REVIEW ARTICLE

Gastric Ultrasound for the Regional Anesthesiologist and Pain Specialist

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Abstract: This article in our series on point-of-care ultrasound (US) for the regional anesthesiologist and pain management specialist describes the emerging role of gastric ultrasonography. Although gastric US is a relatively new point-of-care US application in the perioperative setting, its relevance for the regional anesthesiologist and pain specialist is significant as our clinical practice often involves providing deep sedation without a secured airway. Given that pulmonary aspiration is a well-known cause of perioperative morbidity and mortality, the ability to evaluate for NPO (nil per os) status and risk stratify patients scheduled for anesthesia is a powerful skill set. Gastric US can provide valuable insight into the nature and volume of gastric content before performing a block with sedation or inducing anesthesia for an urgent or emergent procedure where NPO status is unknown. Patients with comorbidities that delay gastric emptying, such as diabetic gastroparesis, neuromuscular disorders, morbid obesity, and advanced hepatic or renal disease, may potentially benefit from additional assessment via gastric US before an elective procedure. Although gastric US should not replace strict adherence to current fasting guidelines or be used routinely in situations when clinical risk is clearly high or low, it can be a useful tool to guide clinical decision making when there is uncertainty about gastric contents.

In this review, we will cover the relevant scanning technique and the desired views for gastric US. We provide a methodology for interpretation of findings and for guiding medical management for adult patients. We also summarize the current literature on specific patient populations including obstetrics, pediatrics, and severely obese subjects.

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This article in our series on point-of-care ultrasound (PoCUS) for the regional anesthesiologist and pain management specialist[1] describes the role gastric ultrasound (US) plays in the perioperative setting. It is well known that pulmonary aspiration of gastric contents is a significant cause of morbidity, with in-hospital mortality approaching 20%.[2–4] As regional anesthesiologists and pain management specialists, we routinely provide moderate to deep sedation to patients without a secured airway. Under ideal circumstances, all patients will adhere to the American Society of Anesthesiologists recommendations for nil per os (NPO) status (fasting for ≥2 hours for clear fluids, ≥6 hours for a light meal such as toast, and ≥8 hours for a full meal consisting of fried/fatty food or meat).[5] However, there is great interindividual variability in gastric-emptying time,[6,7] and up to 2% of patients may have solid gastric contents despite usually recommended fasting intervals and no significant risk factors for delayed emptying.[8] Point-of-care gastric US can provide reliable information regarding gastric content and help individualize risk stratification to guide anesthetic management.[9,10] Alakkad et al[10] reported that the addition of gastric PoCUS to clinical assessment resulted in changes in anesthetic management (either timing and/or technique) in 71% of patients who presented for elective surgery with questionable or borderline adherence to fasting instructions.

Gastric US has the potential to shift the current paradigm of aspiration risk assessment. Current management of the critically ill, patients with diabetic gastroparesis, patients with neuromuscular disorders, those with advanced liver or renal dysfunction, and those on high-dose opioids with gastrointestinal dysmotility is based on the assumption of a full stomach. The ability to accurately confirm gastric contents before providing anesthesia is a powerful and arguably essential skill set to guide intraoperative management. Gastric US may be useful not only in these high-risk patients but also in special patient populations where NPO status is difficult to confirm such as parturients,[11] the severely obese,[12] and pediatrics.[13]

Given that regional anesthesia techniques often lend themselves to potential clinical scenarios where patients are at an increased risk of aspiration, such as emergent or urgent trauma patients with unknown NPO status, or patients with chronic pain on high-dose opioids, gastric US is particularly compelling. As regional anesthesiologists continue to expand upon their US toolbox, gastric US has the potential to improve patient management and care.

As is the case with all diagnostic tools, appropriate education and training must be completed to ensure US images are obtained and interpreted correctly. The Indication, Acquisition, Interpretation and Medical Decision Making framework[14] has been proposed as a means to contextualize and systematize the performance and teaching of gastric PoCUS.[15] In this review, we will use a similar approach to introduce the appropriate indications for gastric US, cover the methodology for obtaining and interpreting images, and provide a structured way to guide medical management.

