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Laparoscopic Appendectomy in Pregnancy: a Case Series of Seven Patients

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ABSTRACT

Background: Appendicitis in the pregnant patient presents with diagnostic difficulties and more serious problems. Open surgery has its own limitations, mostly governed by the stage of the disease and the trimester of pregnancy. Laparoscopic appendectomy is beginning to be recognized as standard appendicitis treatment, as evidenced by several studies. In pregnancy, laparoscopy is even more controversial. Several studies prove the safety of laparoscopy and some studies disprove it.

Methods: We have treated 7 patients in the last 10 years; 6 had acute appendicitis and 1 had a perforated appendix. Ultrasound diagnosed 5 patients, and CT scan identified the other 2 patients. The patient with the perforated appendix had free fluid in the right iliac fossa and pelvis. Laparoscopic appendectomy was done in all patients.

Discussion: Pregnancy poses its own unique problems to the surgeon and anesthesiologist. The normal physiology becomes altered, and sound knowledge of this is necessary to handle these patients. Clinical presentation was mostly straightforward. Both ultrasound and CT scan were useful investigations.

Conclusion: Most studies support the use of laparoscopy in the management of appendicitis. There was no mortality (for mother and fetus) or morbidity in our patients.

Key Words: Pregnancy, Second trimester, Altered physiology, Laparoscopic appendectomy.

INTRODUCTION

The major advantages of minimally invasive therapy can be utilized in the surgical disorders of the pregnant patient. With advancements in laparoscopic surgery, its use in pregnant patients is becoming widely accepted. Any surgeon treating the pregnant patient must have a thorough understanding of the physiology of the pregnant patient and risks and benefits of laparoscopic surgery. The most commonly reported laparoscopic procedure performed during pregnancy is laparoscopic cholecystectomy.[1] The other procedures that are performed are appendicectomy, for bowel obstruction, in adnexal mass, for ovarian torsion, ovarian cystectomy and ectopic pregnancy. In a large series, Lachman et al[2] analyzed 518 pregnant patients undergoing surgery and found that laparoscopic cholecystectomy was the commonest (45%), followed by adnexal surgery (34%) and appendicectomy (15%). The possible drawbacks are injury to the uterus during Veress needle insertion, potential reduction of uterine blood flow secondary to increased intraabdominal pressure, risk of CO_2 absorption to the mother and child, and the technical difficulty of laparoscopic surgery. Physiologic and anatomic changes introduce certain risks unique to the gravid patient, some associated with laparoscopy in pregnancy. These risks have been postulated to include poor visualization due to gravid uterus, uterine injury during trocar placement, decreased uterine blood flow, or premature labor from the increased intraabdominal pressure and increased fetal acidosis or other unknown effects due to CO_2 pneumoperitoneum. Decreased uterine blood flow from pneumoperitoneum remains hypothetical.[3] It is reasoned that this is unlikely to be a major concern given the frequent pressure alternations induced during maternal valsalva, coughing, and straining. Further, it is maintained that pneumoperitoneum may well be safer than manual uterine retraction during open appendectomy or cholecystectomy.

Fetal hemodynamic abnormalities (tachycardia and hypertension) were noted and were attributed to fetal hypercarbia. The latter was reversed by maintaining mild maternal respiratory alkalosis. Monitoring maternal arterial blood gases has proven superior to maternal capnography in this regard.[4]

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Laparoscopy was first used for evaluation of acute abdominal pain in pregnancy in 1980 by gynecologists.[5] There was much controversy then as there is now, due to the high rate of complications and mortality. In the next decade, newer equipment and better understanding of the physiology of the mother and fetus during the procedure made it safer for laparoscopy in pregnancy.

METHODS

We report on 6 cases of acute appendicitis and 1 case of perforated appendix that we have treated in the last 10 years. All patients were in the second trimester of pregnancy and were between 22 and 32 years of age. Patients presented with acute right iliac fossa pain (6 cases), diffuse abdominal pain (1 case), fever (6 cases), nausea (5 cases), vomiting (2 cases), dysuria (5 cases), and loss of appetite (2 cases). The psoas test was positive in 3 patients. Ultrasonogram was performed in all patients. An accurate diagnosis was obtained in 4 patients with acute appendicitis and in the 1 patient with perforated appendix. In the other 2 patients, the appendix was not visualized due to the gravid uterus. CT scan of these 2 patients showed an inflamed appendix. Leukocytosis and mild anemia were present in all cases. The urinary bladder was catheterized in all cases. No patients had any co-morbid conditions. ASA – I status was given to the 6 appendicitis patients and ASA – II status was given to the patient with the perforated appendix. The anesthesiologist was careful to avoid hypercarbia and maternal acidosis. Fetal monitoring was done and compression stockings (to avoid venous stasis) were applied to the patient with the perforated appendix. The other anesthetic drugs used were similar to drugs used by nonpregnant patients. Nasogastric aspiration was done for all patients, and intravenous H_2 receptor antagonist was also given. Two doses of prophylactic antibiotics were given for the 6 patients, and for the patient with a perforated appendix, 6 doses were given.

