


Estimation of Gastric Volume Before Anesthesia in Term-Pregnant Women Undergoing Elective Cesarean Section, Compared With Non-pregnant or First-Trimester Women Undergoing Minor Gynecological Surgical Procedures

Clinical Medicine Insights: Women's Health
Volume 12: 1–4
© The Author(s) 2019
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/1179562X19828372


Oren Gal^{1,2} , Mark Rotshtein^{3,2}, Dan Feldman^{1,2}, Amir Mari^{1,2} , Motti Hallak^{4,2} and Yael Kopelman^{1,2}

¹Gastroenterology Institute, Hillel Yaffe Medical Center, Hadera, Israel. ²Ruth and Bruce Rappaport Faculty of Medicine, Haifa, Israel. ³Obstetric Anesthesia Unit, Hillel Yaffe Medical Center, Hadera, Israel. ⁴Obstetric and Gynecology Department, Hillel Yaffe Medical Center, Hadera, Israel.

ABSTRACT

BACKGROUND: Traditionally, intubation of pregnant women has been performed using a rapid sequence induction. This is due to the classical concept that women with more than 18 weeks of pregnancy (mid-second trimester) are always considered to have an increased risk of aspiration due to a number of factors, regardless of the fasting duration. Rapid sequence induction is associated with a higher rate of adverse events.

AIMS: Our study aimed to illuminate the hypothesis that there is no difference in gastric volume between term-pregnant women and non-pregnant or first-trimester pregnant women who were undergoing minor gynecological surgical procedures. Accordingly, we measured gastric volume and content before anesthesia in term-pregnant women undergoing elective cesarean section, and to compare it with non-pregnant or first-trimester pregnant women who were undergoing minor gynecological surgical procedures.

METHODS: In this single-center prospective study, the gastric volume and content were assessed by abdominal ultrasound (AUS) just prior to the scheduled procedure. AUS was performed in the sagittal or para-sagittal plain in the upright position and the stomach content was estimated according to the antral circumferential area. Group 1 consisted of 50 term-pregnant women scheduled for cesarean section. Group 2 consisted of 45 non-pregnant or first-trimester pregnant women who were scheduled for minor gynecologic procedure.

RESULTS: Despite significant longer fasting time prior to the interventional procedure in the non-pregnant or first-trimester women group, there was no significant difference in gastric volume between term-pregnant and first-trimester pregnant women ($3.2 \pm 0.97 \text{ cm}^2$ vs $3.2 \pm 0.79 \text{ cm}^2$; $P = .97$). Gastric volume was small in the two groups.

CONCLUSION: Fasting gastric volume before cesarean section in term-pregnant women is small and is not different than in non-pregnant or first-trimester women undergoing minor gynecologic procedures. Ultrasound estimation of gastric volume is a reliable and easy-to-perform technique which might help in decision-making regarding the airway management prior to induction of anesthesia in pregnant women.

KEYWORDS: Pregnancy, gastric volume, anesthesia

RECEIVED: December 28, 2018. **ACCEPTED:** January 2, 2019.

TYPE: Study Protocol

FUNDING: The author(s) received no financial support for the research, authorship, and/or publication of this article.

DECLARATION OF CONFLICTING INTERESTS: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

CORRESPONDING AUTHOR: Amir Mari, Gastroenterology Institute, Hillel Yaffe Medical Center, HA- Shalom St, 381000, Hadera, Israel. Email: amir.mari@hotmail.com

Introduction

Cesarean section is one of the most common operations all over the world. The number of cesarean sections steeply increased over the last decades, and nowadays it has reached approximately 30% of deliveries in the United States.¹ Despite a low operative risk, the growing number of operations invariably led to growing number of complications, including those related to anesthesia.

Pulmonary aspiration of gastric content in pregnant women undergoing general anesthesia remains one of the most serious hazards of obstetric anesthesia.² Obstetric and anesthetic management can vary significantly depending on the country

concerned. Most of the specialists strongly advocate regional anesthesia for cesarean section, but there is still a large amount of general anesthesia interventions in case of emergency operations, failed regional technique, or patient's preference.