CLINICAL INDICATIONS FOR GASTRIC US

Ultrasound assessment of gastric content is not the current standard of care for elective surgical patients who have followed existing fasting guidelines. Rather, this emerging PoCUS application may be particularly useful when prandial status is unknown or questionable, which is not uncommon in the practice of the regional anesthesiologist. There are several clinical scenarios where

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TABLE 1. Clinical Indications for Gastric US

Clinical Indications for Gastric US	Systemic Disease	Unconfirmed NPO Status	Special Patient Populations
Examples	• Diabetic gastroparesis • End-stage renal or liver disease • Critical illness • Neuromuscular disorders	• Language barriers • Altered mental status (dementia, delirium, trauma) • Inconsistent history	• Severe obesity • Pediatrics (communication difficulties, lack of appreciation of risk) • Obstetrics (prolonged gastric emptying)

NPO status cannot be assumed, and therefore gastric US has the potential to change intraoperative management (Table 1).

GASTRIC US FUNDAMENTALS

Probe Selection

Probe selection is essential for gastric US. The low-frequency large curvilinear probe (eg, 1–5 MHz) is required for adult patients or children weighing more than 40 kg, as it allows for sufficient US penetration into the abdominal compartment and adequate visualization of the liver, gastric antrum, and great vessels, which are important internal landmarks (Fig. 1A).

For small children (<40 kg) a linear probe may be used as the gastric antrum is more superficial, and the higher frequencies (eg, 5–12 MHz) provide better resolution to image the smaller structures (Fig. 1B).

Patient Positioning

Ideally, a gastric examination includes scanning in both the supine (Fig. 2A) and right lateral decubitus (RLD) positions (Figs. 2B) to localize the gastric antrum, the portion of the stomach most amenable to US imaging. Scanning in the supine position will identify large volumes of solids or liquids but may not be sensitive enough to detect relatively small amounts of content, which will tend to be displaced to the fundus, a portion of the stomach that is not easily accessible with US imaging. In other words, the supine position alone can rule in, but not rule out, a full stomach.

In the RLD, a greater proportion of the gastric contents will move toward the more dependent antrum, increasing the sensitivity of the examination. The RLD position is particularly recommended when gastric content is only clear fluid, as a volume assessment in this position will help discriminate between a low volume that is compatible with baseline gastric secretions from higher-than-baseline volumes.

Scanning Technique

The low-frequency large curvilinear probe is placed in the epigastric area in a sagittal or parasagittal plane immediately inferior to the patient's xiphisternum with the orientation marker directed cephalad (Fig. 2). Image optimization requires scanning in an anterior and cephalad direction toward the liver by tilting the tail of the probe toward the feet (Fig. 2).

Visualization of the gastric antrum in a short-axis cross section often requires either sliding or tilting the probe in a left or right direction until the descending aorta or inferior vena cava (IVC) is seen in long axis. Additional vascular structures that can be seen in long axis are the superior mesenteric artery (SMA) and/or superior mesenteric vein. For a further example, see Video 1, Scanning Techniques in Supine and RLD Position (Supplemental Digital Content 1, http://links.lww.com/AAP/A266).

Sonoanatomy

Gastric contents may be visualized at different cross sections of the stomach, including the gastric antrum, body, and fundus. Of these, the gastric antrum has been most extensively studied as it is most amenable to US examination.[16] For this article, we describe only the assessment of the antrum.

