



Retrospective anesthetic evaluation of non-obstetric surgery during pregnancy: single center experience

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Background: Laparoscopic procedures and ultrasonography are now commonly used in the obstetric field, and more non-obstetric procedures are being performed. However, little domestic data has been published on the topic. This present retrospective study investigated the clinical information and the effect on perinatal outcomes of non-obstetric surgery during pregnancy.

Methods: This retrospective study was performed using data of all adult pregnant women that underwent non-obstetric surgery at our institute between from July 2009 to December 2016. Data was collected from the institutional computerized database. The causes, types, and the gestational ages at surgery were collected as our primary outcomes. Basic characteristics of patients, operation times, anesthesia times, anesthetic methods, anesthetic agents, and adverse perinatal outcomes such as abortion or pre-term delivery were evaluated as secondary outcomes.

Results: During the study period, there were 2,421 deliveries and 60 cases of non-obstetric surgery, an operation rate of 2.48%. The most common cause of non-obstetric surgery was abdominal surgery, followed by orthopedic surgery and neurosurgery. Most of abdominal surgeries were performed laparoscopically during the first trimester. The incidence of adverse perinatal outcomes was increased in the first trimester, was not related with anesthesia.

Conclusions: The rate of non-obstetric surgery was found to be 2.48%, which was higher than those reported in previous domestic studies. This increase seems to have resulted from early diagnosis by ultrasonography and non-invasive surgery using laparoscopy. Adverse perinatal outcomes are not related with age, surgery and anesthetic-related factors but seem to be associated with surgery exposure stage, especially the first trimester.

Key Words: Obstetric anesthesia, Patient outcome assessment, Pregnancy.

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INTRODUCTION

Although the practice of elective surgery during pregnancy is to be avoided, a substantial number of pregnant women undergo surgery and anesthesia [1,2]. These cases are classi-

fied as being directly related to pregnancy such as cerclage, being indirectly related to pregnancy such as ovarian cystectomy, or being unrelated such as appendectomy [3]. Between 0.75% to 2% of pregnant women require surgery during pregnancy [1,4,5]. Currently, the number of non-obstetric surger-

ies is growing, mainly due to routine use of ultrasonography in the obstetric field and the rapid development of laparoscopic procedures [6–8]. These procedures have enabled early diagnosis of disease in pregnancy and non-invasive surgery in obstetric fields.

When a pregnant woman requires surgery, the anesthesiologist must consider the safety of two patients – the mother and fetus [9]. Pregnancy induces a variety of anatomical and physiologic changes with clinical, anesthetic and pharmacological implications that present potential hazards for mother and fetus undergoing anesthesia [9]. Therefore, even though the risk of surgery may not differ in degree, anesthetic management remains extremely challenging during this period [10]. The goals of non-obstetric surgery in pregnant patients are to preserve maternal and fetal safety, ensure fetal well-being by maintaining uterine perfusion and fetal oxygenation and avoiding teratogens, inhibiting uterine contractions, and preventing preterm labor [1].

In this study, we undertook to document the causes, types and rates of non-obstetric surgery at each trimester and examine the effect of variables on perinatal outcomes after non-obstetric surgery.

This retrospective study included all adult pregnant women that underwent non-obstetric surgery at our hospital between from July 2009 to December 2016. The exclusion criteria were as follows: any minor operation under local anesthesia, a pregnancy-related operation such as cervical cerclage, dilation and curettage and cesarean section (CS), and any operation due to ectopic pregnancy or hemoperitoneum by uterine rupture. Data was collected from our institutional computerized database. The causes, types of the non-obstetric surgery and gestational ages at the surgery were collected as our primary outcome measures. In addition, basic characteristics of patients, operation times, anesthesia times, anesthetic methods, anesthetic agents and adverse perinatal outcomes such as abortion or premature delivery were evaluated as secondary outcome measures. In this study, abortion and premature delivery were regarded as the adverse perinatal outcomes, whereas term delivery, such as, normal spontaneous delivery and CS after pregnancy 37 weeks were considered satisfactory outcomes. Abortion was defined as pregnancy termination prior to 20 weeks of gestation or a birth weight of ≤ 500 g. Premature delivery was defined as birth at a gestational age of < 37 weeks.

