Surg Endosc (2007) 21: 1344–1348
DOI: 10.1007/s00464-006-9104-9

SURGICAL ENDOSCOPY
and Other Interventional Techniques

Laparoscopic management of a nonobstetric emergency in the third trimester of pregnancy

A. Upadhyay,[1,2] S. Stanten,[1,2] G. Kazantsev,[1,2] R. Horoupian,[1,2] A. Stanten[1,2]

[1] Department of Surgery, Alta Bates Summit Medical Center, 365 Hawthrone Avenue #101, Oakland, California, 94609, USA
[2] St. Rose Hospital, Hayward, CA, USA

Received: 29 April 2006/Accepted: 16 October 2006/Online publication: 7 February 2007

Abstract
Background: Laparoscopic management of nonobstetric acute abdominal pain during pregnancy remains controversial. A gestational age of 26 to 28 weeks has been considered the upper limit for laparoscopy by some authors. A case series of nonobstetric surgery in advanced pregnancy is reported.
Methods: Third-trimester patients who underwent surgery between 1997 and 2006 were reviewed.
Results: Laparoscopic surgery was performed for nonobstetric emergencies during the third trimester for 11 patients. Four patients underwent open surgery. The laparoscopic surgery group included five cholecystectomies, four appendectomies, and two adenexal surgeries. The laparoscopic surgery procedure was successfully completed for 10 patients. Of these 10 patients, 9 had no complications and went on to deliver a healthy term infant. One patient went into preterm labor after a laparoscopic appendectomy for perforated acute appendicitis with purulent peritonitis and delivered a viable infant at 34 weeks. Another patient at 29 weeks of gestation underwent a diagnostic laparoscopy for abdominal pain. Adenexal torsion of a large multicystic ovarian mass led to a laparotomy (obstetrician preference) and right salpingo-oophrectomy. Her postoperative course was complicated by an episode of sudden syncope, hypotension, and fetal distress on postoperative day 3. An emergent laparotomy showed hemoperitoneum attributable to bleeding from the ovarian pedicle. A cesarean section delivery of a preterm infant requiring neonatal resuscitation was performed. The open surgery group included four patients. Two of the patients underwent appendectomies at 35 and 33 weeks, respectively, followed by a term delivery. The remaining two patients underwent emergent colectomies with a cesarean section delivery at 31 and 38 weeks, respectively.
Conclusions: This study demonstrated that laparoscopic surgery in the third trimester of pregnancy is feasible and can be performed safely with an acceptable risk to the fetus and the mother. Access to the pregnant abdomen is easily obtained. Space generally is not a problem, and there is minimal uterine manipulation.

Key words: Laparoscopic appendectomy — Laparoscopic cholecystectomy — Laparoscopy Pregnancy — Third trimester

The pregnant patient with acute abdominal pain presents a true surgical dilemma. Acute appendicitis and symptomatic cholelithiasis are the most common surgical conditions requiring nonobstetric abdominal surgery during pregnancy [10]. The frequency of surgery for nonobstetric emergencies during pregnancy is approximately 2 per 1,000 cases [10]. Pregnancy once was considered an absolute contraindication for laparoscopic surgery[8], but pregnant patients undergoing laparoscopic surgery have been reported increasingly in the past decade. However, most case reports and case series are confined to patients in the first and second trimesters [5, 15].

Several authors recommend that laparoscopic surgery should be performed in the second trimester [4, 16]. The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) guidelines for laparoscopic surgery in pregnancy recommend that when possible, operative intervention should be deferred until the second trimester or until after parturition [18]. Fatum and Rojansky [7] suggest a gestational age limit of 26 to 28 weeks for laparoscopic surgery.

There is limited data on the role of laparoscopic surgery in the third trimester of pregnancy. Most publications on laparoscopic surgery in the third trimester of pregnancy include either single case reports or small case series involving two to four cases [3, 5, 6, 11, 12, 14,

Paper presented at the Scientific Session of the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), Dallas, Texas, USA, April 2006

Correspondence to: A. Upadhyay

Table 1. Summary of reported cases: laparoscopic approach

Age (years)	Operation	EGA (weeks)	Technique	Toco	Outcome	Infant
30	Lap chol	32	Veress	No	FT delivery	Normal
24	Lap chol	34	Veress	Yes	FT delivery	Normal
22	Lap chol	33	Veress	No	FT delivery	Normal
23	Lap chol	33	Veress	Yes	FT delivery	Normal
26	Lap chol	29	Veress	No	FT delivery	Normal
24	Lap appen	34	Veress	Yes	Preterm delivery	Premature
25	Lap appen	32	Veress	No	FT delivery	Normal
26	Lap appen	30	Veress	No	FT delivery	Normal
33	Lap appen	28	Veress	No	FT delivery	Normal
38	Diag lap[a]	29	Hasson	No	C-section/preterm	Premature[b]
29	Lap adenex	32	Veress	No	FT delivery	Normal