Optimal imaging of the antrum includes visualization of the lower edge of the liver at the level of the aorta or IVC in long axis (Figs. 3A, B). The liver is used as an acoustic window to scan the upper abdomen, and it is an important landmark to identify the stomach as the first hollow viscus distal to the lower edge of the liver

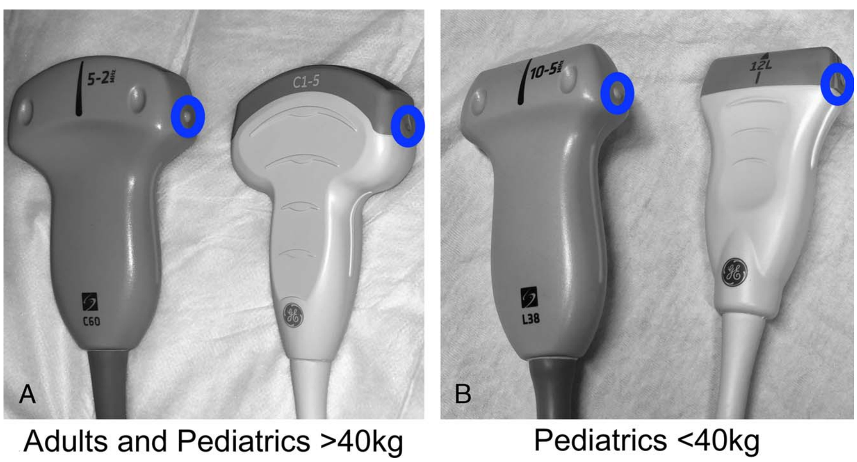


FIGURE 1. Gastric US probes. A, Low-frequency large curvilinear probe. The optimal probe for scanning adult and pediatric patients weighing more than 40 kg. B, Linear high-frequency probe. Optimal for scanning pediatric patients weighing less than 40 kg. Probe orientation markers encircled by blue.

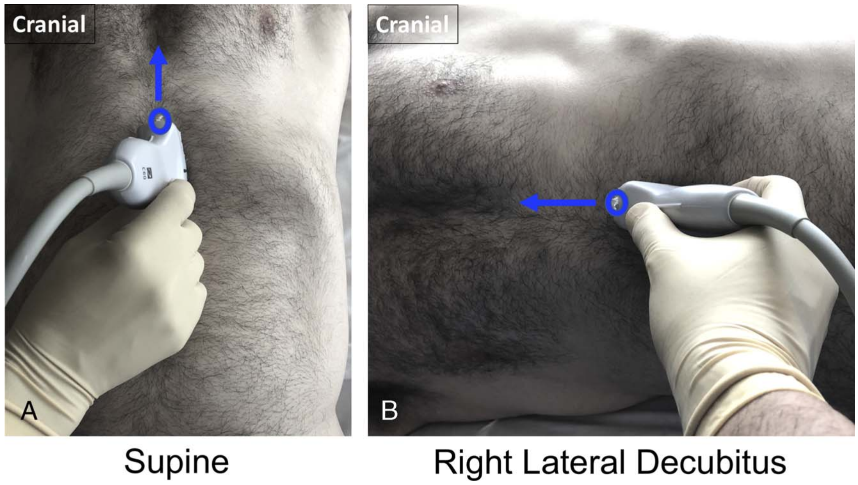


FIGURE 2. Gastric US positioning and probe placement. A, Supine positioning with the US probe in a midline subcostal location, with orientation marker pointed cephalad. B, Right lateral decubitus positioning with the probe in a midline subcostal location, with orientation marker pointed cephalad. Probe orientation markers encircled by blue. Cranial orientation is identified.

in the epigastrium. The pancreas, aorta, and IVC can be seen posterior to the antrum. Of note, the structures deep to the antrum are best visualized with an empty stomach, a stomach with liquids, or a stomach with late-stage solids. Solids that have been recently ingested result in significant air artifact along the anterior antral wall that partially or entirely obscures structures deep to the gastric antrum.