The ports had to be placed so as to avoid injury to the enlarged gravid uterus. A Veress needle was used to create pneumoperitoneum in the patients with uncomplicated appendicitis. Intraabdominal pressure was maintained at 10mm Hg in all cases. We placed the first 5-mm port midway between the umbilicus and the xiphoid process. This is the optic port. We used a 5-mm, 30^{o} telescope in all the cases. The second 10-mm port was placed under direct vision at the right midclavicular line at the same level of the first port. This is for the right-hand working port. The third port (5mm) was placed at the left midclavicular line 3cm below the level of the first port. This is the left-hand working port. The dissection was commenced by carefully grasping the tip of the appendix with the left hand grasper and mobilizing the mesoappendix using a Harmonic scalpel (Ethicon, Somerville, NJ) in the right-hand working port. Once the base was reached, 2 pretied chromic catgut loops were applied **(Figure 1)** and the appendix was cut with scissors. A 5-mm, toothed grasper was used to grasp the cut end of the appendix to avoid spillage of luminal contents. The organ was delivered through the reducer sleeve in the 10-mm port **(Figure 2)**. The base was inspected one last time to recheck the security of the applied endoloops **(Figure 3)**. In the patient with the perforated appendix, the open method was used to create pneumoperitoneum. There was pus in the right iliac fossa that was sucked out. The tip of the suction nozzle was used to perform blunt dissection, as is our policy in dissection in complicated appendectomies. The rest of the procedure was the same, except that a thorough wash was performed, and a drainage tube was kept for 48 hours postoperatively. In all patients, extreme care was taken to avoid touching the gravid uterus.

There were no postoperative problems. Patients were ambulated the same evening. The urinary catheter was removed, and a normal diet was allowed the next day. The patients were discharged on the third postoperative day. The patient with the perforated appendix was discharged on the fourth postoperative day. All the patients went on to deliver healthy children; 2 required a Cesarean delivery. These patients were followed up for 14 months after surgery. There were no problems.

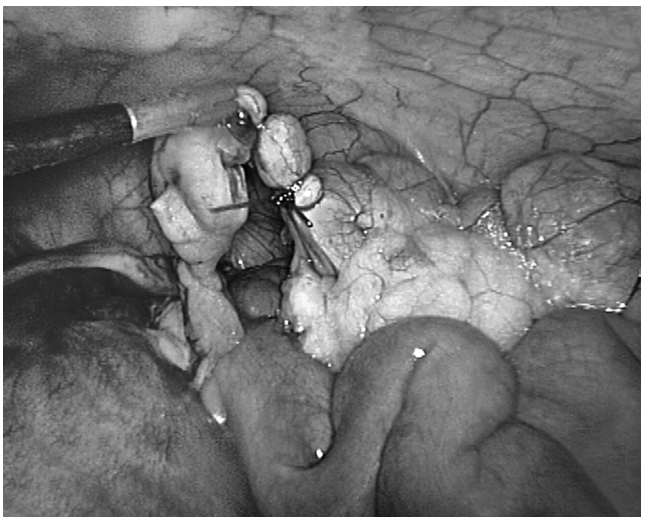

Figure 1. Pretied loops at base of appendix; gravid uterus seen on the left.

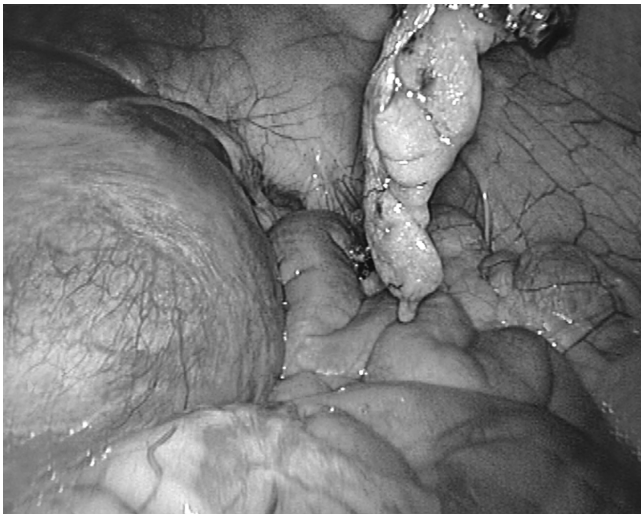

Figure 2. Appendix cut above the 2 loops.

