Outcomes and feasibility of laparoscopic appendectomy for complicated appendicitis in pregnancy

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Background
Acute appendicitis (AA) is considered the most frequent nonobstetric, nongynecologic surgical disease during pregnancy. Laparoscopic appendectomy (LA) is safe and feasible for complicated appendicitis in adults, whereas the role of laparoscopy in complicated AA during pregnancy is not identified.

Aim
This study aimed to assess perioperative surgical and obstetrical outcomes of LA in pregnant women with complicated AA.

Patients and methods
This retrospective cohort study enrolled 19 pregnant women who underwent LA for AA during any trimester of pregnancy and were found to have complicated appendicitis that was defined intraoperatively as perforation of the appendix, gangrene, empyema, phlegmon, or abscess formation. A laparoscopic three-port technique was used. All patients were followed up at the outpatient clinic on postoperative days 7 and 14. Operative and postoperative surgical and obstetric outcomes were recorded.

Results
The mean age of the studied patients was 35.9 ± 6.6 years, and the mean gestational age was 20.9 ± 5.2 weeks. The mean operative time was 63.6 ± 8.0 min, and conversion to open surgery was not needed in any case. Postoperative surgical complications were infected supraumbilical wound and intra-abdominal subhepatic localized abscess formation (5.3% each). Obstetric complications involved abortion in only one (5.3%) patient that occurred 5 days after the operation. The mean length of hospital stay was 2.3 ± 0.9 days.

Conclusion
LA for complicated appendicitis in pregnant women was safe for the mother and the fetus regardless of the gestational age. The procedure was associated with a low risk of operative and postoperative surgical complications, which were managed conservatively. Further, the incidence of fetal loss was also low.

Keywords:
complicated appendicitis, fetal loss, laparoscopic appendectomy, outcomes, pregnancy, wound infection

Introduction

Acute appendicitis (AA) is considered the most frequent nonobstetric nongynecologic surgical disease during pregnancy, with the incidence rate fluctuating from 1.8 to 41 per 10 000 pregnancies [1,2].

The diagnosis of AA in pregnant women is difficult, especially during the early stages of the disease, as the pregnancy-related symptoms and the enlarging gravid uterus can confound the clinical presentation during pregnancy [3]. Furthermore, physiologic leukocytosis seen during pregnancy may make leukocytic count a less sensitive laboratory investigation [4]. Thorough history taking and physical examination with serial evaluations in some cases remain the cornerstone in the diagnosis of these cases [5]. Abdominal ultrasonography is the most regularly utilized imaging technique in the diagnosis of AA; however, it is limited by low sensitivity due to the anatomic changes that occur during pregnancy [6]. MRI is the recommended imaging modality for suspected cases during pregnancy; however, it is not available in all centers [7].

Appendectomy is the standard treatment for complicated AA, especially for pregnant patients [8]. A recent study reported better outcomes of immediate operation for complicated appendicitis in pregnant women than nonoperative management [9].

Recent evidence has indicated that laparoscopic appendectomy (LA) is a safe surgical alternative to open surgery in pregnant women [10]. However, there is no strong evidence recommending a certain modality of appendicectomy, whether open or laparoscopic, during pregnancy. The current evidence regarding fetal and maternal safety remains inconclusive [11,12].

Delayed diagnosis and surgical intervention for more than 24 h after onset of symptoms predispose to complications including gangrene, perforation, abscess formation, and peritonitis, with increased risk of fetal loss and premature delivery [13]. Complicated appendicitis accounts for 14–55% of all cases of appendicitis, and it is associated with a higher incidence of major postoperative complications. Systematic reviews and meta-analyses have concluded that LA is safe and feasible for complicated appendicitis in adults [14,15], whereas the role of laparoscopy in complicated AA during pregnancy is not identified. This study aimed to assess perioperative surgical and obstetrical outcomes of LA in pregnant women with complicated AA.

Patients and methods

Ethical considerations
The study was approved by the Institutional Review Board and conformed to the precepts of 1975 Helsinki Declaration. Written informed consent was taken from the patients before the operation. The confidentiality of the collected data was maintained by giving a code number for every patient.

Study design, setting, and duration
This retrospective cohort study was carried out at Alexandria University Hospital and Mabaret Al-Asafra Hospital and between 2019 and 2020.

Eligibility criteria
The study enrolled pregnant women who underwent LA for AA during any trimester of pregnancy and were found to have complicated appendicitis.