QUALITATIVE GASTRIC US

Antral Sonoanatomy of the Empty Stomach

An empty stomach is seen in both the supine and RLD position as a small, thin, and flat target or a round "bull's-eye"–shaped structure. The bull's-eye shape is due to the 5 alternating hyperechogenic and hypoechogenic layers of the gastric wall, more specifically the hyperechoic outer serosa and inner gastric mucosal-lumen interface that surround the hypoechoic muscularis propria.[17] The antrum is found quite consistently in a sagittal or slightly parasagittal plane between the liver anteriorly and the pancreas posteriorly (Fig. 4). When assessing a patient in optimal RLD position, visualization of a small, thin target or a round bull's eye confirms an empty stomach.

Sonoanatomy for Clear Liquids

Clear fluids (such as normal gastric secretions, tea, or water) have an anechoic (black) appearance on US. With clear liquids in the antrum, the target or bull's-eye appearance seen in an empty stomach will now have a larger center (Fig. 5A). A "starry night" appearance (multiple highly mobile gas bubbles within an anechoic background of clear fluid) is a common finding soon after ingestion of liquids, particularly carbonated drinks (Fig. 5B). In the RLD position, the gas bubbles will be visible in the antrum for several minutes and typically decreases over time, giving way to a more typical anechoic image after the gas component is displaced toward the least dependent areas of the stomach.

Interpretation and clinical implications

Fluid in the gastric antrum can represent recent consumption of fluids, delayed gastric emptying, or normal gastric secretions. A gastric volume assessment can help discriminate a low volume consistent with baseline secretions (≤1.5 mL/kg) from a higher-than-baseline volume.

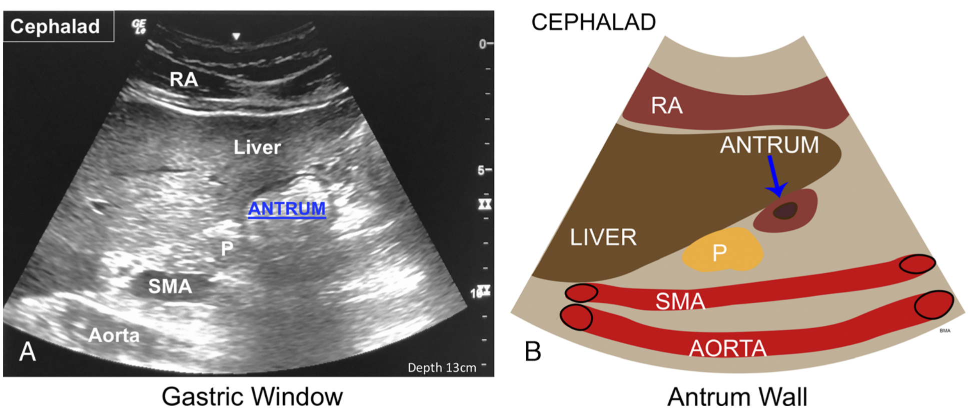


FIGURE 3. Sonoanatomy of gastric window. A, Gastric window. The liver is used as an acoustic window into the abdomen. The gastric antrum and pancreas (P) can be visualized with the aorta and SMA seen in long axis. B, Illustration of gastric window demonstrating relevant anatomy. P indicates pancreas; RA, rectus abdominis.

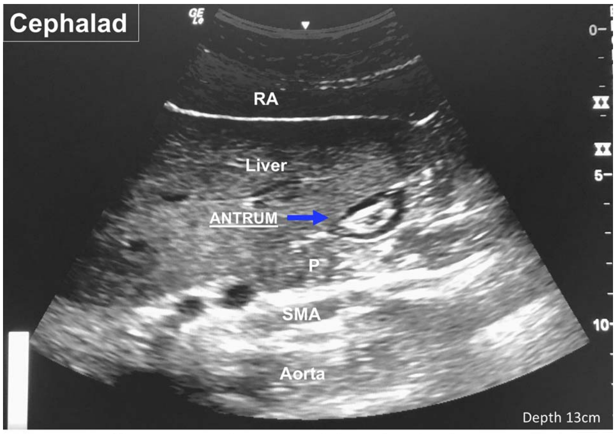


FIGURE 4. Sonoanatomy—empty antrum. The antrum appears as a flat target or round bull's-eye–shaped structure sandwiched between the liver anteriorly and the pancreas posteriorly. P indicates pancreas; RA, rectus abdominis.