MATERIALS AND METHODS

The study protocol was approved and requirement for informed consent was waived by the local Institutional Review Board of our hospital's ethics committee (HC17RES0088).

Statistical analysis

Statistical analysis was performed using SAS (Version 9.2, SAS Inc., USA). Continuous variables are expressed as mean and stand deviations and categorical variables were

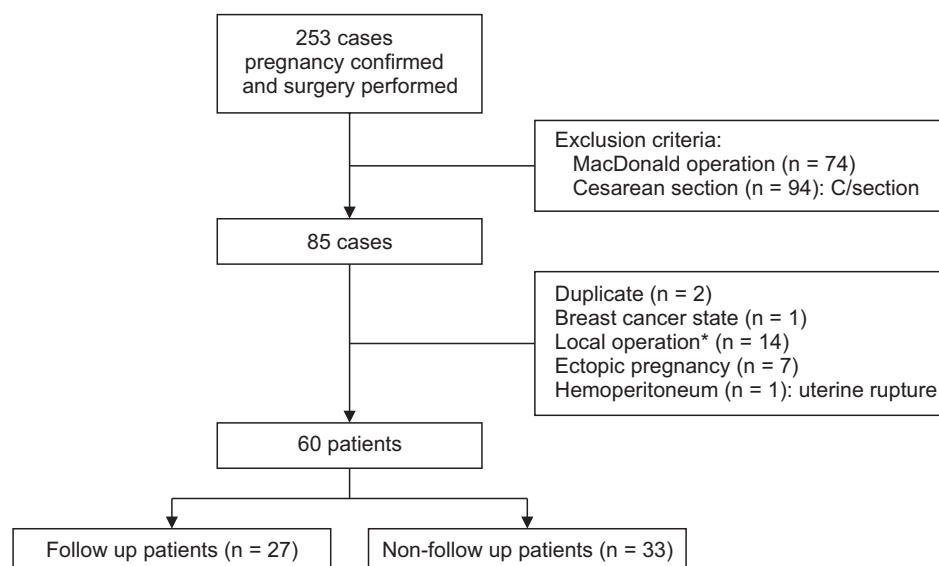


Fig. 1. Flow diagram of patient selection processes for this study. C /section: cesarean section. *A total 14 case of operation performed under local anesthesia were as follows: loop electrosurgical excision procedures, cheek epidermal inclusion cysts, vaginal repairs, cervix polypectomy, breast local excisions, dog bite wound.

counted in numbers (percentages value in parentheses, %). For comparison, analysis of variance was used in continuous variables for age, while Fisher's exact test was used to analyze categorical variables such as American Society of Anesthesiologist physical status, operation procedures, duration of anesthesia, anesthetic methods, induction and inhalation agents, incidences of surgery by type during each trimester, associations between abortion or premature delivery during each trimester and anesthesia-related factors. In addition, multiple logistic regression analysis was performed to identify independent predictors of adverse perinatal outcomes. P values less than 0.05 were considered as statistically significant.

RESULTS

During the study period, there were 2,421 deliveries and 60 women underwent non-obstetric surgery, an operation rate

of 2.48%. Total 253 medical records were retrieved from the institutional database and 193 records were excluded from our study. Finally, 60 patients were enrolled in the present study (Fig. 1).

Table 1 presents the characteristics and perioperative data of the 60 study subjects. There was a significant differences only in the types of operations between trimesters ($P = 0.001$). Laparoscopic procedures were performed more frequently during the first and second trimester, while laparotomy was more frequent in the third trimester. The operations performed under laparotomy were as follows: 4 appendectomies, 1 huge ovarian cystectomy and 1 appendectomy (converted from laparoscopic to laparotomy due to procedural difficulty) and 4 different abdominal surgeries (cholecystitis, traumatic bowel perforation, cecum cancer and adhesiolysis).

