Original Article

Single-port laparoscopic appendectomy for acute appendicitis during pregnancy

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Abstract

Aim of Study: Acute appendicitis is the most common non-obstetric surgical problem in pregnant patients. As minimally invasive surgery has developed, minimising surgical trauma and improving cosmetic outcomes have led to the development of single-port laparoscopic surgery (SPLS). The aim of this study was to assess the feasibility and safety of SPLS for acute appendicitis during pregnancy.

Patients and Methods: Between September 2014 and May 2016, 12 pregnant patients diagnosed with acute appendicitis and having single-port laparoscopic appendectomy were included in the study.

Results: The median gestational age at surgery was 16 weeks (6–30 weeks). All operations were completed safely and without vascular or visceral injury. Four patients (33.3%) required conversion to a reduced-port laparoscopic surgery with 3 patients (25%) having a 5 mm port inserted because of perforated appendicitis with drain placement, and 1 patient (8.3%) having a 2-mm needle instrument insertion. Median operation time was 60 min (32–100 min), and a drainage tube was placed in 5 patients (41.7%). Median total length of incision was 2 cm (1.2–2.5 cm). The median time to soft diet initiation and length of stay in the hospital were 1 day (0–9 days) and 5 days (2–11 days), respectively. Two patients (8.0%) developed post-operative complications: One wound site bleeding and two surgical site infections. One case of abortion (8.3%) was noted on the post-operative day 1 and one case of imperforate hymen was noted after delivery.

Conclusions: SPLS appendectomy is feasible and safe for treating patients with acute appendicitis during pregnancy.

Keywords: Appendectomy, laparoscopy, natural orifice endoscopic surgery, pregnancy

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INTRODUCTION

Acute appendicitis is the most common non-obstetric surgical problem in pregnant patients. It is suspected in 1/600–1/1000 pregnancies and confirmed in 1/800–1/1500 pregnancies.[1] Moreover, the risk of foetal loss is increased if the appendix perforates resulting in pre-term labour and pre-mature delivery rates as high as 40%, compared with a 13% pre-term labour rate and 4% pre-mature delivery rate in non-perforated acute appendicitis.[2,3]

Laparoscopic appendectomy was first described by Semm[4] in 1983, and this approach was rapidly accepted as an adequate option for uncomplicated appendicitis. Previous studies have described laparoscopic appendectomy's

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advantages, compared to open appendectomy, as fewer days to return to a general diet, a shorter duration of parenteral analgesia, fewer morphine-equivalent milligrams of parenteral narcotic, a shorter post-operative hospital stay and earlier return to full activity.[5,6] As minimally invasive surgery has developed, minimising surgical trauma and improving cosmetic outcomes have evolved as current topics of active discussion. These topics have led to the development of single-port laparoscopic surgery (SPLS) for the treatment of a variety of conditions.

Recent literature has shown that patients with an intrauterine pregnancy can undergo laparoscopic surgery safely, during any trimester, without an increased risk to the mother or foetus.[7] However, reports on the management of acute appendicitis using SPLS during pregnancy are limited.[8]

Aim of study

The aim of this study was to describe our initial experience with SPLS for appendicitis in pregnant women to assess the feasibility and safety of SPLS on both the mother and her child.

PATIENTS AND METHODS

Between October 2014 and May 2016, data were collected from pregnant patients who were diagnosed with acute appendicitis and underwent a single-port laparoscopic appendectomy at our centre. The study was approved by the Institutional Review Board of Keimyung University and Donsan medical center (IRB No. 2018-09-008) and performed in accordance with the principles of the Declaration of Helsinki. Patients were diagnosed with either ultrasonography or magnetic resonance imaging to minimise harmful radiation effects on the foetus [Figure 1]. All the patients underwent SPLS using the Glove Port® (Sejong Medical, Paju, Korea). The retrospective data included the patients' demographics, inflammatory laboratory findings and delivery date. Details of the operative outcomes included the types of operation and appendicitis, number of patients who underwent conversion to reduced-port laparoscopic surgery, total operative time, number of patients with periappendiceal fluid collection, diameter and length of the resected appendix, number of patients with drain placement and total length of incision. Post-operative data included the time to diet initiation, duration of the hospital stay, post-operative complications, number of patients needing readmission, abortion rate and foetal congenital anomaly. Conversion to a reduced-port laparoscopic surgery was defined as the use of an additional mini-laparoscopic needlescopic grasper® (Stryker Endoscopy, San Jose, CA, USA) or an additional 5-mm port to safely finish the procedure.