Diagnosis of AA was based on clinical presentation as well as laboratory and imaging findings. Complicated appendicitis was defined intraoperatively as perforation of the appendix, gangrene, empyema, phlegmon, or abscess formation. The severity of peritonitis was classified as mild (turbid/purulent fluid localized in one, two, or three quadrants) or severe (fecal peritonitis or turbid/purulent fluid in four quadrants).

All patients were assessed by an obstetrician to exclude any complication of pregnancy, and obstetric ultrasound was also performed to establish gestational age and to confirm fetal vitality.

Operative technique
All patients received a single preoperative intravenous infusion of broad-spectrum antibiotics 1 h before the surgical incision. A laparoscopic three-port technique was used, and all surgeries were performed by the same surgeon. Trocars' placement was modified in pregnant patients according to their gestational age. During the first or second trimester of pregnancy, we placed a 10-mm umbilical port for the camera and one 5-mm suprapubic and 10-mm left lower quadrant for laparoscopic instruments (similar port placement locations as nonpregnant patients). For patients in the third trimester, the initial 10-mm port was placed 2 cm cephalad to the gravid uterus in the upper midline between the umbilicus and xiphoid process. The second port (10 mm) was placed in the left upper quadrant, and the third port (5 mm) was placed in the left lumbar quadrant opposite the umbilical level. After identification of the appendix, the mesoappendix was cauterized and sectioned with a ligature. A haemoclip was placed at the base of the appendix and sectioned leaving a 5-mm stump. The appendix was removed through the left quadrant port. Peritoneal fluid was irrigated with normal saline and drained when present. A surgical tube drain was placed in all patients.

Postoperative care and follow-up
All patients were administered antibiotic therapy for 7 days and analgesics including acetaminophen and opioids postoperatively. Ambulation and oral feeding with clear liquids were resumed when patients were fully awaked. Patients were discharged when they met the following criteria: normal vital signs, satisfactory pain control, adequate oral intake, ability to ambulate and urinate, and newborns normal examination. Obstetric ultrasound was also performed before patients' discharge. Follow-up was scheduled at the outpatient clinic on postoperative days 7 and 14.

Data collection and outcomes
Preoperative data included the patient's demographics, BMI, associated medical comorbidities, surgical history, clinical symptoms and signs, and obstetric ultrasound findings, including the gestational age and fetal viability. Operative data included the types of appendicitis complications, intraoperative complications, and the operation time. Postoperative surgical and obstetric outcomes were also recorded.

Statistical analysis
Data were tabulated and presented by the IBM SPSS statistics for windows, Version 22.0. Armonk, NY: IBM Corp. Categorical data were summarized as

numbers and percentages, whereas numerical data were tested for normality by the Shapiro–Wilk test and were presented as mean±SD because they were normally distributed. *P* value less than 0.05 was considered statistically significant.

Results

Among 55 pregnant women who underwent LA within 24h after diagnosis of AA during the period between 2019 and 2020, 19 patients had complicated appendicitis. The mean age of the studied patients was 35.9 ± 6.6 years, and the mean BMI was 31.30 ± 3.40 kg/m². The preoperative obstetric ultrasound revealed a mean gestational age of 20.9 ± 5.2 weeks with a normal viable intrauterine fetus in all (100.0%) cases. Their medical history involved diabetes mellitus II, hypertension, and obesity (10.5% each), whereas their surgical history included one or more (26.3%) cesarean sections, laparoscopic cholecystectomy (15.8%), paraumbilical hernia (10.5%), and back lipoma (5.3%). Pain and nausea were the most frequent symptoms (89.5%), followed by vomiting (10.5%), generalized pain and dyspnea in one (5.3%) patient, and right hypochondrial pain in another one (5.3%). Examination revealed tenderness and rebound tenderness in the right iliac and lumbar regions (89.5%), whereas generalized abdominal tenderness and distension were detected in two (10.5%) and one (5.3%) of patients, respectively. Laboratory investigations showed a mean white blood cells count of 17737 ± 1910 (Table 1).

The detected appendicitis complications during the operation included perforation (36.8%), phlegmon (31.6%), gangrenous appendix (21.1%), and empyema (10.5%). Among patients with perforation, there was a subhepatic abscess in one (14.3%), adhesive intestinal obstruction in one (14.3%), and generalized peritonitis in another one (14.3%). Moreover, one (16.7%) of six patients with phlegmon was associated with a localized abscess. During the operation, a slipped appendicular artery was controlled by clipping in one (5.3%) patient. The mean operative time was 63.6 ± 8.0 min, and conversion to open surgery was not needed in any case (Table 2).