Table 2 presents the causes and incidences of non-obstetric surgery by trimester. The greatest proportion of non-

Table 1. Patient Characteristics and Perioperative Data

Variable	First trimester (n = 30)	Second trimester (n = 20)	Third trimester (n = 10)	P value
Age (yr)	30.1 ± 4.8	30.75 ± 5.1	33 ± 2.9	0.245
Age-group (yr)				0.384
< 20	1 (3.3)	0 (0.0)	0 (0.0)	
20–30	15 (50.0)	8 (40.0)	2 (20.0)	
31–40	13 (43.3)	12 (60.0)	8 (80.0)	
Over 40	1 (3.3)	0 (0.0)	0 (0.0)	
ASA physical status				0.150
ASA 1	20 (66.7)	9 (45.0)	5 (50.0)	
ASA 2	10 (33.3)	11 (55.0)	4 (40.0)	
ASA 3	0 (0.0)	0 (0.0)	1 (10.0)	
ASA 4	0 (0.0)	0 (0.0)	0 (0.0)	
Duration of anesthesia (min)				0.258
< 60	12 (40.0)	8 (40.0)	2 (20.0)	
60–120	15 (50.0)	9 (45.0)	6 (60.0)	
Over 120	3 (10.0)	3 (15.0)	2 (20.0)	
Operation procedures				0.001
Laparoscopy	26 (89.7)	14 (93.3)	0 (0.0)	
Laparotomy	3 (10.3)	1 (6.7)	6 (85.7)	
Anesthesia methods				0.746
General	29 (96.7)	19 (95.0)	9 (90.0)	
Spinal	1 (3.3)	1 (5.00)	1 (10.0)	
Induction agents				0.805
Thiopental sodium	20 (69.0)	13 (68.4)	5 (55.6)	
Propofol	9 (31.0)	6 (31.6)	4 (44.4)	
Inhalation agents				0.811
Sevoflurane	19 (65.5)	11 (57.9)	5 (55.6)	
Desflurane	10 (34.5)	8 (42.1)	4 (44.4)	

Values are presented as mean ± SD or number (%). ASA: American Society of Anesthesiologist. Operation procedures were compared between laparoscopy and laparotomy between trimesters. A total 30 cases of non-obstetric surgery during the first trimester were performed: 29 cases of abdominal surgery and 1 case of metatarsal fracture. There was a significant difference between operation procedures and each trimester ($P = 0.001$).

Table 2. The Causes and Incidences of Non-obstetric Surgery in Our Study Population

Surgery type	First trimester (n = 30, 50.0%)	Second trimester (n = 20, 33.3%)	Third trimester (n = 10, 16.7%)
Abdominal surgery (n = 50, 83.3%)			
Appendicitis (n = 22)	7 (23.3)	10 (50.0)	5 (50.0)
Ovary cystectomy (n = 19)	14 (46.7)	5 (25.0)	0 (0.0)
Ovary adnexal surgery (n = 5)	5 (16.7)	0 (0.0)	0 (0.0)
Adhesiolysis (n = 1)	0 (0.0)	0 (0.0)	1 (10.0)
Cholecystitis (n = 1)	1 (3.3)	0 (0.0)	0 (0.0)
Traumatic bowel perforation (n = 1)	1 (3.3)	0 (0.0)	0 (0.0)
Cecum cancer (n = 1)	1 (3.3)	0 (0.0)	0 (0.0)
Orthopedic procedures (n = 5, 8.3%)			
Tibia fracture (n = 1)	0 (0.0)	1 (5.0)	0 (0.0)
Communicating fracture (n = 1)	0 (0.0)	0 (0.0)	1 (10.0)
Ankle fracture (n = 1)	0 (0.0)	0 (0.0)	1 (10.0)
Metatarsal fracture (n = 1)	1 (3.3)	0 (0.0)	0 (0.0)
Knee patellar fracture (n = 1)	0 (0.0)	1 (5.0)	0 (0.0)
Neurosurgery procedures (n = 2, 3.3%)			
Spinal AVM (n = 1)	0 (0.0)	1 (5.0)	0 (0.0)
Moya-moya disease (n = 1)	0 (0.0)	0 (0.0)	1 (10.0)
Others (n = 3, 5.0%)			
Infected nose implant (n = 1)	0 (0.0)	1 (5.0)	0 (0.0)
Thyroid papillary cancer (n = 1)	0 (0.0)	1 (5.0)	0 (0.0)
Breast ductal carcinoma (n = 1)	0 (0.0)	0 (0.0)	1 (10.0)

Values are expressed as number (%). AVM: arteriovenous malformation.