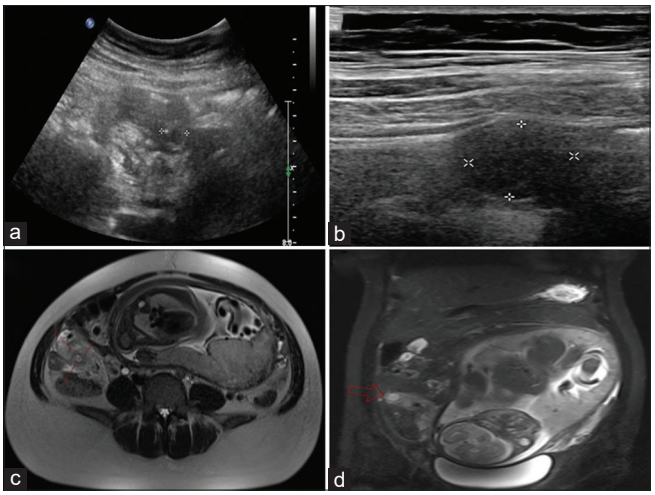

Figure 1: Pre-operative image. (a) Enlarged appendix seen in ultrasonography. (b) Appendicitis noticed in ultrasonography. (c) Axial image of appendicitis with appendicolith in magnetic resonance imaging. (d) Coronal image of appendicitis with appendicolith in magnetic resonance imaging

All surgical procedures were carried out with the patient layed in the supine position and under general anaesthesia with paralysis. The patient's head was elevated in an angle of 30° and tilted to the right 10°–15°. After the base of the umbilical stalk had been everted by using two penetrating towel clamps, placed on either side of the midline, a single 2 cm vertical incision was made through the umbilical skin. The subcutaneous tissue was dissected towards the linea alba, which was incised vertically to open the peritoneum. A single-port was placed in the abdominal cavity through the umbilical incision. After pneumoperitoneum, with insufflation of CO_2 up to 12 mmHg, had been achieved, a 5-mm diameter rigid telescope, with a fibre-optic light transmission and a 30° angled view, was inserted through the 5 mm channel of the single-port. The laparoscope was introduced through the port, and all four quadrants were inspected. When adequate and timely counter-traction was needed, a 2-mm needle instrument or 5-mm additional port was inserted into the right lower quadrant under direct vision. The mesoappendix was divided by the sequential use of a Covidien Sonicision (Covidien, Mansfield, [MA], USA) device. The appendiceal base was ligated by the application of 2 Vicryl endo-loops® (Ethicon, Somerville, NJ, USA) or the Endo-GIA stapler® (Covidien, Mansfield, MA, USA). The appendix resected was extracted from the abdominal cavity through the umbilical incision and placed into the sterile bag component of the single-port, after which thorough irrigation of the periappendiceal and subhepatic

