

Laparoscopic surgery performed in advanced pregnancy compared to early pregnancy

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Abstract

Purpose The aim of our study was to assess the clinical and obstetric outcomes of laparoscopic surgeries performed during advanced pregnancy compared to those performed in early pregnancy.

Methods We retrospectively reviewed all cases of patients who underwent laparoscopic surgery during pregnancy in our institution between 1996 and 2013.

Results We reviewed cases of 117 pregnant women who underwent laparoscopic surgery during the study period. There were no conversions to laparotomy. 71 surgeries were performed in the first trimester (group 1, mean gestational age 7.7 ± 1.9 weeks) and 46 were performed in the second and third trimesters (group 2, mean gestational age 18.1 ± 4.3 weeks). More patients in group 1 underwent surgery for suspected adnexal torsion ($p < 0.001$), while more patients in group 2 underwent surgery for presumptive cholecystitis ($p = 0.014$) and persistent ovarian mass ($p = 0.011$). The interval between admission and surgery differed significantly between the groups and was longer in group 2 compared to group 1 (18.2 ± 24.0 vs. 6.8 ± 10.6 h, $p = 0.001$). No difference was found between the two groups regarding surgical complications, histopathological findings and pregnancy outcomes.

Conclusion In our experience, laparoscopic surgery in advanced pregnancy was found to be feasible and safe as in

early pregnancy, without any adverse effects on pregnancy outcome.

Keywords Laparoscopy · Advanced pregnancy · Pregnancy outcome · Pregnancy

Introduction

The rate of pregnant women requiring an abdominal surgery varies in the literature from 1 in 500 to 635 [1, 2] to approximately 1 in 130 [3]. The most common non-gynecological indications are acute appendicitis and cholecystitis, and the most common gynecological indications are suspected ovarian torsion and symptomatic adnexal masses [4]. The first laparoscopic surgery in pregnancy was a cholecystectomy performed in 1991 [5]. Following that important milestone, the subject of laparoscopy in pregnancy was initially controversial with concerns such as uterine injury, fetal perfusion during surgery, fetal anomalies, abortions and preterm labor being raised. In the not so distant past, pregnancy was considered an absolute contraindication to laparoscopy, however, in the last two decades, as minimally invasive surgery has become more common, data regarding the safety of laparoscopy in pregnancy have become more widely appreciated.

To date, data on operative laparoscopy in pregnancy are still limited, especially in the second and third trimesters. The aim of our study was to assess the clinical and obstetric outcomes of laparoscopic surgeries performed at our institute between January 1996 and September 2013, and to compare the surgical characteristics and the maternal and fetal outcome between surgeries performed during the first trimester and those performed during the second and third trimesters.

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Materials and methods

The present study retrospectively included pregnant patients who underwent laparoscopic surgeries during the first, second, and third trimesters of pregnancy in a 17 year period between January 1996 and December 2013 in E. Wolfson Medical Center, Holon, Israel. The study was approved by the local institutional review board. The medical records of all participants were reviewed and data were collected concerning demographic characteristics (age, gravidity, parity), pregnancy characteristics (gestational age, number of embryos, IVF), hospitalization and the surgery characteristics (main complaint, time from admission to surgery, presumed diagnosis, fever, leukocytosis, findings in surgery, procedure performed, duration of surgery), postoperative hospitalization and complications, pathological report and obstetric outcome. For those patients whose medical records were not informative concerning pregnancy outcome, such as those who delivered in other institutes, an attempt was made to collect that information by a phone survey. All procedures were performed by either gynecological surgeons or general surgeons experienced in laparoscopic surgery. Administration of tocolytic agents preoperatively or postoperatively was done on a case-by-case basis, and not routinely. All patients undergoing laparoscopy were positioned in the dorsal supine position with a leftward tilt. Positional changes were modified with close communication with the anesthesia personnel. General anesthesia was used in all patients. The individual placement of the laparoscope and operating trocars was modified depending on uterine size and gestational age. Our rule was, in the first trimester of pregnancy, to initially place the trocar for the laparoscope in the umbilicus by placing a Veres-Palmer needle followed by a 10 mm trocar. The remaining trocar sites were determined by the surgeons according to the operation being performed. In patients in the second and third trimesters of pregnancy, the initial trocar was placed in the umbilicus or supra umbilical region, in the midline using the Hasson open technique, at position a few centimeters cephalic to the uterine fundus. The other ports were placed under direct vision in the different regions depending on the surgery being performed. In all cases, the number of trocars inserted was 3–4 including the port for laparoscope. The insufflation was carried out with carbon dioxide and intra-abdominal pressure was maintained below 12 mmHg to ensure adequate venous return, minimize pressure on the inferior vena cava, and prevent fetal acidosis [6–8]. Using multiple graspers and manipulators, the abdominal contents were manipulated based on the location, symptoms, and characteristics of the pelvic or abdominal pathology, and the appropriate procedure was performed. The fascia was closed in all ports of entry of trocars >10 mm. Measures were taken in all cases

