BJA Education, 21(11): 404–407 (2021)

doi: 10.1016/j.bjae.2021.08.001
Advance Access Publication Date: 23 September 2021

Revalidation FOR ANAESTHETISTS RCA Revalidation matrix Matrix codes: 1H02, 2A07, 3B00

ESSENTIAL NOTES

Using gastric ultrasound to assess gastric content in the pregnant patient

M. Sherwin* and D. Katz

Icahn School of Medicine at Mount Sinai Hospital, New York, NY, USA

*Corresponding author: marc.sherwin@mountsinai.org

Keywords: diagnostic imaging; gastrointestinal contents; respiratory aspiration of gastric contents; ultrasonography

Perioperative pulmonary aspiration of gastric content can lead to prolonged tracheal intubation, hospitalisation, aspiration pneumonitis and pneumonia.[1] Unfortunately, the risk of aspiration is often estimated by fasting time, not accounting for comorbidities that affect gastric emptying, such as labour. Bedside point-of-care ultrasound (POCUS) of gastric content is a validated tool that allows the anaesthetist to assess the qualitative and quantitative content of the stomach.[2] This technique has been used and validated in pregnant women to define the cut-off values for the risk of aspiration.[3] This article examines the current studies examining gastric content in the third trimester and in labour; demonstrates the technique for gastric ultrasound in the parturient; and discusses the interpretation of findings such as antral cross-sectional area (CSA) to inform clinical decisions.

Uses

Ultrasound assessment of the stomach has been validated in the perioperative period. It may be a useful tool to assess risk of aspiration when there is uncertainty about the duration of fasting or when encountering comorbidities that may prolong gastric emptying beyond recommended guidelines.[4] Although it is possible to proceed with a plan for anaesthesia that assumes aspiration risk, such as inducing anaesthesia with a rapid-sequence technique or awake intubation, these plans are not without their own risks. Being able to assess the patient's aspiration risk may influence the anaesthetic plan in the pregnant or non-pregnant patient. When procedures are required that cannot be performed with neuraxial blockade, the decision between general anaesthesia with tracheal intubation and conscious sedation could be guided by this information. Likewise, if an elective procedure is required, the decision of whether to proceed with a rapid-sequence induction may be avoided by visualising the content of the stomach. Pregnancy can predispose to aspiration because of altered physiology, such as the progesterone-induced relaxation of the lower oesophageal sphincter, increased intra-abdominal pressure from the gravid uterus, and from gastroparesis during labour. Gastric ultrasound is a noninvasive tool that can be used to determine the nature and volume of the gastric content, and whether the volume presents a high or low risk for aspiration, thereby informing the anaesthetic plan for the pregnant patient.

Technique

An ultrasound with a low frequency (2–5 Hz) curvilinear probe should be used. Unlike positioning in the non-pregnant patient, which involves supine and right lateral decubitus, supine positioning is avoided in the third trimester to prevent aortocaval compression; therefore, the 45° semirecumbent and the right lateral semirecumbent positions are preferred.[5] The procedure begins with a sagittal scan in the epigastric area, typically just to the right of midline above the umbilicus,

Marc Sherwin MD is an assistant professor of medical education, anesthesiology, pain and perioperative medicine, and assistant programme director and director of marketing and communications for the Department of Anesthesiology at Mount Sinai Hospital. He is certified by the American Society of Regional Anaesthesia in point-of-care ultrasound (POCUS) and has presented at national and international meetings on gastric ultrasound.

Daniel Katz MD is an associate professor of anesthesiology, pain and perioperative medicine and vice-chair of education at the department of anesthesiology at the Mount Sinai Hospital. He has published several papers on obstetric anaesthesia. He is currently organising a series of videos on POCUS in pregnancy.