Table 3 shows postoperative outcomes. One patient needed ICU admission. The return to the usual oral feeding was after 24h in 16 (84.2%) patients, after 48h in only one patient, and after 72h in two (10.5%) patients. Postoperative surgical complications were infected supraumbilical wound, which was managed by frequent dressing and broad-spectrum antibiotics, and intra-abdominal subhepatic localized abscess formation (5.3% each), which was managed conservatively by

Table 1 Preoperative data of the studied patients

Age, years (mean±SD)	35.9 ± 6.6
BMI, kg/m² (mean±SD)	31.30 ± 3.40
Gestational age, weeks (mean±SD)	20.9 ± 5.2
Normal viable intrauterine fetus by the obstetric US (*n*, %)	19 (100.0)
Medical history (*n*, %)	
Diabetes mellitus II	2 (10.5)
Hypertension	2 (10.5)
Obesity	2 (10.5)
Surgical history (*n*, %)	
Cesarean section	5 (26.3)
Laparoscopic cholecystectomy	3 (15.8)
Paraumbilical hernia	2 (10.5)
Back lipoma	1 (5.3)
Symptoms (*n*, %)	
Pain and nausea	17 (89.5)
Vomiting	2 (10.5)
Generalized pain and dyspnea	1 (5.3)
Right hypochondrial pain	1 (5.3)
Signs (*n*, %)	
Tenderness and rebound tenderness in the right iliac and lumbar regions	17 (89.5)
Generalized tenderness	2 (10.5)
Abdominal distension	1 (5.3)
WBCs count (mean±SD)	17737 ± 1910

US, ultrasound; WBCs, white blood cells.

Table 2 Operative data of the studied patients

Types of appendicitis complications (*n*, %)	
Phlegmon	5 (26.3)
Phlegmon with localized abscess	1 (5.3)
Perforation	4 (21.1)
Perforation with subhepatic abscess	1 (5.3)
Perforation with adhesive intestinal obstruction	1 (5.3)
Neglected perforation with generalized peritonitis	1 (5.3)
Gangrenous appendix	4 (21.1)
Empyema	2 (10.5)
Intraoperative complications (*n*, %)	
Slipped appendicular artery that was controlled by clipping	1 (5.3)
Operative time, min (mean±SD)	63.6 ± 8.0

Table 3 Postoperative outcomes

ICU admission (*n*, %)	1 (5.3)
Postoperative complications (*n*, %)	
Infected supraumbilical wound	1 (5.3)
Localized abscess	1 (5.3)
Return to the usual oral feeding (*n*, %)	
After 24 h	16 (84.2)
After 48 h	1 (5.3)
After 72 h	2 (10.5)
Readmission for ileus 7 days after the operation (*n*, %)	1 (5.3)
Obstetric complications (*n*, %)	
Abortion	1 (5.3)
Preterm delivery	0
Normal obstetric US after the discharge	18 (94.7)
Length of hospital stay, days (mean±SD)	2.3 ± 0.9

US, ultrasound.

ultrasound-guided aspiration and antibiotics. Obstetric complications involved abortion in only one patient that occurred 5 days after the operation, with normal obstetric ultrasound in 18 (94.7%) patients before the discharge. The mean length of hospital stay was 2.3 ± 0.9 days, and only one case needed readmission for ileus 7 days after the operation.

Discussion

Complicated AA has a significant effect on postoperative outcomes. A multicenter large cohort study considered complicated AA as a risk factor for serious morbidity and mortality, besides the prolonged length of hospital stay and hospital readmission [16]. Previous studies have indicated that LA has many advantages in comparison with open appendectomy, including decreased recovery time, a shorter duration of hospital stay, and a lower rate of wound infection [17]. Therefore, this study aimed to assess the perioperative surgical and obstetric outcomes of LA such as the operative time, intraoperative complications, the rate of postoperative complications, the length of hospital stay, and the incidence of fetal loss in pregnant women with complicated AA.