Sonoanatomy for Solids

Soon after a solid meal, the sonographic appearance of the gastric content is often described as resembling "ground glass" or "frosted glass" as a result of the US interface between air, liquid, and solids (Fig. 6A). The air swallowed along with the solid food causes the posterior gastric wall and the organs and vessels posterior to the antrum to be either partially or completely obscured. After a variable period, and/or if the solid food was ingested along with fluids, the gastric content will appear heterogeneous with mixed echogenicity (more hyperechoic areas corresponding to the particulate matter and more hypoechoic areas corresponding to fluid; Fig. 6B). In these situations, the swallowed air has dissipated, and the posterior gastric wall and the organs and vessels deep to the antrum are once again visible. Thick fluids such as milk or dairy products tend to appear homogenous and hyperechoic.

Interpretation and clinical implications

The presence of solid or thick particulate content in the stomach is strong evidence of a "full stomach" and suggests a higher-than-baseline aspiration risk. With these findings in the setting of an elective surgical procedure, postponement or rescheduling of the surgical procedure should be considered. Aspiration precautions including endotracheal intubation and rapid sequence induction or a regional technique with no sedation may be appropriate alternatives in urgent and emergency settings.

QUANTITATIVE US TO EVALUATE GASTRIC VOLUME

While the presence of solid food or thick fluid content in the antrum is unequivocal evidence of a "full stomach," clear fluid may be a normal finding and is reported in approximately 50% of all fasted low-risk patients.[11–13,17–19] The questions that follow are: (*a*) How much gastric fluid is normal for a fasted individual? (*b*) Can US discriminate between a normal volume of baseline gastric secretions and a greater-than-normal volume consistent with a "full stomach?"

Although a threshold of gastric volume that increases aspiration risk is not well defined and is far from being universally accepted, there are substantial data on what constitutes a normal volume of baseline secretions. Although the mean volume of baseline gastric secretions is approximately 0.4 to 0.6 mL/kg, the upper end of "normal" (95th percentile) is approximately 1.5 mL/kg (or 100–130 mL in an average 70-kg adult) in elective surgical fasting patients with low aspiration risk. These values are remarkably similar in obstetric and nonobstetric adult patients, as well as in pediatric and obese populations.[11–13,20–24] It seems reasonable therefore to use a threshold of 1.5 mL/kg to discriminate between fasting and greater than fasting gastric volumes.[15–17,23]

Several authors have studied the mathematical correlation between the gastric antral cross-sectional area (CSA) and the total gastric fluid volume,[13,18,23,25–34] with the majority reporting a linear correlation.[13,18,23,25,27,28,31,32,34] Those authors who examined the effect of patient position on the correlation consistently found it most robust when the CSA of the antrum was measured in the RLD position.[17,23,28,29,31–34] For any given volume, the antrum appears "fuller" or "larger" when imaged in the RLD compared with the supine or semirecumbent positions. Several mathematical models have been proposed to date.[18,23,29,32] We have favored the model below as it was validated against a robust criterion standard of endoscopically guided gastric suctioning,[23,35] and its accuracy has been established for a wide range of gastric volumes (0–500 mL), patient sizes (body mass index 19–60 kg/m^2), and ages (18–85 years). The model is described as follows: gastric volume (mL) = 27.0 + 14.6 × right-lat CSA − 1.28 × age.[23] It is a statistically robust model and has been shown to have high intrarater and interrater reliability. The fact that it has only 1 demographic covariate (age) makes it relatively easy to apply (Fig. 7A).[23,36]

Ultimately, regardless of the particular model used, the scanning and measuring technique must be meticulous and follow the