in attempt to minimize uterine manipulation. Preoperatively, all patients underwent assessment of fetal well-being by sonography and fetal heart rate monitoring in advanced pregnancies, above 24 weeks of gestation. Postoperatively, all patients were closely followed for preterm uterine contractions and were treated accordingly. No routine tocolysis was administered. Fetal well-being was assessed again routinely on postoperative day 1. For those patients who continued their pregnancy follow-up and delivered in our institution, pregnancy outcome was obtained from their medical records. For those patients who delivered elsewhere, three attempts were made to collect that information by telephone. Those cases in which information was received by telephone, the patients were asked to deliver the information from the official birth documents to minimize the effect of recall bias.

Analysis of data was carried out using SPSS 21.0 statistical analysis software (IBM Inc., Chicago, IL). Normality of distribution of continuous variables was assessed using the Kolmogorov–Smirnov test (cut off at $p = 0.01$). Continuous variables with distributions significantly deviating from normal were described as median (min–max) and compared by group using the Mann–Whitney U test. Variables with approximately normal distributions were described as mean \pm standard deviation and compared by group using the t test for independent samples. Associations between continuous variables were described by calculating Spearman's rho. Categorical variables were described as frequency counts are presented as n (%). Categorical variables were compared by group using the Chi square test. All tests are two-sided and considered significant at $p < 0.05$.

Results

Of the 117 laparoscopic surgeries performed at our institute during the study period, 71 were performed in the first trimester of pregnancy until $13 + 0$ gestational weeks and were included in the group of early pregnancy (group 1), and 46 were performed later (35 cases between $13 + 1$ weeks and $26 + 0$ weeks and 11 cases between $26 + 1$ weeks and $34 + 0$ weeks) and included in the group of advanced pregnancy (group 2).

There were no conversions to laparotomy. The overall mean gestational age at the time of surgery was 10.1 weeks. The mean gestational age in the early pregnancy group was 7.7 weeks and the mean gestational age in the advanced pregnancy group was 18.1 weeks.

The maternal demographic data are analyzed in Table 1. The two groups did not differ in terms of maternal age, gravidity, parity, the percentage undergoing in vitro fertilization (IVF) treatments and in the average number of embryos (multiple pregnancies).

Table 1 Demographic data

	Group 1 <i>N</i> = 71	Group 2 <i>N</i> = 46	<i>p</i> value
Age (years)	29.2 ± 4.8	28.8 ± 4.5	0.663
Gravidity	1.7 ± 0.8	1.8 ± 0.93	0.08
Parity	0.71 ± 1.04	0.91 ± 0.89	0.09
IVF ^a	24/71 (33.8 %)	11/46 (29.9 %)	0.175
Number of embryos	1.31 ± 0.59	1.13 ± 0.34	0.119
Symptomatic	68/71 (95.5 %)	40/46 (86.9 %)	0.649
Gestational age (weeks)	7.7 ± 1.9	18.1 ± 4.3	<0.001

Data are given as mean ± SD or No. (%)

^a In vitro fertilization

Table 2 Indications for surgery and surgery characteristics

	Group 1 <i>N</i> = 71	Group 2 <i>N</i> = 46	<i>p</i> value
Indications			
Suspected torsion	56/71 (78.9 %)	20/46 (43.5 %)	<0.001
Suspected ruptured EUP ^a	3/71 (4.2 %)	0/46 (0 %)	0.158
Suspected cholecystitis	1/71 (1.4 %)	6/46 (13 %)	0.014
Persistent mass	3/71 (4.2 %)	9/46 (19.6 %)	0.011
Suspected bowel obstruction	1/71 (1.4 %)	3/46 (6.5 %)	0.137
Suspected appendicitis	7/71 (9.9 %)	8/46 (17.4 %)	0.234
Characteristics			
Duration of surgery (min)	41 ± 32.6	44.3 ± 20	0.077
Total hospitalization (days)	3.13 ± 1.41	4.83 ± 3.97	0.001
Admission-surgery (h)	6.85 ± 10.66	18.29 ± 24.04	0.001