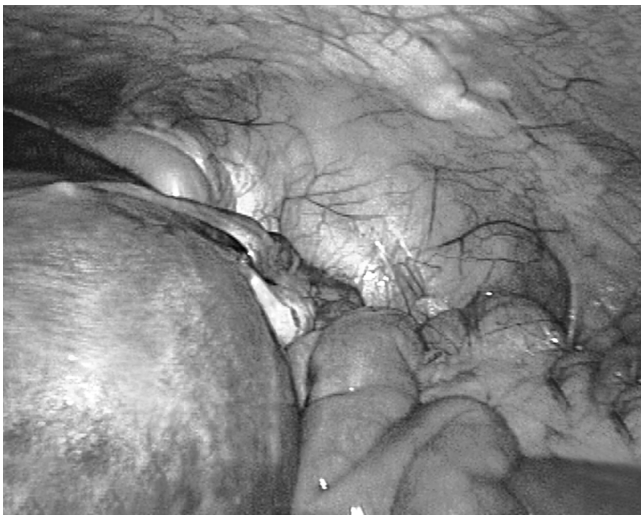

Figure 3. Appendicular stump.

Table 1.
Laboratory Findings

	Total Cases	%
Leukocyte count:		
<10,000/mm^3	3	42.8
10,000–15,000/mm^3	3	42.8
>15,000/mm^3	1	14.2
Pyuria	3	42.8
Bacteriuria	2	28.5
Presenting symptoms:		
Abdominal pain:		
Right iliac fossa	6	85.7
Upper abdominal	0	00
Diffuse	1	14.2
Nausea	5	71.4
Vomiting	2	28.5
Anorexia	2	28.5
Diarrhea	1	14.2
Constipation	0	00
Fever	6	85.7
Lump abdomen	1	14.2
Dysuria	6	85.7
Vaginal bleeding	1	14.2
Physical signs:		
Temperature:		
99–101 F	5	71.4
>101.5 F	1	14.2
Pulse:		
<100/min	2	28.5
>100/min	4	57.4
Right iliac fossa tenderness	6	85.7
Rebound tenderness	6	85.7
Diffuse tenderness	1	14.2
Abdominal guarding	1	14.2
Lump	0	00
Decreased bowel sounds	1	14.2
Psoas test	3	42.8

RESULTS

Table 1 provides all laboratory findings.

DISCUSSION

Appendicitis is the second most common nonobstetric emergency requiring surgery during pregnancy. Diagnosis of appendicitis is complicated by the physiologic and anatomic changes that occur during pregnancy. This can result in delayed diagnosis, increased risk of morbidity for mother and fetus. The rate of fetal loss is 0% to 1.5% in uncomplicated disease.[6] The incidence of appendicitis during pregnancy ranges from 0.05% to 0.13%; it usually occurs in the second or third trimesters.[7] Appendicitis occurs at the same rate in pregnant and nonpregnant women, but pregnant women have a higher rate of perforation. One study found an inverse relationship be-

tween pregnancy and appendicitis, especially in the third trimester, suggesting that pregnancy has a protective effect.[6]

Difficulty in diagnosing appendicitis during pregnancy arises from the fact that its symptoms are similar to those of pregnancy: anorexia, nausea, and vomiting. Leukocytosis and a diminished tendency to develop hypotension and tachycardia, which are physiologic in pregnancy, add complexity to the diagnosis. Displacement of the appendix by the uterus and increased separation of the visceral and parietal peritoneum, which decreases the ability to localize tenderness on examination, further complicates the diagnosis.[8] History and physical examination remain useful. Right lower quadrant pain, diffuse periumbilical pain migrating to the right lower quadrant and nausea/vomiting are common symptoms. The most common signs of appendicitis are abdominal tenderness, most often in the right lower quadrant and rebound tenderness and guarding, which are thought to be less common late in pregnancy due to the laxity of abdominal wall muscles. Fever, leukocytosis, and C-reactive protein are not reliable signs of appendicitis. Ultrasonography was found helpful during the first trimester, but less useful as pregnancy progressed due to displacement of the appendix.[9] It was helpful in excluding other pathology. Laparoscopy has been described as useful, particularly when diagnosis is uncertain. Helical computed tomography is almost 100% sensitive in diagnosing appendicitis.[10] Radiography and contrast studies should be avoided.