Table 3. Comparison between Abdominal Surgeries and Other Surgeries during Each Trimester

Surgery type	Total	First trimester	Second trimester	Third trimester	P value
Abdominal surgery	50 (80.0)	29 (96.7)	15 (75.0)	5 (50.0)	0.002
Other surgery	10 (20.0)	1 (3.3)	5 (25.0)	5 (50.0)	

Values are expressed as number (%).

obstetric surgery cases (30 cases [50.0%]), occurred in the first trimester, and this decreased in the second and third trimesters to 20 cases (33.3%) and 10 cases (16.7%), respectively. The most frequent causes of non-obstetric surgery were abdominal surgery (83.3%) and followed by orthopedic surgery (8.3%), neurosurgery (3.3%) and others (5.0%). Of the 50 cases of abdominal surgeries, 24 cases (48.0%) were ovarian surgeries (ovarian cystectomy and adnexal surgery) and 22 cases (44.0%) were appendectomies and 4 cases (8.0%) were other abdominal surgeries. All ovarian masses were benign and the most common types of ovarian mass were dermoid cysts, which were followed by functional cysts, serous cysts and mucinous cystadenomas. Among the 22 cases of appendicitis, 4 cases were perforated appendicitis. Most orthopedic surgeries were performed during the second and third trimester and 1 case of orthopedic surgery was performed

after fetus delivery at the same time as CS was performed. When the incidences of abdominal and other surgeries were compared, abdominal surgery tended to be performed more frequently in the first trimester than in the second or third trimester ($P = 0.002$) (Table 3).

Twenty seven patients were followed after the non-obstetric surgery. Perinatal rates of abortion or premature delivery are presented in Table 4. Adverse perinatal outcomes differed significantly between trimesters ($P = 0.020$). Ten cases of abortion or premature delivery occurred among the 27 cases followed up. Six cases of abortion and 2 cases of premature delivery occurred in the first trimester and 2 cases of premature delivery occurred in the second trimester.

Table 5 presents associations between anesthetic factors and adverse perinatal outcomes. Anesthetic factors including American Society of Anesthesiologist physical status, dura-

Table 4. Perinatal Outcome after Non-obstetric Surgery

Variable	Total (n = 27)	First trimester (n = 13)	Second trimester (n = 9)	Third trimester (n = 5)	P value
Delivery of a full-term newborn	17 (63.0)	5 (38.5)	7 (77.8)	5 (100.0)	0.020
Abortion or premature delivery	10 (37.0)	8 (61.5)	2 (22.2)	0 (0.0)	

Values are expressed as number (%).

Table 5. The Association with Adverse Perinatal Outcomes and Anesthesia-related Factors

Variable	NSVD or cesarean section	Abortion or premature delivery	P value
ASA physical status			0.056
ASA 1	6 (35.3)	8 (80.0)	
ASA 2	10 (58.8)	2 (20.0)	
ASA 3	1 (5.9)	0 (0.0)	
ASA 4	0 (0.0)	0 (0.0)	
Duration of anesthesia (min)			0.224
<60	2 (11.8)	4 (40.0)	
60–120	13 (76.5)	5 (50.0)	
Over 120	2 (11.8)	1 (10.0)	
Anesthesia method			0.516
General	15 (88.2)	10 (100.0)	
Spinal	2 (11.8)	0 (0.0)	
Induction agents			1
Thiopental sodium	10 (66.7)	7 (70.0)	
Propofol	5 (33.3)	3 (30.0)	
Inhalation agents			0.697
Sevoflurane	9 (60.0)	5 (50.0)	
Desflurane	6 (40.0)	5 (50.0)	
Air/N ₂ O			0.697
Air	7 (50.0)	6 (60.0)	
N ₂ O	7 (50.0)	4 (40.0)	