Data are given as mean No (%) or mean ± SD

^a Extra uterine pregnancy

There was a significant difference between the two groups in the circumstances under which the surgery was performed. Significantly more emergency surgeries were performed in the early pregnancy group in comparison with the advanced pregnancy group (Table 2). Suspected torsion occurred significantly more frequently in patients in the early pregnancy group ($p < 0.0001$), while suspected cholecystitis ($p = 0.014$) and persistent pain due to ovarian mass ($p = 0.011$) were more frequent in the advanced pregnancy group.

The characteristics of the surgical procedure and the hospitalization are also analyzed in Table 2. The interval between admission and surgery differed significantly between the groups and was longer in the advanced pregnancy group compared to the early pregnancy group (18.2 ± 24.0 vs. 6.8 ± 10.6 h, $p = 0.001$). This significant difference was most probably due to emergent surgeries that were more common in the early pregnancy group. The duration of laparoscopic procedures was similar in both groups (41 ± 32.6 min in group 1 vs. 44.3 ± 20 min in group 2, $p = 0.077$). Total length of hospitalization was significantly longer in the advanced pregnancy group compared to the early pregnancy group.

When each surgical finding was compared by group, ovarian torsion was significantly more frequent in the early

pregnancy group ($p < 0.0001$) and suspected cholecystitis was significantly more frequent in the advanced pregnancy group, $p = 0.003$ (Table 3). Interestingly, there were two cases of heterotopic pregnancies. In these two cases, a young intrauterine pregnancy was observed sonographically prior to surgery. Intra-operatively, in one case, tubal pregnancy was observed and treated by salpingectomy, and in the other case, tubal abortion was observed with no active bleeding, and only irrigation and aspiration was performed. The intra-uterine pregnancies were followed to term. Detorsion and ovarian cystectomy were the most common procedures performed in the early pregnancy group, and diagnostic laparoscopy and cholecystectomy were the most common procedures performed in the advanced pregnancy group (Table 4).

A histopathological sample was collected in 31 of the cases in the early pregnancy group, and in 29 of the cases in the advanced pregnancy group. Functional cysts (follicular and corpus luteum) and serous cyst adenoma were the most common pathologic diagnosis made. There was no difference between the two groups in terms of pathologic diagnosis.

Postoperative complications including hematomas (none in both groups), blood transfusions (one case in the early pregnancy group vs. none in the late group), wound infections (one case in the early pregnancy group vs. none in

the late group), re-laparoscopy (one case in the early pregnancy group vs. none in the late group), peritonitis (none in the early pregnancy group vs. one case in the late group) and vaginal bleeding (one case in the early pregnancy group vs. one case in the late group) were rare and did not differ significantly between the groups. Tocolytic agents (indomethacin) were administered in three cases in the advanced pregnancy group due to uterine contractions.

Pregnancy outcome results are analyzed in Table 5. The loss for follow-up rate was 23.9 % in the early pregnancy group and 10.9 % in the advanced pregnancy group. Pregnancy outcome was obtained by telephone in five of the cases in the early group (7 %) and four of the cases in the late group (8.7 %). In all other cases, pregnancy outcome was obtained from the patients' medical records. Pregnancy outcome did not differ between the groups. Of

Table 3 Surgical diagnoses

	Group 1 <i>N</i> = 71	Group 2 <i>N</i> = 46	<i>p</i> value
Ovarian simple cyst (not torted)	7/71 (9.9 %)	6/46 (13.0 %)	0.592
Adnexal torsion	52/71 (73.2 %)	16/46 (34.8 %)	<0.0001
Tubal pregnancy (heterotopic)	2/71 (2.8 %)	0/46 (0 %)	0.251
Endometriosis	1/71 (1.4 %)	1/46 (2.2 %)	0.755
Pedunculated leiomyoma	0/71 (0 %)	2/46 (4.3 %)	0.076
Teratoma	1/71 (1.4 %)	0/71 (0 %)	0.419
Appendicitis	3/71 (4.2 %)	6/46 (13 %)	0.08
Small bowel obstruction	0/71 (0 %)	3/46 (6.5 %)	0.058
Cholecystitis	0/71 (0 %)	6/46 (13 %)	0.0003
Nothing abnormal found	5/71 (7 %)	6/46 (13 %)	0.277