It is generally accepted to secure the airway after anesthesia induction with rapid sequence technique, including pre-oxygenation, Sellick maneuver, and no mask ventilation until airway is protected. This technique is the used one in our local clinical practice. However, this technique is considered to contribute to 4–5 times higher frequency of intubation problems and significantly higher incidence of desaturation during induction of anesthesia.³



The concept of “full stomach” and increased risk of aspiration in pregnant women is based mostly on the physiology of pregnancy, referring to the increased gastric volume and intra-abdominal pressure, progesterone-induced decreased gastric motility, and gastro-esophageal sphincter tone. Anesthesiologists consider the fasting status of women after 18 weeks of pregnancy as “full stomach” and increased risk of aspiration and other complications, regardless of actual pre-operative fasting period.^{4,5}

Nevertheless, direct and indirect measurements of gastric volume in pregnant women showed conflicting results.⁶⁻⁸ There is substantial evidence displaying that gastric emptying time in “term”-pregnant women is the same as in non-pregnant subjects.^{9,10} Recently, abdominal ultrasound (AUS) was approved by a few investigators as a simple, safe, and reliable method to estimate the stomach content and volume.^{11,12} Arzola et al¹³ found only 1 of 103 women who meet “full stomach” criteria before cesarean section. The aim of our study was to estimate the gastric volume and content before anesthesia in term-pregnant women undergoing elective cesarean section, compared with non-pregnant or first-trimester women undergoing minor gynecological surgical procedures.

Methods

Setting

This is a single-center, prospective study of consecutive pre-surgical pregnant and non-pregnant women scheduled for elective surgery. The local institutional review board approved the study. Written informed consent was obtained from all patients.

Selection criteria

Inclusion criteria. Pregnant healthy young women, between 18 and 45 years of age, scheduled for elective cesarean section or termination of pregnancy, and non-pregnant women, 18-45 years of age, scheduled for minor gynecological procedures. Minimum fasting time was 6 hours.

Exclusion criteria. Exclusion criteria were as follows: American Society of Anesthesiologists (ASA) score of more than II (2), emergency operation, any gastrointestinal (GI) problems in the anamnesis or medical history, morbid obesity, or diabetes.

Diagnostic workup

All women underwent AUS examination up to 1 hour prior to the anesthesia.

Ultrasound examination was performed with a real-time AUS transducer of 2-6 MHz using the General Electric Logiq C5 premium ultrasound system.

AUS was performed in the sagittal or para-sagittal plain in the upright position and the stomach content was estimated according to the antral circumferential area as measured by the

ultrasound image. Sonographic landmarks such as liver, aorta, vena cava, and pancreas, as well as the classical appearance of the gastric antrum on sonography, were used to identify the antrum in the scanning area.

The ultrasound was done by two operators skilled in image acquisition and identification of the gastric antrum (O.G. and M.R.).

Patient groups

The study compared two groups of patients scheduled for elective surgery as follows:

Group 1—elective cesarean section term-pregnant patients, in whom airway was secured by rapid sequence induction technique, which is the guideline-recommended technique.

Group 2—elective minor gynecologic procedures in non-pregnant or first-trimester patients, in whom no airway protection was needed.

Data collection

Data collected included age, pregnancy week, weight, height, fasting time prior to the performance of AUS, and antral circumferential area.

Statistical analysis

SPSS version 21 was used for the statistical analysis. *T*-test and Kruskal-Wallis test were used for finding differences between quantitative parameters. *P*-value less than .05 was considered as significant. OpenEpi program was used for calculating power analysis following three assumptions: (a) 95% confidence interval, (b) power = 80%, and (c) mean difference between the two groups was 1 (SD = 1) cm, which means that we need to recruit at least 16 patients in each group. We were able to recruit 50 women to make sample size more powerful.

Results

A total of 95 women were included. The first group consisted of 50 women scheduled for elective cesarean section. The second group consisted of a total of 45 women scheduled for elective minor gynecologic procedures. The second group women were either non-pregnant or in first trimester (up to 12 weeks pregnant). In total, 25 of them underwent hysteroscopy, 19 had dilation and curettage for the termination of early pregnancy, and 1 cervical cerclage. The time needed for bedside ultrasound assessment of gastric volume was approximately 5 minutes. The collected data are presented in Table 1.