EGA, expected gestational age; Toco, tocolytics given; Lap chol, laparoscopic cholecystectomy; FT, full-term; Lap appen, laparoscopic appendectomy; Diag lap, diagnostic laparoscopy; C-section, cesarean section; Lap adnex, laparoscopic adenexal surgery
[a] Conversion to open procedure
[b] Prolonged intensive care unit (ICU) stay, neurologic deficit

19]. Afflick et al. [1] described 15 cases of third-trimester laparoscopic surgery in the largest single-institution series of laparoscopic surgery, involving 77 patients. In this series, the preterm delivery rate was similar in both the laparoscopic and open groups. There were no fetal losses, uterine injuries, or spontaneous abortions in the laparoscopic group. We present our experience with 15 cases of third-trimester surgeries, 11 of which involved a laparoscopic approach, and we attempt to review the relevant literature.

Patients and methods

Between 1997 and 2006, we managed 15 patients in the third trimester of pregnancy requiring nonobstetric surgical intervention for acute abdominal pathology. The records were kept prospectively, but a retrospective review of the charts was performed. Of the 15 patients, 11 were subjected to an initial laparoscopic approach. During the same period, 4 patients underwent an open operation. The data collected included the age of the patient, the estimated gestational age, fetal loss, fetal or maternal injuries, preterm labor, and long-term complication to the newborn.

Laparoscopic technique

The patients were placed in the supine position with the table tilted to the left side. Sequential pneumatic compression was used for deep vein thrombosis prophylaxis. A Foley catheter was placed. A prophylactic antibiotic was administered intravenously before incision. The Veress needle was used for 10 patients, and the Hasson technique was used for 1 patient. The Veress needle was inserted in either the left or the right upper quadrant in the midclavicular line approximately 1 to 2 cm below the costal margin. A carbon dioxide (CO_2) pneumoperitoneum of 12 mmHg was obtained. The pressure was increased to 15 mmHg if deemed necessary during the operation.

A 5-mm trocar was inserted for a 30° 5-mm laparoscope. Subsequent trocars were placed under laparoscopic vision. The position of these trocars was determined by the gestational age, the position of the uterine fundus, and the surgical procedure. In most cases, the periumblical port needed to be placed in a more cephalad position. A standard laparoscopic cholecystectomy was performed using four to five ports. Intraoperative cholangiography was used if indicated. Linear endoscopic staplers were used for the appendectomies and adenexal surgery. Specimen retrieval was obtained at the end of the procedures using an endopouch.

Fetal monitoring during the surgery was left to the discretion of the individual obstetrician. All the patients were monitored for fetal activity during the postoperative period in the labor and delivery units. Tocolytics were administered for perceived or documented contractions. Preterm delivery was defined as any delivery before 37 weeks gestation. Fetal and maternal outcome were analyzed. All the patients were followed in the outpatient setting except two patients who were followed by telephone interview because they had been transferred to our hospital from out of town.

Open cases

A right lower quadrant (RLQ) muscle-splitting incision was used for the two appendectomies. A cesarean section was followed by right colectomy in the first patient and a total colectomy in the second patient.

Results

Laparoscopic cholecystectomy

Five patients in the laparoscopic group underwent laparoscopic cholecystectomy (Table 1). Intraoperative cholangiography was performed for one patient, and intraoperative fetal monitoring was performed in all the five cases. Two patients required tocolytics in the postoperative period for contractions. All five patients went on to a full-term delivery of a healthy infant. Indications for cholecystectomy were acute cholecystitis nonresponsive to medical treatment in three patients. One patient underwent surgery for recurrent biliary colic unresponsive to medical management. One patient was admitted for the second time in 4 weeks for right upper quadrant pain, nausea, vomiting, and failure to gain weight.