Data are given as No. (%)

Table 4 Procedure performed

	Group 1 <i>N</i> = 71	Group 2 <i>N</i> = 46	<i>p</i> value
Cystectomy only	6/71 (8.5 %)	7/46 (15.2 %)	0.255
Detorsion only	23/71 (32.4 %)	9/46 (19.6 %)	0.128
Detorsion + fixation	3/71 (4.2 %)	1/46 (2.2 %)	0.551
Detorsion + cystectomy	14/71 (19.7 %)	3/46 (6.5 %)	0.048
Irrigation + suction	5/71 (7 %)	0/46 (0 %)	0.066
Diagnostic laparoscopy	4/71 (5.6 %)	8/46 (17.4 %)	0.041
Myomectomy	0/71 (0 %)	1/46 (2.2 %)	0.212
Appendectomy	4/71 (5.6 %)	6/46 (13 %)	0.161
Adhesiolysis	0/71 (0 %)	1/46 (2.2 %)	0.212
Cholecystectomy	0/71 (0 %)	6/46 (13 %)	0.003
Detorsion + fenestration	12/71 (16.9 %)	4/46 (8.7 %)	0.273

Data are given as No. (%)

Table 5 Pregnancy outcome (patients with complete follow-up)

	Group 1 <i>N</i> = 54	Group 2 <i>N</i> = 41	<i>p</i> value
Fetal demise/abortion	7/54 (13 %)	1/41 (2.4 %)	0.13
Term vaginal delivery	24/54 (44.4 %)	22/41 (53.7 %)	0.41
Preterm vaginal delivery	3/54 (5.6 %)	4/41 (9.8 %)	0.46
Term CS	12/54 (22.1 %)	10/41 (24.3 %)	0.81
Preterm CS	5/54 (9.3 %)	4/41 (9.8 %)	1
Termination of pregnancy	3/54 (5.6 %)	0/41 (0 %)	0.69

Term ≥ 37 gestational weeks

Preterm <37 gestational weeks

Data are given as mean No. (%)

17/71 (23.9 %) of the patients in group 1 and 5/46 (10.9 %) of the patients in group 2 were lost to follow-up
CS cesarean section

the cases followed, 13 % of the cases in the early pregnancy group and 2.4 % in the advanced pregnancy group have resulted in an abortion/fetal demise ($p = 0.13$). Vaginal preterm delivery prior to 37 weeks of gestation occurred in 5.6 % of the cases in the early pregnancy group and 9.8 % of the cases in the advanced pregnancy group ($p = 0.46$). Cesarean preterm delivery prior to 37 weeks of gestation occurred in 9.3 % of the cases in the early pregnancy group and 9.8 % of the cases in the advanced pregnancy group ($p = 1.0$). Term vaginal delivery >37 weeks of gestation occurred in 44.4 % of the cases in the early pregnancy group and 53.7 % of the cases in the advanced pregnancy group ($p = 0.41$). Term cesarean delivery >37 weeks of gestation occurred in 22.1 % of the cases in the early pregnancy group and 24.3 % of the cases in the advanced pregnancy group ($p = 0.81$). Pregnancy was electively terminated in three cases (5.5 % of the cases followed) in the early pregnancy group (two cases due to social reasons and one due to complex fetal malformations) and in none of the cases in the advanced pregnancy group ($p = 0.69$). Other than the case described, no other major fetal malformations were observed.

Discussion

Over the past two decades laparoscopy has become increasingly popular and more frequently performed during pregnancy. In addition to its well-known advantages, laparoscopy has decreased the risk of postoperative thrombosis due to earlier return to normal activity [9]. This advantage is especially important in gravid patients, as pregnancy is a hypercoagulable state and thromboembolic events are more frequent in pregnant women. Although laparoscopic surgery has been performed in all trimesters of pregnancy, the risk of injury to the gravid uterus and preterm delivery may be increased with advancing gestation. The gravid uterus may interfere with visualization of the surgical field. An enlarged uterus is at risk of possible injury during Veres-Palmer needle or trocar insertion throughout the procedure. Procedures may be technically more difficult because of the enlarged uterus and congestion of pregnancy. The growing uterus may make the traditional umbilical site less desirable. To reduce the risk of injury, it is imperative to consider alternative sites for entering the peritoneum, in advanced pregnancy. Although operative laparoscopy is performed in all trimesters of pregnancy, data regarding advanced pregnancy are limited. In this study, we compared laparoscopic surgeries performed in advanced pregnancies with those performed early in pregnancy in terms of feasibility, safety, complications, and pregnancy outcome. To the best of our knowledge, this is the first study to compare laparoscopic surgeries performed in advanced pregnancy