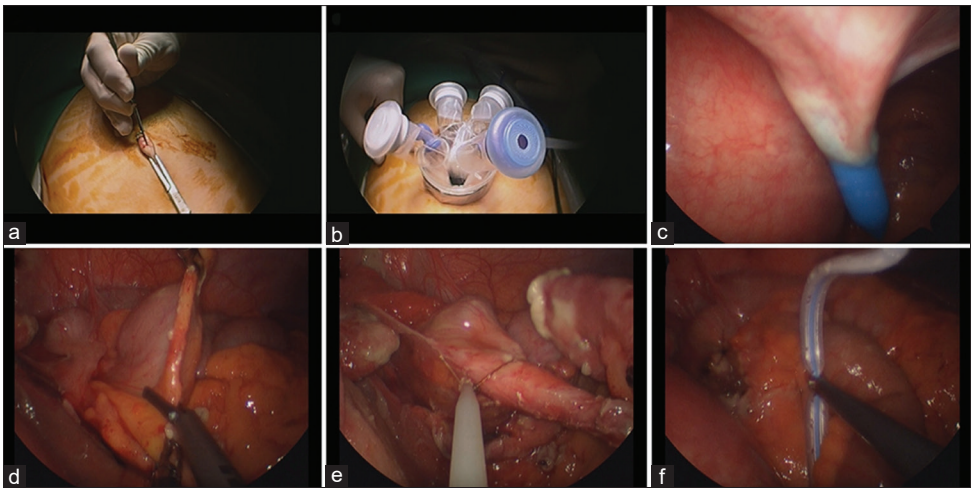

Figure 2: Single-incision plus one-port laparoscopic appendectomy for perforated appendicitis. (a) A single 1.2-cm vertical incision was made through the umbilical skin. (b) A multi-channel single port was inserted through the umbilical incision. (c) An additional 5-mm port was inserted in the right quadrant. (d) The mesoappendix was divided with adequate and timely traction. (e) The appendiceal base was ligated with the application of 2 Vicryl endo-loops. (f) The 5-mm port site was used for drain placement

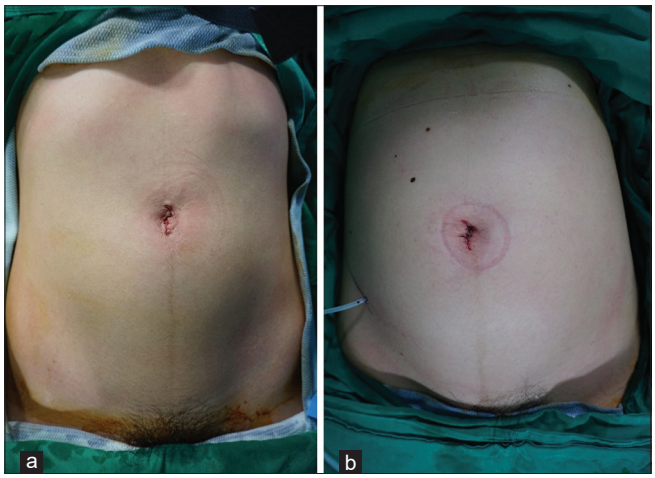

Figure 3: Immediate post-operative wound comparison. (a) Single-incision with no closed suction drain. (b) Single-incision with closed suction drainage in additional port site

areas was performed [Figure 2]. Following removal of the single-port, the umbilical fascia and the subcutaneous layer were closed with 2–0 Vicryl® (Covidien, Mansfield, [MA], USA) and 4–0 Monosyn® (B. Braun Aesculap AG and Co KG, Tuttlingen, Germany) buried interrupted sutures, respectively. An umbilical dressing, consisting of a small piece of gauze packed into the umbilicus, was applied and then covered with a compressive dressing [Figure 3]. The data were expressed as medians with a range and the statistical analyses were performed using IBM SPSS Statistics version 20.0 (IBM Co., Armonk, NY, USA).

RESULTS

The median age of the 12 patients in the study group was 31.5 years (26–38 years) [Table 1]. The patients had no co-morbidities, and the median body mass index was 21.03 kg/m^2 (18.5–27.7 kg/m^2). The median gestational age of the study group was 16 weeks (6–30 weeks). The median duration of symptoms, before diagnosis, was 1 day (1–8 days). Two patients (16.7%) had past operation history that included laparoscopic myomectomy and caesarean section. The median white blood cell count at admission was 14325/uL (8260–19400/uL). The median for C-reactive protein was 2.45 (0.01–19.72).

All 12 patients underwent technically successful procedures without the need for conversion to open surgery [Table 2]. Of the 12 patients undergoing SPLS, 8 patients (66.7%) underwent pure SPLS, 3 patients (25%) underwent SPLS with a 5-mm port insertion and 1 patient (6.7%) underwent SPLS with a 2-mm needle instrument. The median total operation time for all 12 patients was 60 min (32–100 min). Of the 12 patients in the study, 6 patients (50%), 2 patients (16.7%) and 4 patients (33.3%) developed suppurative, gangrenous and perforated appendicitis, respectively. The appendix was located retrocecalin 8 patients (66.7%), pelvic in 2 patients (16.7%), retroperitoneal in 1 patient (8.3%) and antececal in 1 patient (8.3%). In addition, intra-operative findings included 4 patients (33.3%) and 7 patients (58.3%) with severe adhesions to adjacent organs and periappendiceal fluid collection, respectively. The abscess was found intraoperatively in 3 patients (25%), and blood loss was minimal. The median diameter and length of the resected appendixes were 8.5 mm (5–13 mm) and 6.25 cm (4.2–8.5 cm), respectively. A drain was placed in the pelvic cavity in 5 patients (41.7%), and the median total length of incision was 2 cm (1.2–2.5 cm).