Laparoscopic appendectomy

Laparoscopic appendectomy was performed for four patients (Table 1). Three of the patients underwent intraoperative fetal monitoring. No fetal monitoring was performed for the remaining patient at the discretion of the obstetrician. All the patients underwent postoperative monitoring for fetal activity. One patient was given tocolytics in the postoperative period. Three patients had acute appendicitis according to the pathologic

Table 2. Summary of open cases

Age (years)	Operation	EGA	Toco	Delivery	Diagnosis	Infant
29	Open appendectomy	35 wks	Yes	Full-term	Acute appendicitis	Normal
26	Open appendectomy	33 wks	Yes	Full-term	Acute appendicitis	Normal
23	C-section followed by total colectomy	31 wks	Yes	C-section	*C. diff* colitis	Twin A viable Twin B stillborn
34	C-section followed by right colectomy	38 wks	—	C-section	Colon duplication	Normal

EGA, expected gestational age; Toco, tocolytics given; C-section, cesarean section; *C. diff, Clostridium difficile*

examination, and one patient had a normal appendix. The three patients subsequently delivered a full-term infant.

The fourth patient, a 24-year-old with an estimated gestational age of 34 weeks, presented with a 2-day history of RLQ abdominal pain, tenderness, guarding, an elevated white cell count of 16,000, and an abdominal sonogram showing minimal fluid in the RLQ and non-visualization of the appendix. At laparoscopy, an acute suppurative perforated appendicitis with pus in the peritoneal cavity was noted. A laparoscopic appendectomy was completed with suction irrigation of the abdominal cavity. This patient improved clinically in the postoperative period, but experienced contractions the following morning and dilated rapidly. She delivered a 5-lb viable male infant with Apgar scores of 8 and 9. Her postoperative stay was 10 days.

Laparoscopic adenexal surgery

Two patients presented with RLQ abdominal pain and were found to have adenexal pathology. One patient presented at 32 weeks gestation with torsion of the fallopian tube. She underwent a laparoscopic salpingo-oophrectomy using a linear endostapler. Subsequently, she delivered a healthy full-term infant.

The second patient with a sudden onset of RLQ abdominal pain and tenderness, no fever, a normal white count, and an abdominal sonogram showing minimal fluid in the RLQ underwent a diagnostic laparoscopy. A complex 8 × 5-cm multiloculated right ovarian cystic neoplasm with torsion was noted. The obstetric team subsequently performed a midline laparotomy to remove the adenexal mass.

On postoperative day 3, the patient fainted in her room. She was found to be hypotensive with generalized abdominal tenderness. At laparotomy, a large amount of blood, clots, and bleeding from the right ovarian pedicle was noted. A premature infant was delivered that required urgent resuscitation and transfer to a neonatal intensive care unit.

There were no complications related to the access for any of the 11 laparoscopic cases. The Veress needle was used in 10 cases, and the Hasson technique was used for one patient. Of the 11 patients in the laparoscopic group, 9 had normal deliveries of a term infant. One patient who had ruptured appendicitis with purulence went into preterm labor after a laparoscopic appendectomy and delivered a preterm infant. This was possibly because of her underlying pathology (i.e., ruptured purulent acute appendicitis). There were no long-term complications.

The only patient in the laparoscopic group with a significant complication was a 29-week-pregnant patient who underwent a diagnostic laparoscopy for RLQ abdominal pain. At laparoscopy, a large multiloculated cystic adenexal mass with torsion was noted. The obstetric team elected to perform a laparotomy and salpingo-ooophrectomy. This patient subsequently experienced hypotension and fetal distress requiring a return to the operating room. Hypotension was secondary to blood loss from the ovarian pedicle. An emergent cesarean section delivery was performed. The newborn required a prolonged intensive care stay and had residual neurologic damage.

The age range of the patients was 22 to 38 years. The estimated gestational age of the patients undergoing laparoscopic surgery was 28 to 34 weeks. For 10 of the 11 patients, access was obtained using a Veress needle. The Hasson technique was used for one patient. Tocolysis was used for three patients. There was only one preterm delivery with no morbidity.

Open surgery group

The open group included a 33-week-pregnant patient and a 35-week pregnant patient with acute appendicitis. Both underwent an uneventful open appendectomy followed by full-term delivery of normal infants (Table 2).

A third patient at approximately 31 weeks with twin gestation was transferred from another institution with RLQ abdominal pain, diarrhea, and elevated white blood cell count because of *Clostridium difficile* colitis after the administration of an antibiotic for urinary tract infection. Her clinical condition worsened rapidly followed by preterm labor and fetal compromise. An emergent cesarean section using midline laparotomy incision was performed. The one twin was stillborn, and the other twin had Apgar scores of 4 and 8. The latter required resuscitation and subsequent prolonged neonatal intensive care stay. This twin had delayed developmental milestones with neurologic damage.