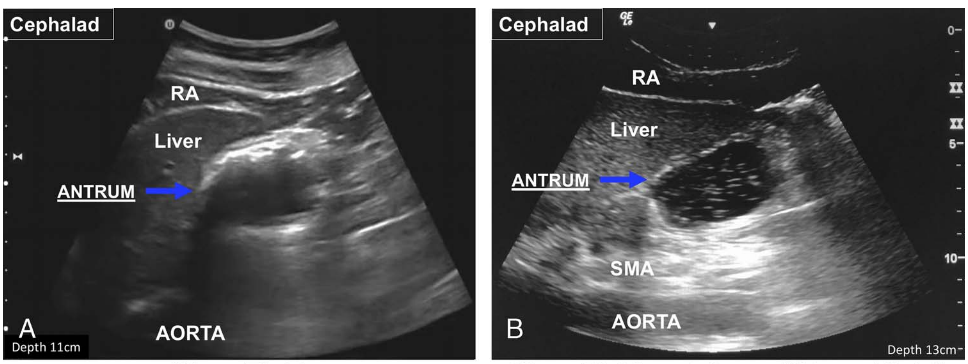


FIGURE 5. Sonoanatomy—clear fluids. A, Clear fluids. Anechoic (black) fluid fills the center of the bull's eye or target with the size of the antrum relating directly to the volume. B, Clear fluid and gas. Carbonated beverages or fluids mixed with air have a "starry night" appearance due to the liquid/gas interface. RA indicates rectus abdominis.

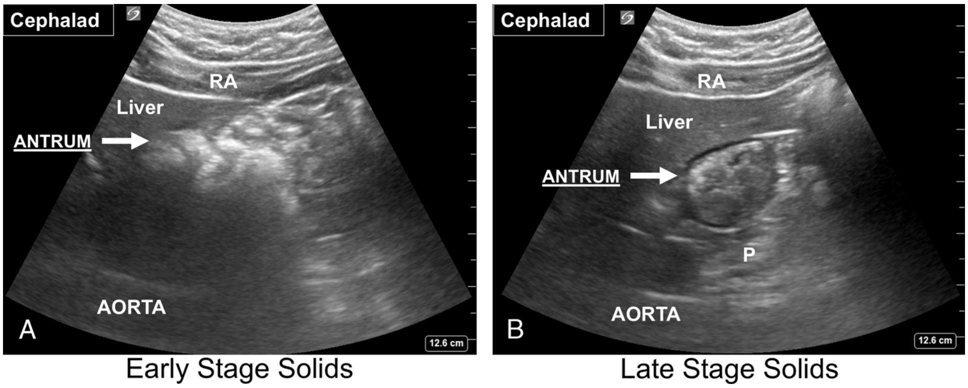


FIGURE 6. Sonoanatomy—solids. A, Early-stage solid resembles a ground-glass or frosted-glass appearance. The posterior gastric wall, as well as the more posterior organs, is either partially or completely obscured. B, Late-stage solid contents appear heterogeneous, particulate, and hyperechoic. The posterior gastric wall and posterior organs are visible. P indicates pancreas; RA, rectus abdominis.

same steps and assumptions used during model development. For the model described previously, a CSA of the gastric antrum is measured using the "free-tracing" caliper of the US equipment with the patient in the RLD position (Fig. 7B). Measurements should be made at the level of the aorta with the antrum at rest (ie, between peristaltic contractions) and including the full thickness of the gastric wall.[23] Similar to other US measurements, a mean of 3 measurements is recommended to minimize error.[36]