Accepted: 11 August 2021

providing a cross-sectional view of the gastric antrum (Fig. 1). The distal portion of the stomach is most amenable to being imaged, as it has less air content and is more superficial than the body or fundus. The view is identified deep and inferior to the left lobe of the liver. In the non-pregnant patient, the aorta in long axis may be a useful landmark, but it is not as easily appreciated when scanning a pregnant patient. The image should be identified first in the 45° semirecumbent position followed by the right lateral semirecumbent position for full examination of the gastric content. It may be more difficult to obtain adequate views in a patient who is pregnant, partly because of the increased respiratory demands, which may make keeping a steady view a struggle. Asking the patient to hold her breath on inspiration once in position can help this challenge. In addition, the body habitus of the patient in the third trimester may push the antrum more cephalad and to the right. Having the patient straighten their legs can also help distance the uterus from pushing up on the stomach. Compared with the non-pregnant female, the uterus will appear in the image.[6]

Interpreting views

Some of the ultrasound views observed when evaluating the stomach are empty, clear fluid, clear effervescent fluid, thick fluid and solids[7] (Fig. 2). Interpretation of gastric ultrasound can be qualitative and quantitative.

Qualitative interpretation

The most widely used method for qualitative evaluation is the Perlas grading scale.[2] This system grades the ultrasound views as 0, 1, 2 or 3 depending on what is seen in which position.

Perlas grading scale:

- Grade 0: an empty stomach is appreciated in both the semirecumbent and right lateral semirecumbent position.
- Grade 1: an empty antrum viewed in the semirecumbent position, but clear fluid visible in the right lateral semirecumbent position.

Fig 1 Image of proper placement of curvilinear ultrasound probe on patient with orientation marker cephalad for evaluation of gastric contents in the right lateral semirecumbent position.

- Grade 2: clear fluid can be seen in both positions.
- Grade 3: stomach that contains either thick fluid or solids.

Validation of this grading system in the non-pregnant adult demonstrated that Grade 1 corresponds to <100 ml of gastric volume in 75% of patients, indicating a low risk of aspiration. Grade 2 is >100 ml of gastric volume in 75% of patients, indicating a high risk of aspiration.[2] This qualitative assessment discriminates between a low aspiration risk of an empty stomach (Grade 0) and high risk of the solid/thick fluid (Grade 3) contents, with the assumption of liquid content volume based on positioning.

Quantitative interpretation

Quantitative measures can be made when clear fluid is present, allowing the ultrasonographer to estimate gastric volume based on the CSA of the gastric antrum when viewed in the right lateral decubitus or right lateral semirecumbent positions in the sagittal plane. When assessing quantitative volume of clear liquid in the stomach, the antral CSA can be derived, depending on the capabilities of the ultrasound used, by free-tracing the circumference of the stomach or by applying the formula for the area of an ellipse ($CSA = (D_1 \times D_2 \times \pi)/4$) by measuring two perpendicular diameters of the antrum[2] (Fig. 3).

After determining the CSA of the antrum, a validated mathematical model can be used to estimate the volume within the stomach. There are several models that have been validated in the pregnant patient and will be discussed in the next section. Baseline gastric secretions typically leave <1.5 ml kg^{-1} of clear fluid in the stomach, which can be seen on ultrasound. Volumes >1.5 ml kg^{-1} indicate an increased risk of aspiration.[8]

Evidence

The first studies examining the gastric content of the stomach were initiated in the late 1980s and further studied in pregnant patients in the 1990s. Studies have shown that ultrasonographers have correctly identified content 87.5% of the time when blindly evaluating pregnant patients.[6] The success of these diagnoses was related to how far into the pregnancy the patient was, with decreasing rates later in pregnancy, attributable to the increased difficulty of the larger gravid uterus. Before the third trimester, nearly 100% were successful, whereas results were closer to 88% when the patient was >36 weeks' gestation.[9]

In 2018, Roukhomovsky and colleagues[9] studied the Perlas score described above in the pregnant patient and revealed that the grade designations also correlated well in pregnancy.

Numerous studies since the late 1980s have evaluated the volume of the fluid content in the gastric antrum. These studies were based on non-obese, non-pregnant adults, and thus further research was necessary to validate a model for the pregnant population. Two publications that have since validated the mathematical formula used to estimate volume have been conducted by Roukhomovsky and colleagues[9] and Arzola and colleagues.[10] Both models were determined based on scanning the patient in the sagittal plane in the 45° semirecumbent position in the third trimester. The study by Arzola and colleagues[10] used a known ingested volume as the standard for comparison, whereas the study by Roukhomovsky and colleagues[9] used MRI measurements for comparison of volumes. The formula used by Arzola and colleagues[10] is:

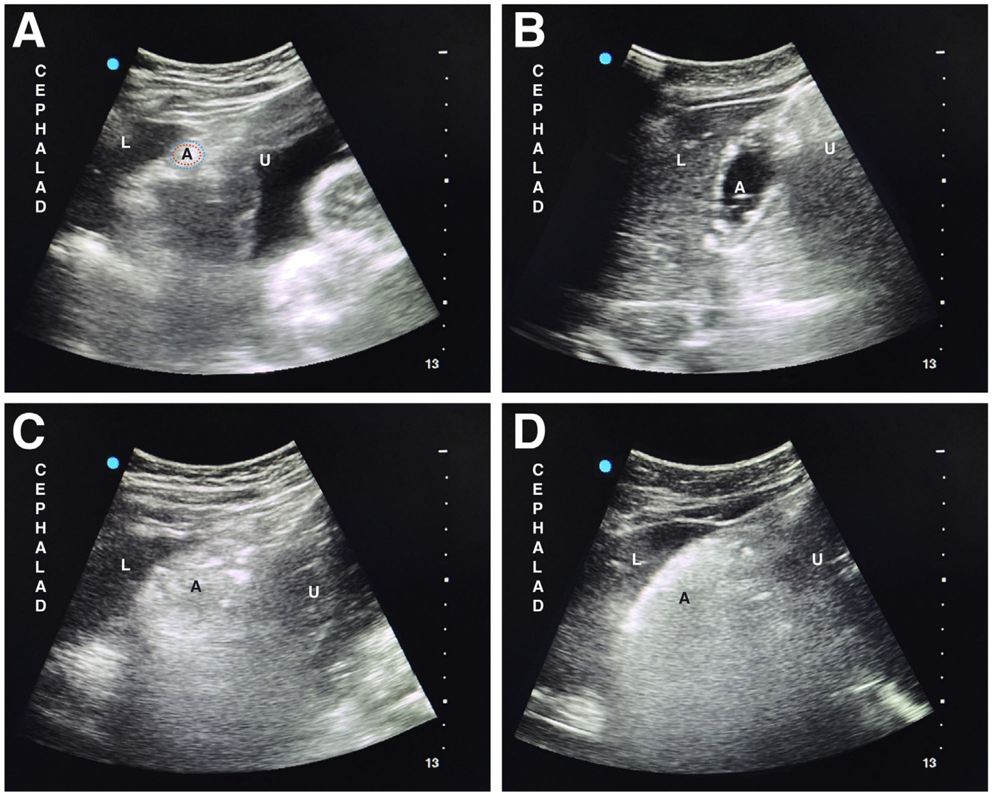

Fig 2 Images acquired with curvilinear ultrasound probe in sagittal plane with orientation marker cephalad to depth of 13 cm with patient in right lateral semirecumbent position. (A) An empty stomach appears small and collapsed, either round or ovoid about 2–3 cm in diameter. It may appear to have a 'target' or 'bullseye'-like appearance because of the reciprocal hyperechoic (red) and hypoechoic (blue) muscular and serosal layers of the stomach, respectively. (B) Clear fluid or effervescent fluid expands the stomach diameter and leaves a homogeneous hypoechoic/anechoic centre, or mobile hypoechoic punctuate echoes with a hypoechoic background, respectively. (C) Solids appear heterogeneous with large and small particles seen, sometimes mixed with air that is ingested during swallowing. (D) With large volumes of air ingestion immediately after eating, the stomach has a 'frosted glass' appearance because of an artefact from the intragastric air. L, liver; A, antrum; U, uterus.