Values are expressed as number (%). NSVD: normal spontaneous vaginal delivery, ASA: American Society of Anesthesiologist, N₂O: nitrous oxide.

tion of anesthesia, anesthesia methods and type of drugs used were not found to be significantly associated with abortion or premature delivery. The multiple logistic regression analysis was performed to determine the natures of associations between different variables and adverse perinatal outcomes and the results of the multiple logistic regression models for the perinatal outcomes obtained are shown in Table 6. Abortion or premature deliveries were found to be significantly associated with trimester, especially the first trimester ($P = 0.030$), whereas maternal age and type of surgery were not.

Table 6. Multiple Logistic Regression Analysis of Adverse Perinatal Outcomes

Variable	OR (95% CI)	P value
Age	0.961 (0.781–1.183)	0.709
Surgery (abdominal surgery vs. other)	1.803 (0.152–21.408)	0.640
Trimester (second, third vs. first)	0.112 (0.016–0.81)	0.030

OR: odds ratio, CI: confidence interval.

DISCUSSION

The current domestic incidence of non-obstetric surgery has been reported to range between 0.2% and 0.43% [11,12], and continues to increase despite a decrease in the number of deliveries. The causes of this continued increase may be the routine use of ultrasound as the first modality during early pregnancy [8] and the rapid development of laparoscopic surgery, which has replaced conventional laparotomy in the obstetric field [7]. As a result, early diagnosis of diseases in pregnancy by ultrasonography has become more common and laparoscopic procedures have facilitated non-invasive surgery. In addition, laparoscopy is also helpful for defining the etiology of abdominal pain, and thus, for avoiding delayed diagnoses [13].

In the present study, the most common cause of non-obstetric surgery was abdominal surgery, which included appendectomy and ovary surgery. Most abdominal surgeries were performed using laparoscopic procedures, only 10 cases were performed by conventional abdominal laparotomy. In accord with this change in surgical procedures from conventional laparotomy to laparoscopic procedures, spinal anesthesia was largely replaced by general anesthesia. Spinal anesthesia was performed only in cases of lower limb surgery. On the other hand, in the previous Lee's study [12], spinal anesthesia (29.4%) was more common during non-obstetric surgery, and laparoscopic procedures were performed in only 2 cases of ovary cystectomy.

In the past, laparoscopy has been considered as an absolute contraindication during pregnancy [2]. Because laparoscopy has potential risks of direct fetal and uterine trauma [14], and fetal respiratory acidosis from absorbed carbon dioxide [13,15]. More importantly, fetal asphyxia with compromise of utero-placental perfusion can be induced by increased abdominal pressure from intraperitoneal gas insufflation [5,8,13]. For these reasons, the use of laparoscopic procedures during pregnancy was controversial until comparatively recently. However, currently indications have extended to pregnant patients with the success of laparoscopy in the non-pregnant patient and it became a common procedure in obstetric field [13]. Furthermore, laparoscopy provides the benefits of early ambulation, minimal postoperative pain and reduced analgesics requirements. Several previous studies that compared open with laparoscopic procedures concluded that no significant difference was evident between two groups [5,14,16]. However, maintaining low pneumoperitoneum pressure (<15 mmHg) or the use of a gasless technique and left uterine displacement after the second trimester to facilitate uterine perfusion and ventilation to prevent maternal CO₂ retention and acidosis are recommended with monitoring maternal end-tidal CO₂ concentration during laparoscopic procedure during pregnancy [2,6,17].

In the present study, 50.0% of total surgeries in the first trimester, 33.3% in the second trimester and 16.7% during the third trimester was performed, respectively. This finding is consistent with the previous Mazz and Källén's study [18]. They reported that 42% of surgery during pregnancy occurred in the first trimester, then 35% in the second trimester, and 23% in third trimester. However, the previous Lee's study [12] showed that 56.8% of non-obstetric surgeries were performed in the second trimester and only 15.6% was performed in the first trimester.