The median times to initiation of a soft diet and length of stay were 1 day (1–9 days) and 4.5 days (2–11 days), respectively [Table 3]. Three patients (25%) developed post-operative complications; 2 patients (16.7%) developed superficial surgical site infection and 1 patient (8.3%) had post-operative ileus. None of the patients were readmitted. One patient (8.3%) had a spontaneous abortion on the postoperative 1st day, and one patient's child had a congenital anomaly, which was an imperforate hymen.

Table 1: Patient characteristics

Patient number	12
Age (years), median (range)	31.5 (26-38)
Co-morbidity (%)	0 (0)
BMI (kg/m^2), median (range)	21.03 (18.5-27.7)
Gestational age (week) , median (range)	16 (6-30)
Duration of symptoms prior to diagnosis (days)	1 (1-8)
Past operation history (%)	2 (16.7)
WBC at admission	14,325 (8260-19,400)
CRP at admission	2.45 (0.01-19.72)

WBC: White blood cell; CRP: C-reactive protein, BMI: Body mass index

Table 2: Operative outcomes

Types of operations, *n* (%)	
SPLS	8 (66.7)
SPLS + 2-mm needle instrument	1 (8.3)
SPLS + 5-mm port	3 (25)
Total operation time (min), median (range)	60 (32-100)
Type of appendicitis, *n* (%)	
Suppurative appendicitis	6 (50)
Gangrenous appendicitis	2 (16.7)
Perforated appendicitis	4 (33.3)
Location of appendix, *n* (%)	
Retrocecal	8 (66.7)
Pelvic	2 (16.7)
Retroperitoneal	1 (8.3)
Antececal	1 (8.3)
Adhesion, *n* (%)	
No	5 (41.7)
Mild	2 (16.7)
Moderate	1 (8.3)
Severe	4 (33.3)
Abscess, *n* (%)	3 (25)
Periappendiceal fluid collection, *n* (%)	7 (58.3)
Blood loss (mL)	0 (0-10)
Diameter of resected appendix (mm), median (range)	8.5 (5-13)
Length of resected appendix (cm), median (range)	6.25 (4.2-8.5)
Drain placement, *n* (%)	5 (41.7)
Total length of incision (cm), median (range)	2 (1.2-2.5)

SPLS: Single-port laparoscopic surgery

Table 3: Post-operative outcomes

Days to 1st soft diet (day), median (range)	1 (1-9)
Hospital stay (day), median (range)	4.5 (2-11)
Complications, *n* (%)	3 (25)
Surgical site infection	2 (16.7)
Ileus	1 (8.3)
Readmission, *n* (%)	0 (0)
Abortion, *n* (%)	1 (8.3)
Congenital anomaly, *n* (%)[a]	1 (8.3)

[a]Imperforate hymen

DISCUSSION

Since the first description of SPLS for laparoscopic appendectomy in 1998,[9] the SPLS technique has been incorporated into a variety of laparoscopic procedures. The potential advantages of this approach are less post-operative incisional pain, fewer wound complications and improved cosmetic outcomes. In addition, this approach has less risk of haemorrhage, incisional hernias and organ injury. Although Koh *et al*.[8] reported two cases of single-port laparoscopic appendectomy for uncomplicated appendicitis during pregnancy using single-port access, the data in the literature about this procedure are extremely limited, and to our knowledge, the present study has the most patients diagnosed with acute appendicitis during pregnancy who underwent SPLS.

The operative times of multi-port and single-port laparoscopic appendectomy in non-pregnant patients were 17–90 min and 22–90 min, respectively, in previous studies.[10-12] Sadot *et al*. reported an operative time of 54 min in their study of laparoscopic appendectomy in pregnant patients[13] and similarly, the median operative time in the current study was 60 min.