A semiquantitative 3-point grading system can be a simpler screening tool to differentiate between high- and low-volume states based solely on qualitative findings in the supine and RLD positions (Table 2).[17,23] A grade 0 antrum (which appears empty in both positions) highly correlates with an empty stomach and is found in approximately half of all fasted subjects.[11–13,23] A grade 1 antrum (which appears empty in the supine position but where clear fluids become visible in the RLD) correlates with a volume of less than 100 mL in most cases and is also a common finding in healthy fasting individuals (approximately half of all cases). On the other hand, a grade 2 antrum (when clear fluid is evidenced in both examination positions) more often corresponds to a volume greater than 100 mL in adults and is not commonly seen in fasting individuals (<5%).[8,11–13,17,19]

Finally, a combination of qualitative US and volume assessment (if required) is used to interpret the gastric US findings in a binary manner as "empty stomach" (no content or low volume of clear fluid compatible with baseline secretions) or "full stomach" (solid content or a high volume of clear fluid inconsistent with baseline gastric secretions) (Fig. 8).

EVALUATION OF THE OBSTETRIC PATIENT

Regional anesthesia is a ubiquitous component of obstetric anesthesia. Evaluation of gastric content is particularly applicable in this population, where the default assumption is high aspiration risk due to possibly prolonged gastric emptying during labor and delivery.[37–39]

Gastric scanning in the obstetric patient may be more challenging than that of the nonobstetric patient because of mechanical compression or displacement of the distal stomach by the gravid uterus and the associated tachypnea and hyperdynamic circulation characteristic of late pregnancy.[11,40–42] Nevertheless, antral visualization is feasible and reproducible in the majority of obstetric patients[11,33,34,40,42–44] and may be optimized through the use of the semirecumbent and RLD position, slight manual displacement of the gravid uterus, and timing image capture with end expiration (Fig. 9).[40] In addition, qualitative gastric US (to discriminate empty from clear fluid or solid content) has been shown to be accurate and reliable in the third trimester.[40]

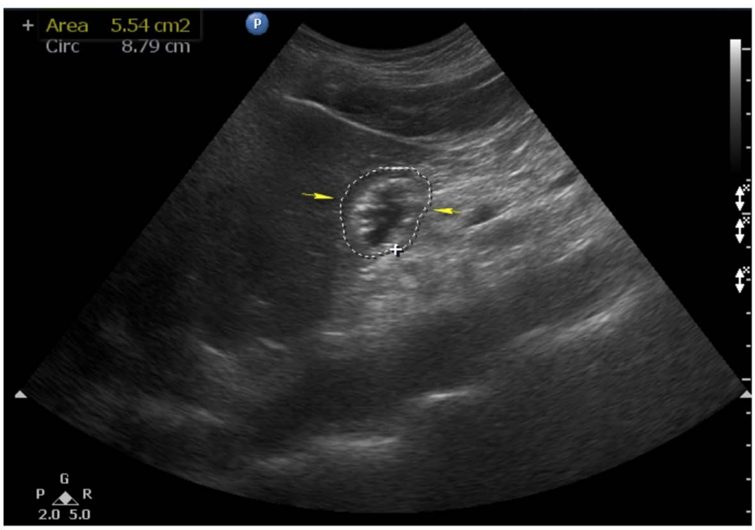
Several authors have studied quantitative gastric US in the obstetric population.[33,34,43–45] Most have focused on defining cutoff values for the gastric antral area that would allow rapid differentiation between varying levels of aspiration risk. For instance, Jay et al[44] reported that using Bouvet's model, a gastric antral area of less than 381 mm^2 in the supine position is 81% sensitive and 76% specific to identify a grade 0 antrum. The clinical relevance of this threshold, however, is limited because approximately half of healthy, fasted parturients present a grade 1 antrum. Therefore, the higher values of the antral area do not represent a higher risk.[11] Along the same lines, Zieleskiewicz et al[43] proposed a gastric antral area cutoff value of 608 mm^2 in the supine position to predict gastric volumes greater than 1.5 mL/kg, suggestive of increased aspiration risk. Although a single antral measurement in the supine position may appear attractive in emergency situations or when patients cannot be turned, it should be emphasized that the literature does not support defining low-risk gastric contents (ie, empty or low volume) on a supine examination alone. Imaging in the supine position can grossly underestimate gastric contents because of gravitational displacement to the gastric body and fundus.[17,23,29] In fact, Zieleskiewicz et al[43] noted that the correlation between gastric volume and antral area improved when area measurements were completed in the RLD as opposed to the supine position, consistent with previous literature.[17,28,32]