with those performed in early pregnancy. Moreover, the present study is the largest reported to date and it supports the feasibility and overall favorable outcome of laparoscopic surgery performed in the second and third trimesters of pregnancy. Historical recommendations were to delay laparoscopic surgery to the second trimester to reduce the rate of spontaneous abortions and preterm labor [10]. However, recent literature, as our study, has shown that pregnant patients can undergo laparoscopic surgeries safely during any trimester without any increased risk to the mother or fetus [11–15]. Most of these reports consist of small case series. Postponing unnecessary operations until after parturition may, in some cases, increase the rate of complications for both the mother and the fetus [16–19]. The upper gestational limit for laparoscopic surgery is not defined. If surgery is emergent, it can be performed safely during the first trimester. If non-emergent surgery has to be performed during pregnancy, the second trimester has classically been considered the safest. Our study showed that laparoscopic surgeries, for any indication, can be performed safely in advanced pregnancy up to 34 gestational weeks. By the end of the first trimester organogenesis is completed, pregnancy loss rate decreases. Laparoscopic surgery in a pregnant patient should be performed quickly and efficiently. Experience is crucial. In advanced pregnancy, once all the ports are placed, the surgeon is limited by the diminished peritoneal space available to perform surgery. Care should be taken to prevent sharp instrumental injury to the uterus. Gravid patients should be placed in the left lateral decubitus position in an attempt to minimize caval compression, improving venous return and cardiac output [20]. Carbon dioxide insufflation of 10–15 mmHg can be safely used for laparoscopy in pregnancy. Some studies have recommended that the intra-abdominal insufflation pressure be maintained under 12 mmHg to avoid worsening pulmonary physiology in gravid patients [21, 22] while others have argued that insufflation of less than 12 mmHg may not provide adequate visualization of the intra-abdominal cavity [13, 23]. Pressure of 15 mmHg has been used during laparoscopies in pregnant patients without any adverse outcome, neither maternal nor fetal [13, 23]. The issue of prophylactic tocolysis is not well addressed in the literature. This issue should, therefore, be tailored individually in each case both preoperatively and postoperatively. Recommendations for performing laparoscopy in advanced pregnancy are summarized in Table 6.

In our experience, laparoscopic surgery up to 32 weeks can be performed safely. Preoperative and postoperative monitoring is recommended. The limitations of our study are the retrospective design and the relatively high percentage of patient lost to follow-up. However, the percentage of patients lost to follow-up was similar in both groups. Due to the study design, we did not identify in-

Table 6 Strategies to minimize complications during laparoscopy in advanced pregnancy

Early diagnosis of the condition requiring surgery
Careful assessment of the patient including gestational age, history of pelvic infections, body habitus, prior incisions, and size of the uterus
Consideration of the Hasson open technique
Consideration of alternative sites to the umbilicus for entry into the peritoneal cavity
Level position of the patient (not Trendelenburgs' position) at the time of first entry
Continuous urinary catheterization and gastric aspiration
Manual deflection of the uterus away from the entry sites
Left lateral recumbent position during the operation
Use of pneumatic compression stockings during and after the operation
Effort to minimize intra-abdominal pressure below 12 mmHg
Meticulous evacuation of intra-abdominal smoke
Monitoring uterine activity post-operatively (in general >24 weeks) and tocolysis should be considered individually
Closely monitoring maternal recovery postoperatively, preferably in a trained fetal-maternal unit
Assessment of fetal well-being before discharge

patients that may have been followed as out-patients during pregnancy.

In summary, based on our experience, laparoscopic surgery can be performed efficiently in all trimesters of pregnancy. We presume these surgeries can be performed safely without any adverse effects on pregnancy outcome. Although concerns such as the difficult intra-abdominal access, the reduced visual space, and the fear of excessive uterine manipulation remain, in the hands of an experienced surgeon, laparoscopic surgery seems to be safe in advanced pregnancy.

Conflict of interest The authors report no conflicts of interest.

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