Abdominal exploration showed a normal-appearing appendix and an inflamed but viable colon. No resection was performed. Approximately 20 h later, in the postoperative period, the patient became extremely ill with hemodynamic instability, adult respiratory distress syndrome, and a rapid increase in her white blood cell count to 90,000 despite oral vancomycin and intravenous metronidazole for *C. difficile* colitis. The patient

was returned to the operating room, and an emergent total colectomy was performed. The postoperative course was followed by a prolonged intensive care stay, but the mother experienced complete recovery.

The fourth patient at 38 weeks gestation presented with RLQ pain and fever. A planned cesarean section was performed, with the delivery of a normal infant followed by right hemicolectomy for colon duplication.

Discussion

Management of nonobstetric emergencies in the third trimester poses a unique challenge to the surgeon, obstetrician, anesthesiologist, and neonatologist because the risks of surgery must be balanced against the possible risks to the mother and the fetus. Advanced pregnancy continues to obscure accurate diagnosis of the acute abdomen because of the anatomic and physiologic changes of pregnancy leading to atypical presentation of common surgical problems [7].

The recommendation throughout the literature before the laparoscopic era for the management of gallstone disease and adenexal masses was initially nonoperative treatment [9]. If surgery was necessary, it was recommended that the surgery be performed ideally in the second trimester [9]. It is believed that in the second trimester, the rate of spontaneous abortion decreases, and the likelihood of premature labor is less than in the third trimester. It is not surprising that some earlier reports of laparoscopic surgery during pregnancy followed the most widely accepted standard of care and reserved laparoscopy for the second trimester only.

However, as early as 1991, Pucci and Seed [14] published a case report of a successful laparoscopic cholecystectomy for a 27-year-old patient who was 31 weeks pregnant. In the past decade, laparoscopic surgery in the third trimester was sporadically reported in the literature [3, 5, 6, 11, 12, 14, 19]. Most of these reports included one to four patients in the third trimester. Many still recommend an open approach for the third trimester [13].

Most reports and a review of the literature attest to the safety of laparoscopic surgery during all three trimesters of pregnancy [11, 15, 16]. One exception is a report by Amos et al. [2], who caution concerning the use of laparoscopy during pregnancy on the basis of their adverse outcome in a series of seven patients. Eichenberg et al. [6] reviewed the literature over the past 30 years and found no reported case of cholecystectomy, laparoscopic or open, in the third trimester of pregnancy that had not resulted in a viable birth.

Rollins et al. [17] subsequently published a second paper describing their experience in a 4-year period after the first study period, once again showing an excellent outcome. This report included 59 additional laparoscopic surgeries during pregnancy, 18 of which were in the third trimester. There were five preterm deliveries [17].

Our experience has been similar to that of Afflick et al. [1] and Rollins et al. [17]. Of 11 patients, 9 had an uneventful course followed by delivery of a full-term infant. One patient with preterm delivery had no late morbidity and a normal outcome. Only one patient in the laparoscopic group who underwent a diagnostic laparoscopy had a bad outcome. However, in this case, the complication appears to have been related directly to the open part of the procedure. We included this patient in the laparoscopic group because of the intent-to-treat principle.

We recommend laparoscopic surgery in all the three trimesters. We believe that laparoscopic surgery is beneficial in the third trimester. Contrary to SAGES guidelines, we have used a Veress needle approach more frequently because of surgeon preference. Our experience has been similar to that of Rollins et al. [17].

The third trimester poses additional difficulty mainly because of the diminished working space available due the enlarging uterus, the risk of injuring the uterus, and the perceived risk for excessive manipulation of the gravid uterus leading to preterm labor. However, Reedy et al. [15] found an extremely low rate of complications for laparoscopy during pregnancy in a survey of laparoendoscopic surgeons.

Access to the abdomen in the third trimester is easily obtained. The Veress needle or the Hasson technique can be used. Use of the Veress needle is safe in experienced hands. We have noted that the space is not a problem, and the operative field is not obscured by the gravid uterus up to 34 weeks. The umbilical port needs to be moved cephalad in most cases involving laparoscopic cholecystectomy, appendectomy, or adenexal surgery. The pressure of 15 mmHg should not be a problem when it is considered that in the third trimester the uterine pressures can be very high at times because of spontaneous intermittent contractions.

The upper gestational limit for laparoscopic surgery is not defined. We have shown that laparoscopic surgery up to 34 weeks can be performed safely. Intraoperative fetal monitoring is recommended, and postoperative monitoring should be performed.