There are numerous types of post-operative maternal complications reported in previous studies that include wound site infection, intra-abdominal abscess, deep vein thrombosis and post-operative ileus. In one study of 894 pregnant patients who underwent laparoscopic appendectomy, wound complications were reported in 0.67% of patients and other major complications were reported in 1.2% of patients.[14] One meta-analysis of 20 prospective and retrospective clinical trials reported an overall complication of 4.57% and wound complication of 1.03% in patients who underwent laparoscopic appendectomy.[15] In our study, maternal post-operative complication was observed in 3 patients (25%), with 2 of these patients (16.7%) having a superficial wound site infection and 1 patient (8.3%) having post-operative ileus. Despite the higher percentage rate in our study, because one-third of our patients' appendixes were perforated type with a high rate of abscess and adhesion, we think that the complication rate is acceptable compared with other studies.

The laparoscopic appendectomy can affect the foetus as well as the mother by causing pre-term labour or abortion. In a study comparing laparoscopic and open procedures of appendectomy during pregnancy, laparoscopic appendectomy caused two foetal complications among thirty patients but neither was foetal loss.[16] Another study reported foetal loss in 5.6% (35/624) of patients

and pre-term delivery in 2.1% (13/624) of patients.[15] A prospective study of pregnant patients with appendicitis who had an appendectomy reported an abortion rate of 6.25% in uncomplicated and 22.2% in complicated appendicitis; a foetal demise rate of 7.8% in uncomplicated and 24.1% in complicated appendicitis.[17] Abbasi *et al*.[18] conducted a study to specifically evaluate the impact of peritonitis in 1203 pregnant patients with acute appendicitis. That study showed a foetal death rate of 2.7% in appendicitis with peritonitis and 0.3% in appendicitis without peritonitis, and showed 8.2 of odds ratio. In our study, an abortion was observed in one patient with perforated appendicitis, and we think that the cause of this foetal death was not the type of surgery performed, but rather the severe inflammation around the foetal environment.

Although our study was not focused on comparing SPLS with multi-port laparoscopy, when the application of SPLS for the management of acute appendicitis in gravid women was further taken into consideration, SPLS may have had additional advantages over multi-port laparoscopy. First, using SPLS for an appendectomy during pregnancy provides easier and safer surgical access to the pelvic cavity through a single large umbilical incision, while later in pregnancy, the port placements should be performed more caudally, with a narrow abdominal space, in multi-port surgery. Second, SPLS can reduce the potential incisional injury on the foetus and uterus by a lower number of port placements. Third, in SPLS, the resected appendix can be easily extracted through the umbilical incision, and the operation time to remove the resected appendix can be minimized. Conversely, an additional instrument, a retrieval bag, is needed in a conventional laparoscopic appendectomy.

In our study, three patients needed an additional port of 5 mm and one patient needed a 2 mm needle instrument. Soon after laparoscopic exploration, we decided to add the 5 mm port or 2 mm needle instrument under direct vision in the right quadrant for the safe and efficient continuation of the operation. There were several reasons for conversion, in complicated cases, from pure SPLS to a reduced-port laparoscopic surgery. First, we needed a counter-traction in order to perform the operation safely, because there were severe adhesions in some cases. Second, we wanted to shorten the operation time for the safety of the foetus in complicated cases. Third, we used the incision that was made for the additional port for the drain placement in perforated appendicitis cases. Placing a drain in the umbilicus may cause post-operative umbilical hernia, which is an unwanted result after pregnancy. Therefore, we conclude that the use of an additional port or instrument does not demonstrate a failure of SPLS, but rather a modification that results in a better surgery.

The current study has several limitations that include its retrospective nature, the small size of the study due to the rarity of appendicitis during pregnancy, the lack of data on pain or cosmesis, and the lack of control (e.g., multi-port laparoscopic surgery).

CONCLUSIONS

Single-port laparoscopic appendectomy during pregnancy, using a multi-channel single-port, is feasible and safe. Furthermore, multi-centre comparative studies on a larger scale are needed to prove the advantages of this procedure.

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Conflicts of interest

There are no conflicts of interest.

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