [1–3, 6]. Although the main limitation of most studies, including ours, is the number of patients, it has been found that the laparoscopic approach is safe and can be indicated in all trimesters of pregnancy [21], thus benefiting from all the well-known advantages of laparoscopy. The SAGES recommendation for laparoscopic appendectomy during pregnancy in 2011 was "laparoscopic appendectomy can be performed safely in pregnant women with appendicitis" [1]. In 2017, it was changed to "laparoscopic appendectomy is the method of choice in pregnant women with acute appendicitis" [1]. Laparoscopic surgery can be safely performed in all trimesters of pregnancy. In our group of patients, the laparoscopic approach was preferred in accordance with the SAGES recommendation, and all patients in the subgroup with pregnancy duration up to 23 weeks were operated on laparoscopically. In the subgroup of patients with a pregnancy longer than 23 weeks, laparoscopic appendectomy was performed in 8/13 patients (61%).

In terms of technical performance, SAGES recommend maintaining insufflation pressure between 10- and 15-mm Hg. The patient's position on the operating table in the 2nd and 3rd trimesters should be on the left side to avoid compression of the inferior vena cava by the enlarged uterus. The first entry can be done by open technique, optical trocar and Veress needle. Both 5 mm and 10 mm optics can be used, and oblique is preferred to straights. The working ports are positioned under the control of the optic according to the level of the uterine fundus, which is verified by palpation or sonography in obese patients. If the first trocar enters at Palmer's point, insertion of a nasogastric probe is recommended to decompress the stomach [13]. The general rule is that the working instruments used shouldn't pass through the pregnant uterus. Its injury may lead to later rupture, infection, preterm labour or placental laceration [13]. Due to the increased risk of infectious complications in pregnancy, emphasis is placed on gentle manipulation in the abdominal cavity, careful remediation of the infectious focus, careful protection of the surgical wounds and removal of the specimen in the endobag. Appendectomy can be performed using either a harmonic scalpel or monopolar or bipolar coagulation. Drainage of the abdominal cavity isn't universally indicated. Because of the 1–2% risk of herniation in incisions over 10 mm, fascia closure is recommended for these incisions [13].

In the postoperative course, effective analgesia, hydration, prevention of postoperative nausea and vomiting, and prophylaxis of deep vein thrombosis are essential [9, 11]. Antibiotics are indicated individually. Routine tocolysis isn't recommended; systematic reviews haven't shown a difference in the rate of preterm labour between women who received prophylactic tocolysis and those who didn't [13, 19].

It's important to remember that pregnancy isn't a reason to delay urgent surgical treatment. Early surgery for uncomplicated appendicitis means shorter operative time, shorter hospital stays, fewer early complications, lower reoperation rates, lower risk of thromboembolic complications, and overall lower morbidity [2, 18, 22, 23]. In our group, complicated forms of acute appendicitis were also associated with statistically significantly longer hospital stay. The choice of approach (laparoscopic/open) should be a decision not only of the multidisciplinary team (surgeon, gynaecologist, obstetrician, anaesthesiologist, neonatologist) but also of the pregnant patient.

CONCLUSIONS

In conclusion, the results of this study support the fact that advanced pregnancy may be associated with complicated forms of appendicitis. Therefore, early appendectomy is still the method of choice. In accordance with the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) recommendation, laparoscopic approach is preferred in pregnant patients even in advanced pregnancy.

Article information and declarations

Data availability statement

Data available on request from the study author.

Ethics statement

All procedures in this study were performed in accordance with protocols approved by the local ethics committee.

Author contributions

LT and PG concept, assumptions, study design and article draft. LM and DT revised article critically. AV analysis and interpretation of data, OŠ and RŠ interpretation of data. LT corresponding author. All authors discussed the results and commented on the manuscript.

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Conflict of interest

The authors declare that they have no competing interests.

Supplementary material

None.

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