Our experience and a review of the published literature suggest that laparoscopic surgery can be performed safely in the third trimester with acceptable risk to the fetus and the mother. We observed no significant increase in the fetal or maternal mortality or morbidity in cases of acute abdomen due to appendicitis, acute cholecystitis, adenexal pathology, or other miscellaneous conditions. Recurrent biliary colic causing nausea, vomiting, weight loss, repeated admissions, fetal retardation, risk of gallstone pancreatitis, and cholangitis with its associated morbidity and mortality as well as increased risk of fetal loss can be avoided by laparoscopic cholecystectomy. Nonoperative treatment of gallstone disease carries the risk of multiple admissions, pancreatitis, cholangitis, and even preterm labor. Appendicitis and adenexal torsion in the third trimester can be treated safely using a laparoscopic approach. Laparoscopy decreases maternal morbidity, may decrease the length of hospital stay, minimizes fetal depression due to reduced requirement for narcotic analgesics, and avoids a long incision for a gravid patient in labor.

References

1. Afflick DG, Handrahan DL, Egger MJ, Price RR (1999) The laparoscopic management of appendicitis and cholelithiasis during pregnancy. Am J Surg 178: 523–529
2. Amos JD, Schorr SJ, Norman PF, Poole GV, Thomae KR, Mancino AT, Hall TJ, Scott-Conner CE (1996) Laparoscopic surgery during pregnancy. Am J Surg 171: 435–437
3. Barnes SL, Shane MD, Schoemann MB, Bernard AC, Boulanger BR (2004) Laparoscopic appendectomy after 30 weeks pregnancy: report of two cases and description of technique. Am Surg 70: 733–136
4. Conron RW, Abbruzzi K, Cochrane SO, Sarno AJ, Cochrane PJ (1999) Laparoscopic procedures in pregnancy. Am Surg 65: 259–263
5. de Perrot M, Jenny A, Morales M, Kohlik M, Morel P (2000) Laparoscopic appendectomy during pregnancy. Surg Laparosc Endosc Percutan Tech 10: 368–371
6. Eichenberg BJ, Vanderlinden J, Miguel C, Bianchi C, Robles A, McLarty R, Tabuenca A (1996) Laparoscopic cholecystectomy in the third trimester of pregnancy. Am Surg 62: 874–877
7. Fatum M, Rojansky N (2001) Laparoscopic surgery during pregnancy. Obstet Gynecol Surg 56: 50–59
8. Gadacz TR, Talamani MA (1991) Traditional versus laparoscopic cholecystectomy. Am J Surg 161: 336–338
9. Holthausen UH, Mettler L, Troidl H (1999) Pregnancy: a contraindication? World J Surg 23: 856–862
10. Kammerer WS (1979) Nonobstetric surgery during pregnancy. Med Clin North Am 63: 1157–1164
11. Lemaire BM, van Erp WF (1997) Laparoscopic surgery during pregnancy. Surg Endosc 11: 15–18
12. Lin YH, Hwang JL, Huang LW, Seow KMJ (2003) Successful laparoscopic management of a huge ovarian tumor in the 27th week of pregnancy: a case report. Reprod Med 48: 834–836
13. Melnick DM, Wahl WL, Dalton VK (2004) Management of general surgical problems in the pregnant patient. Am J Surg 187: 170–180
14. Pucci RO, Seed RW (1991) Case report of laparoscopic cholecystectomy in the third trimester of pregnancy. Am J Obstet Gynecol 165: 401–402
15. Reedy MB, Galan HL, Richards WE, Preece CK, Wetter PA, Kuehl TJ (1997) Laparoscopy during pregnancy: a survey of laparoendoscopic surgeons. J Reprod Med 42: 33–38
16. Reedy MB, Kallen B, Kuehl TJ (1997) Laparoscopy during pregnancy: a study of five fetal outcome parameters with use of the Swedish health registry. Am J Obstet Gynecol 177: 673–679
17. Rollins MD, Chan KJ, Price RR (2004) Laparoscopy for appendicitis and cholelithiasis during pregnancy: a new standard of care. Surg Endosc 18: 237–241
18. SAGES guidelines for laparoscopic surgery during pregnancy. SAGES publication 0023. Accessed 18 April 2006 at http://www.sages.org/sg_pub23.html
19. Sen G, Nagabhushan JS, Joypaul V (2002) Laparoscopic cholecystectomy in third trimester of pregnancy. J Obstet Gynaecol 22: 556–557