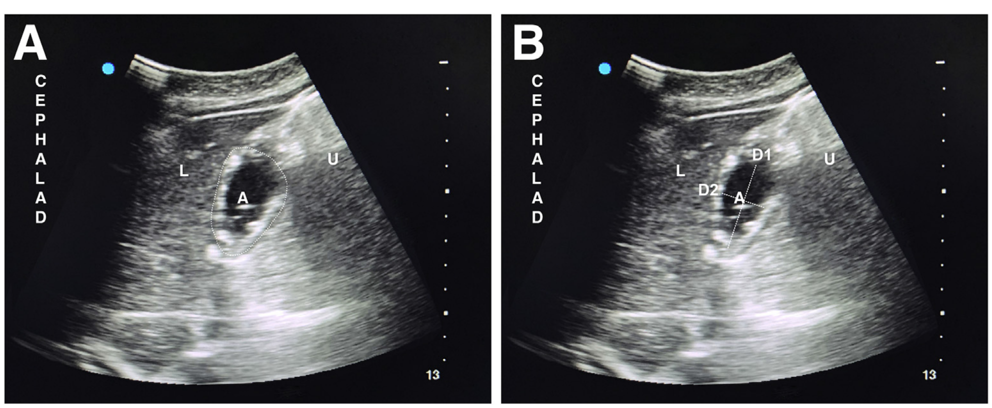

Fig 3 Image of clear liquid acquired with curvilinear ultrasound probe in sagittal plane with orientation marker cephalad to depth of 13 cm with patient in right lateral semirecumbent position. In image (A) free-tracing is used whereas in image (B) two perpendicular lines are used to measure the circumference of the gastric antrum. L, liver; A, antrum; U, uterus; D_1, diameter 1; D_2, diameter 2.

gastric volume (ml) = 327.1 + 215.2 × log right-lateral CSA (cm^2), whereas the formula used by Roukhomovsky and colleagues[9] is: gastric volume (ml) = 0.24 × right-lateral CSA (mm^2) − 54.9. Antral CSA correlates strongly with gastric volume, and either mathematical model can be used to derive the gastric volumes in the pregnant patient.

Conclusions

Ultrasound assessment of gastric content can potentially influence plans for anaesthesia and gives useful information for determining the risk of pulmonary aspiration. With the inherent risks of aspiration in pregnancy, ultrasound can be used to understand the type of content and the volume of liquid content in the patient who may require airway interventions. The role of POCUS in anaesthesia practice is increasing, and the validated models and grading scales of gastric ultrasound aids risk stratification to improve safe care for pregnant patients.

Declaration of interests

The authors declare that they have no conflicts of interest.

References

1. Lienhart A, Auroy Y, Pequignot F *et al*. Survey of anaesthesia related mortality in France. *Anesthesiology* 2006; **105**: 1087−97
2. Perlas A, Van de Putte P, Van Houwe P, Chan V. I-AIM framework for point-of-care gastric ultrasound. *Br J Anaesth* 2016; **116**: 7−11
3. Bataille A, Rousset J, Marret E, Bonnet F. Ultrasonographic evaluation of gastric content during labour under epidural analgesia: a prospective cohort study. *Br J Anaesth* 2014; **112**: 703−7
4. Van de Putte P, Vernieuwe L, Jerjir A, Verschueren L, Tacken M, Perlas A. When fasted is not empty: a retrospective cohort study of gastric content in fasted surgical patients. *Br J Anaesth* 2017; **118**: 363−71
5. Arzola C, Perlas A, Siddiqui NT, Carvalho JC. Bedside Gastric Ultrasonography in term pregnant women before elective cesarean delivery: a prospective cohort study. *Anesth Analg* 2015; **121**: 752−8
6. Arzola C, Cubillos J, Perlas A, Downey K, Carvalho JC. Interrater reliability of qualitative ultrasound assessment of gastric content in the third trimester of pregnancy. *Br J Anaesth* 2014; **113**: 1018−23
7. El-Boghdadly K, Wojcikiewicz T, Perlas A. Perioperative point-of-care gastric ultrasound. *BJA Educ* 2019; **19**: 219−26
8. Zieleskiewicz L, Boghossian M, Delmas A *et al*. Ultrasonographic measurement of antral area for estimating gastric fluid volume in parturients. *Br J Anaesth* 2016; **117**: 198−205
9. Roukhomovsky M, Zieleskiewicz L, Diaz A *et al*. Ultrasound examination of the antrum to predict gastric content volume in the third trimester of pregnancy as assessed by MRI: a prospective cohort study. *Eur J Anaesthesiol* 2018; **35**: 379−89
10. Arzola C, Perlas A, Siddiqui NT, Downey K, Ye XY, Carvalho JCA. Gastric ultrasound in the third trimester of pregnancy: a randomized controlled trial to develop a predictive model of volume assessment. *Anaesthesia* 2018; **73**: 295−303