While delay in diagnosis is usually thought to result in a perforated appendix, some studies found no association between duration of symptoms and incidence of perforation and no correlation between time to surgery and incidence of perforation. Complications of appendicitis, including perforation, increase by trimester, and a ruptured appendix results in increased fetal morbidity and mortality. The rate of fetal loss in ruptured appendicitis ranges from 20% to 35%.[8] Perforation can also result in an increased incidence of wound infection and an increased risk of generalized peritonitis because the omentum cannot isolate the infection.[6] Preterm labor is common in cases of a ruptured appendix during the third trimester. Maternal mortality is 4% in advanced gestation and perforation.[5]

The patient position is of utmost importance in pregnant patients. In the supine position, venous compression may cause decreased venous return and reduced cardiac output. The ideal position is the lateral recumbent position for various reasons. This position increases cardiac output by 20%, and because of the increased venous drainage from the lower limbs, the risk of deep vein thrombosis is lower.[11] Hypovolemia can easily occur and will cause decreased cardiac output with decreased placental perfusion. Strict replacement of fluid is essential during the course of the procedure. Maternal pulmonary functions are also altered. As pregnancy progresses, functional residual capacity and residual volume decreases due to an elevated diaphragm. The blood has an increased oxygen-carrying capacity and increased oxygen consumption that can lead to hypoxemia. So there is a chronic state of mild respiratory alkalosis that has to be maintained during surgery.[3]

Another important change relevant to fetal well-being is the maternal acid-base status. CO_2 diffuses rapidly between maternal-fetal circulations. During laparoscopy, CO_2 may increase in the maternal circulation that is partly due to CO_2 insufflation. If PCO_2 increases to more than 40mm Hg, decreased removal of fetal CO_2 occurs leading to fetal acidosis. This can be overcome by hyperventilating the lungs during surgery. Capnography is adequate to monitor CO_2 levels in routine cases, for difficult cases serial maternal arterial blood gas estimations are necessary.

Hormonal changes lead to decreased motility of the gastrointestinal tract. Gastroesophageal reflux is common in pregnancy due to decreased lower esophageal sphincter tone, delayed gastric emptying and mechanical compression by the enlarging uterus. Nasogastric tube suction and strict airway management is mandatory for all pregnant patients undergoing laparoscopic surgery to prevent aspiration into the lungs. Prophylactic antibiotics are used in all cases because pregnant women are mildly immunocompromised.

The effects of the pneumoperitoneum on the fetus have not yet been fully investigated. For obvious reasons, prospective studies on humans have not been performed. It is well established that the increased intraabdominal pressure associated with a pneumoperitoneum can lead to a decrease in venous return with a concomitant decrease in cardiac output. Carbon dioxide can also be absorbed across the peritoneum and can lead to fetal acidosis. Hunter and colleagues meticulously investigated the physiological impact of a CO_2 pneumoperitoneum in these clinical settings. Their conclusions were that a CO_2 pneumoperitoneum created minimal impact on the patient and the fetus when intraabdominal pressure of 15mm Hg or less was used.[3] Nevertheless, it is advisable to use

gasless techniques or keep intraabdominal pressure at 10mm Hg.

Despite concerns, good outcomes have increasingly been reported. Rates of fetal loss, rates of other complications, and the length of the procedure were similar for laparoscopic surgery and open appendectomy.[4] One source demonstrated the feasibility of laparoscopic surgery during all trimesters; others have described it as safe during the first 2 trimesters and generally contraindicated during the third trimester.[7] The second trimester has been reported the safest for performing laparoscopy.[5]

Preterm labor is a complication of appendicitis during pregnancy. One study[12] reported the rate of preterm contractions and preterm labor in third-trimester patients as 83% and 13%, respectively. No increase has occurred in stillborn infants or in congenitally malformed infants.[13]

CONCLUSION

Prompt surgery, along with perioperative antibiotics, is recommended to prevent perforation and to improve the overall outcome for mother and fetus. Under appropriate conditions, laparoscopic appendectomy can be as safe as open appendectomy. Laparoscopic surgery has the advantage of allowing reduced narcotic use and hence less fetal depression, better intraoperative visualization and exposure, less postoperative pain, early return of bowel function, early ambulation, and shorter postoperative stays. Also, in a perforated appendix, open surgery would have required a larger incision; theoretical increased risk of wound infection and incisional hernia is present. This may interfere with the delivery of the baby. Several large studies[8] prove that laparoscopic surgery is safe in pregnancy, provided it is done in specialized centers by experienced surgeons. It can be concluded that laparoscopic surgery is now proving to be as safe as open surgery in pregnancy, with no deleterious effects to either mothers or children. Ultimately, experience is the most important determinant of a successful maternal-fetal outcome. Despite the growing clinical experience suggesting laparoscopy is as safe as laparotomy in pregnancy, long-term clinical studies are lacking.

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