Despite significant long fasting time prior to the interventional procedure in the minor gynecologic procedure group, there was no statistical significant difference in the antral circumferential area between both groups, correlating to a similar gastric volume.

Table 1. Collected data of the study.

	CESAREAN SECTION TERM-PREGNANT WOMEN (N=50)	NON-PREGNANT OR FIRST-TRIMESTER PREGNANT WOMEN (N=45)	P-VALUE
Age (years)	32.7 ± 6.6	33.6 ± 9.0	.54
Height (m)	1.63 ± 0.08	1.62 ± 0.06	.76
Hours of fasting	9.7 ± 3.1	12.0 ± 2.3	<.0001
Antral area (cm ²)	3.2 ± 0.97	3.2 ± 0.79	.97

Discussion

The main finding of our study is the similarity in gastric volume between the two groups. Despite significant long fasting time prior to the interventional procedure in the minor gynecologic procedure group, there was no statistical significant difference in the antral circumferential area, correlating to a similar gastric volume.

Changes in the anatomy and physiology of the pregnant woman's body contribute to difficulties with airway management during anesthesia, which increase the risk of maternal morbidity and mortality.

Currently, anesthetic-associated obstetric mortality has decreased to seventh on the list of causes for maternal mortality in the United States and remains at the rate of 1-3 maternal deaths per million maternities in both the United States and the United Kingdom.¹ Although each organ system is affected by pregnancy, the changes in the cardiovascular, respiratory, and GI systems have specific pertinent anesthetic implications in relation to cesarean delivery.¹⁴ Another concern related to pregnancy and anesthesia is the respiratory function which is affected by both.

The gravid uterus displaces the stomach and pylorus cephalad, and places the intra-abdominal portion of the esophagus intrathoracic. This decreases the competence of the lower esophageal sphincter, with further reductions in tone from increased progesterone and estrogen levels. Gastric pressure is increased by the enlarged uterus, and gastrin secreted by the placenta stimulates stomach acid secretion, reducing the gastric pH in pregnancy.¹⁵ Mortality from an aspiration event during labor can range from 5% to 15%.¹⁶

Sedation and general anesthesia depress or impede the physiological mechanisms that protect against aspiration (the tone of the lower esophageal sphincter and upper airway reflexes).¹⁷ Therefore, pulmonary aspiration is involved up to 9% of all anesthesia-related deaths.¹⁸

Current guidelines by the ASA recommend a minimum of 2 hours of fasting for clear fluids, 6 hours after a light meal, and 8 hours after a full meal with high calorie or fat content. These guidelines apply only to patients undergoing elective surgery and are not reliable in patients with coexisting diseases that affect gastric emptying or volume, patients in whom airway management might be difficult, or in emergency situations.¹⁹

Previous studies have evaluated the role of abdominal ultrasonography in the assessment of gastric volume content. Carp et al²⁰ were able to differentiate between liquid and solid gastric content by ultrasonography. Carp et al²⁰ imaged the gastric antrum in a cross-sectional view and calculated antral cross-sectional area (CSA). Antral CSA has been shown to be larger in obstetric women in the second and third trimesters, who are allowed to eat during labor versus those on a clear-fluid-only diet, and it decreases with time after oral intake.^{21,22} Sequential measurements of antral CSA after a standardized oral intake have been used to measure gastric emptying time, with good correlation with scintigraphic evaluation.²³ The authors have suggested that bedside two-dimensional ultrasonography can provide reliable qualitative and quantitative information regarding gastric content.²³

General anesthesia may be considered for cesarean delivery scenarios such as emergency cesarean delivery; insufficient time to perform neuraxial anesthesia or to achieve a surgical level via labor epidural catheter; maternal refusal of, inability to cooperate with neuraxial anesthesia, contraindications to neuraxial anesthesia; and failed neuraxial technique.^{24,25}

The "full stomach" concept with the resultant increased risk of aspiration first described by Mendelson in 1946, later known as the Mendelson syndrome, is a well-known entity which since its early description led to a specific attitude in relation to induction of anesthesia in pregnant women undergoing cesarean section.