In the present study, the most frequently performed surgery in the first trimester was abdominal surgery, which included appendectomy and ovarian surgery, whereas in the second and the third trimesters abdominal surgery was superseded by orthopedic surgery, neurosurgery and cancer surgery. As has occurred for appendicitis, the most common cause of non-obstetric surgery, that is, ovarian surgery, has also increased significantly, which is attributable at least in part, to the use of ultrasonography during early pregnancy as the first diagnostic tool. Goh et al. [8] reported that the

increased use of ultrasonography in the first trimester has resulted in up to 1% of all pregnancies being incidentally diagnosed with an adnexal mass. Also the other study reported that the great majority of adnexal masses are diagnosed by ultrasonography in the first trimester [19].

Surgery may be required during any stage of pregnancy but maternal and fetal outcomes seem to be critical dependent on the timing of surgery [1]. In general, the second trimester is preferred for surgical intervention [1,5,13], because the first trimester is closely associated with organogenesis and a high rate of miscarriage [5,15] and the third trimester with high premature labor rate [4,8,13]. In our series, no fetal stillbirth or maternal death occurred after non-obstetric surgery, but an increase in the incidences in adverse outcomes was observed after non-obstetric surgery during pregnancy, and most cases of abortion or premature delivery occurred in the first trimester. Therefore multiple logistic regression analysis performed to identify the association between different variables and abortion or premature delivery. Multiple logistic regression analysis showed an association between abortion or premature delivery and the timing, especially the first trimester rather than patient's age or type of surgery. These findings are supported by the results of a systemic review of 54 studies on adverse outcomes after non-obstetric surgery [20]. In this previous study, the overall rate of miscarriages was reported to be 5.8% and the miscarriage rate of pregnant patients that underwent surgical intervention in the first trimester was 10.5%. Similarly, several studies have also suggested that exposure to anesthesia and surgery carries potential risks of preterm labor and abortion [16,18]. Accordingly, we sought to identify anesthetic factors that accounted for adverse outcomes in our patients, but we failed to find any significant correlation observed between adverse perinatal outcomes and anesthesia factors. In a previous study, it was suggested that adverse outcomes such as abortion or preterm labor were the results of surgery itself, the direct manipulation of the uterus or underlying patient conditions, especially infection [1]. Thus, although the present study shows a significant increase in the incidence of adverse perinatal outcomes among pregnant patients exposed to surgery and anesthesia during the first trimester, we suggest additional studies be undertaken to identify the factors responsible for these adverse outcomes.

The present study has several important limitations. First,

the study sample size was too small to draw firm conclusions. Of the 60 patients that underwent non-obstetric surgery only 27 patients (45%) were followed up, the other 33 patients (55%) were lost to follow-up because they registered at other hospitals for delivery. Therefore, although we found an increased incidence of adverse perinatal outcome after exposure to surgery and anesthesia in the first trimester, interpretations of these findings are limited, because small sample size are known to be associated with risk of bias. We suggest additional prospective and multi-institutional based observational cohort study be undertaken to address these shortcomings. Second, the study is inherently limited by its single institutional, non-controlled, retrospective design. In particular, its retrospective nature meant that it was not possible to distinguish between spontaneous abortion and elective termination of pregnancy. Nonetheless, we believe the study provides meaningful, preliminary domestic data regarding non-obstetric surgery, and that it highlights the importance of the association between surgical timing and perinatal outcomes after non-obstetric surgery during pregnancy.

In conclusion, in this single center, retrospective analysis, the incidence of non-obstetric surgery among pregnant women was found to be 2.48%, which is higher than those reported in previous domestic studies. The main cause of the increased rate of non-obstetric surgery among pregnant women appears to be due to the early diagnosis of diseases during early period of pregnancy by ultrasonography and the availability of non-invasive laparoscopic surgery. Furthermore, the increased rate of abortion or premature delivery after non-obstetric surgery was found to be associated with the first trimester rather than age, surgery type, or anesthetic-related factors. Though surgery during the first trimester was found to be associated with adverse perinatal outcomes, sample size limitations prevented the precise delineation of the effects of non-obstetric surgery on outcomes. We recommend a further large cohort, multicenter, prospective observational study be undertaken to clarify this issue.

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