In the current study, laparoscopy revealed seven (36.8%) patients with perforation of the appendix, which was complicated either by a subhepatic abscess, adhesive intestinal obstruction, or generalized peritonitis. Other AA complications included phlegmon (31.6%), gangrenous appendix (21.1%), and empyema (10.5%). The rate of perforation in our study agrees with the reported perforation rate of appendicitis in pregnant women, which is around 14–43% [18]. Appendiceal perforation is known to be associated with increased morbidity and mortality compared with nonperforating AA, and it carries a higher mortality rate of around 5% [19].

In the present study, the mean operative time was 63.6 ± 8.0 min, and the only recorded intraoperative complication was slipped appendicular artery in one patient that was controlled by clipping. Similarly, an earlier study reported a mean operative time of 55 min for LA in pregnant patients with complicated appendicitis [20]. Furthermore, Alkatary and Bahgat [21] reported that the operative time ranged from 50 to 80 min in pregnant patients who were operated by LA for uncomplicated AA. Another study reported a slightly shorter operative time of 44 ± 16 min for LA in pregnant patients with uncomplicated AA [22].

It has been reported that the likelihood of conversion to open appendectomy increases in the presence of AA with abscess formation and peritonitis particularly in ages more than 40 years and in the presence of diabetes mellitus and obesity [23]. In our study, none of the patients in this study needed conversion to open appendectomy. This finding agrees with Khan *et al.* [22], and it reflects the great experience in laparoscopic surgery as there is an association between the surgeon's experience and the rate of conversion to open procedures [24]. Alternatively, Prodromidou *et al.* [11] reported a conversion rate of laparoscopic to open appendectomy of 1%, and Yau *et al.* [20] also reported one (0.6%) conversion patient in pregnant patients operated with LA for complicated appendicitis.

The identified postoperative surgical complications in this study comprised infected supraumbilical wound in one patient, which was managed by frequent dressing and broad-spectrum antibiotics, and intra-abdominal subhepatic localized abscess formation in another patient, which was conservatively managed by ultrasound-guided aspiration and antibiotics. This coincides with Alkatary and Bahgat [21], who detected postoperative wound infection in one patient following LA for AA in pregnant patients. Other studies reported absence of wound infection following LA compared with two cases following the open procedure in pregnant patients operated for uncomplicated AA [22,25].

The postoperative length of hospital stay is an excellent indicator of efficient surgery, and it is directly related to the effectiveness of recovery programs and resource allocation [26]. In the present study, the mean length of hospital stay was 2.3 ± 0.9 days, and we observed a prolonged duration of hospitalization in the two patients who developed postoperative complications. A comparable study involving 160 patients with complicated AA who were managed by LA reported a median length of hospital stay of 5 days, with a significant effect of the perforation, degree of peritonitis, gangrenous appendix, the placement of a drain, and the development of postoperative complications on the length of hospital stay [27]. Another study also identified complicated appendicitis and the occurrence of postoperative complications as risk factors for the prolonged hospital stay of more than three days in adults who underwent LA [28]. In a prior study, the mean length of hospital stay was 3.97 days for LA in complicated appendicitis in nonpregnant patients [29]. Studies that enrolled uncomplicated AA during pregnancy reported a shorter hospital stay following LA than the open appendectomy [11,21,22,25].

Despite the incidence of fetal loss is much higher (36%) in women with perforated appendicitis than

those with nonperforated appendicitis (1.5%) [30], our study detected only one (5.3%) case of abortion that occurred 5 days after the appendectomy operation. This finding coincides with Khan *et al.* [22], who reported one case of fetal loss following LA compared with three cases following the open procedure. A randomized clinical trial also reported one (4.5%) case of fetal loss after LA for uncomplicated AA in pregnant patients [25]. A recent meta-analysis supports the absence of increased risk of fetal loss in pregnant patients undergoing a LA [17].

Strengths and limitations

This study is the first to assess the surgical and obstetric outcomes of LA in pregnant patients with complicated appendicitis and adopted a standardized definition for complicated appendicitis condition. However, it is limited by being retrospective with risk of selection bias, the small sample size, and the lack of a control group for comparison with the outcomes of open appendectomy in conditions of complicated appendicitis during pregnancy.

Conclusion

LA for complicated AA in pregnant women was safe for the mother and the fetus regardless of the gestational age. The procedure was associated with a low risk of operative and postoperative surgical complications that were managed conservatively. Furthermore, the incidence of fetal loss was also low.

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Nil.

Conflicts of interest

The authors declare that they have no conflict of interest.

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