The combination of low functional residual capacity (FRC) and no ventilation until insertion of an endotracheal tube, as well as the increased oxygen consumption, are the main reasons for rapid desaturation and more frequent intubation failure in pregnant women undergoing cesarean section.

A reduction in aspiration risk is necessary and appropriate precautions need to be taken with anesthetic induction. These typically include the use of a non-particulate antacid (sodium citrate), rapid onset muscle relaxant (succinylcholine), rapid sequence induction, cricoid pressure, and use of a cuffed endotracheal tube to secure and protect the airway during rapid sequence induction and when mask ventilation is not normally provided between induction and laryngoscopy to prevent unwanted insufflation of the stomach that would increase the aspiration risk.²⁶

As described above, the importance of risk assessment for potential aspiration during rapid sequence induction anesthesia seems crucial. Measuring gastric volume over time is difficult, and scintigraphy to assess gastric emptying function has remained the gold standard technique for many years.²⁷ Due to cost, radiation exposure, and the need for specific equipment, this technique has remained largely restricted to research purposes and is not practical on a daily basis. Ultrasound has progressively emerged as a useful replacement because it is cheap and can be performed at the bedside.²⁴

During sonography, the gastric antrum is the gastric landmark most consistently identified (98%–100% of cases).²⁸ The important vascular landmarks including the aorta or inferior vena cava (IVC) and either the superior mesenteric artery or vein have been used to standardize a scanning plane through the antrum.²⁹ With increasing volume, the antrum becomes round and distended with thin walls, and its dimensions can be measured by a standard AUS transducer.

Our impression is that the assessment of gastric volume before a scheduled intervention is a simple, non-invasive, and not time-consuming tool that can be done in a bedside setting just prior to admitting the patient to the operating room. The test requires an ultrasound console and an abdominal transducer, and according to our experience, the ultrasound landmarks and image could be easily taught and done based on the available local team (anesthesiologist or gynecologist).

The assumption of “full stomach” in women admitted for cesarean section is generally attributed to physiological and anatomical changes related to pregnancy, especially deviations in abdominal volumes, pressures, and motility. We found that despite a shorter fasting time before the procedure in the cesarean section women group, there was no clinical difference in their gastric volumes compared to the non-pregnant or early pregnant women.

The main limitations of our study are as follows: the single-center nature of the study, the relatively small sample size, and the inability to assess inter-observer agreement regarding the antral surface area as determined in ultrasound.

Our results should encourage further multicenter studies to better define the role of ultrasound in assessing gastric content and volume in the preoperative setting.

Author Contributions

OG, YK, MR and DF designed the study. OG, YK, DF, MH and AM collected and analyzed the Data. All co-authors contributed to the paper writing and critical revision of the final draft.

ORCID iDs

Oren Gal  <https://orcid.org/0000-0003-3570-4545>

Amir Mari  <https://orcid.org/0000-0002-6828-4738>

REFERENCES

- Hamilton BE, Martin JAVS. Births: preliminary data for 2010. *Natl Vital Stat Rep.* 2011;60:1–25.
- Amie HO, Albert YU, Anna KA. Anesthetic complications in pregnancy. *Crit Care Clin.* 2016;32:1–28.
- Bedson R, Riccoboni A. Physiology of pregnancy: clinical anaesthetic implications. *Crit Care Pain.* 2014;14:69–72.
- Chang J, Streitman D. Physiologic adaptations to pregnancy. *Neurol Clin.* 2012;30:781–789.
- Moore CL, Copel JA. Point-of-care ultrasonography. *N Engl J Med.* 2011;364:749–757.
- Hong J-Y, Park JW, Oh JI. Comparison of preoperative gastric contents and serum gastrin concentrations in pregnant and nonpregnant women. *J Clin Anesth.* 2005;17:451–455.
- Simpson KH, Stakes AF, Miller M. Pregnancy delays paracetamol absorption gastric emptying in patients undergoing surgery. *Br J Anaesth.* 1988;60:24–27.
- Sandhar BK, Elliott RH, Windram I, Rowbotham DJ. Peripartum changes in gastric emptying. *Anaesthesia.* 1992;47:196–198.
- O'Sullivan G. Gastric emptying during pregnancy the puerperium. *Int J Obstet Anesth.* 1993;2:216–224.
- Wong CA, Loffredi M, Ganchiff JN, et al. Gastric emptying of water in term pregnancy. *Anesthesiology.* 2002;96:1395–1400.
- Perlas A, Chan VWS, Lupu CM, Mitsakakis N, Hanbidge A. Ultrasound assessment of gastric content volume. *Anesthesiology.* 2009;111:82–89.
- Putte P, Van de Perlas A. Ultrasound assessment of gastric content volume. *Br J Anaesth.* 2014;113:12–22.
- Arzola C, Perlas A, Siddiqui NT, Carvalho JCA. Bedside gastric ultrasonography in term pregnant women before elective cesarean delivery. *Anesth Analg.* 2015;121:752–758.
- Rollins M, Lucero J. Overview of anesthetic considerations for Cesarean delivery. *Br Med Bull.* 2012;101:105–125.
- Marrero JM, Goggin PM, Caestecker JS, de Pearce JM, Maxwell JD. Determinants of pregnancy heartburn. *Br J Obstet Gynaecol.* 1992;99:731–734.
- Janda M, Scheeren TWL, Nöldge-Schomburg GFE. Management of pulmonary aspiration. *Best Pract Res Clin Anaesthesiol.* 2006;20:409–427.
- Vanner RG, Pryle BJ, O'Dwyer JP, Reynolds F. Upper oesophageal sphincter pressure the intravenous induction of anaesthesia. *Anaesthesia.* 1992;47:371–375.
- Shime N, Ono A, Chihara E, Tanaka Y. Current status of pulmonary aspiration associated with general anesthesia: a nationwide survey in Japan. *Masui.* 2005;54:1177–1185.
- American Society of Anesthesiologists Committee. Practice guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures: an updated report by the American Society of Anesthesiologists Committee on Standards and Practice Parameters. *Anesthesiology.* 2011;114:495–511.
- Carp H, Jayaram A, Stoll M. Ultrasound examination of the stomach contents of parturients. *Anesth Analg.* 1992;74:683–687.
- Scrutton MJL, Metclaf GA, Lowy C, Seed PT, O'Sullivan G. Eating in labour. A randomized controlled trial assessing the risks and benefits. *Anaesthesia.* 1999;54:329–334.
- Fujigaki T, Fukusaki M, Nakamura H, Shibata O. Sumikawa evaluation of gastric contents using ultrasound. *J Clin Anesth.* 1993;5:451–455.
- Darwiche G, Bjorgell O, Thorsson O, Almer LO. Correlation between simultaneous scintigraphic ultrasonographic measurement of gastric emptying in patients with type 1, diabetes mellitus. *J Ultrasound Med.* 2003;22:459–466.
- Bucklin BA, Hawkins JL, Anderson JR, Ullrich FA. Obstetric anesthesia workforce survey: twenty-year update. *Anesthesiology.* 2005;103:645–653.
- Ismail S, Huda A. An observational study of anaesthesia surgical time in elective caesarean section: spinal compared with general anaesthesia. *Int J Obstet Anesth.* 2009;18:352–355.
- Paranjothy S, Griffiths JD, Broughton HK, et al. Interventions at caesarean section for reducing the risk of aspiration pneumonia. *Cochrane Database Syst Rev.* 2010;1:CD004943. doi:10.1002/14651858.CD004943.
- Maughan RJ, Leiper JB. Methods for the assessment of gastric emptying in humans: an overview. *Diabet Med.* 1996;13:S6–S10.
- Sijbrandij LS, Op den Orth JO. Transabdominal ultrasound of the stomach: a pictorial essay. *Eur J Radiol.* 1991;13:81–87.
- Cubillos J, Tse C, Chan VWS, Perlas A. Bedside ultrasound assessment of gastric content: an observational study. *Can J Anesth.* 2012;59:416–423.