Finally, 2 mathematical models have been recently proposed to estimate gastric volume in third-trimester obstetric patients.[33,34] Using ingested volume as a reference standard, Arzola and colleagues[33] proposed a nonlinear model based on the antral CSA with no other covariates. Their model suggests that an antral CSA of 9.6 cm^2 in the semirecumbent RLD position can differentiate between high and low gastric volumes (ie, >1.5 or <1.5 mL/kg) with a sensitivity of 80%.[33] This cutoff value was consistent with a previous study where an antral CSA of 9.6 cm^2 was identified as the 95th percentile for fasted parturients before scheduled cesarean delivery.[11] At the same time, Roukhomovsky and colleagues[34] proposed a linear model for the calculation of total gastric volume (regardless of gastric content) using magnetic resonance imaging as the reference standard. Their model was based on antral area measurements in both the RLD and semirecumbent positions with no other covariates. Both models require further research before widespread adoption into clinical practice.

An old question that has been rekindled by the availability of gastric US is whether gastric emptying is any different in pregnant

Right lat CSA	Age(y)						
	20	30	40	50	60	70	80
2	**31**	**18**	**5**	**0**	**0**	**0**	**0**
3	**45**	**32**	**20**	**7**	**0**	**0**	**0**
4	**60**	**47**	**34**	**21**	**9**	**0**	**0**
5	**74**	**62**	**49**	**36**	**23**	**10**	**0**
6	**89**	**76**	**63**	**51**	**38**	**25**	**12**
7	103	**91**	**78**	**65**	**52**	**40**	**27**
8	118	105	**93**	**80**	**67**	**54**	**41**
9	133	120	107	**94**	**82**	**69**	**56**
10	147	135	122	109	**96**	**83**	**71**
11	162	149	136	123	111	**98**	**85**
12	177	164	151	138	125	113	100
13	191	178	165	153	140	127	114
14	206	193	180	167	155	142	129
15	220	207	194	182	169	156	143
16	235	222	209	200	184	171	158
17	249	236	224	211	198	185	173
18	164	251	239	226	213	200	187
19	278	266	253	240	227	214	202
20	293	281	268	255	242	229	217
21	307	295	282	269	256	244	231
22	323	310	297	284	271	259	246
23	337	324	311	298	285	273	260
24	352	339	326	313	301	288	275
25	366	353	340	327	315	302	289
26	381	368	355	343	330	317	304
27	395	382	369	357	344	331	318
28	410	397	385	372	359	346	333
29	424	411	398	386	373	360	347
30	439	427	414	401	388	375	363

A



B

FIGURE 7. Gastric volume assessment. A, Measurements based on a CSA of the gastric antrum in the RLD. Reprinted with permission from gastricultrasound.org. B, Gastric antrum with clear fluids demonstrating how to accurately measure the CSA of the antrum in the RLD position.

TABLE 2. Antral Grading System

Grade	Antral Presentation	Volume Implications	Aspiration Risk
0	Empty in supine and RLD	Minimal	Low
1	Empty supine and clear fluids in RLD	<1.5 mL/kg, suggesting baseline gastric secretions	Low
2	Clear fluid visible in both positions	>1.5 mL/kg, suggesting in excess of gastric secretions	High

Adapted from gastricultrasound.org.

subjects. Available data are limited and somewhat contradictory. Whereas Wong et al[46,47] concluded that the emptying of clear fluids in nonlaboring term obstetric patients is not different from nonobstetric patients, Barboni et al[41] reported slower gastric emptying of solids in term pregnancy. Arzola et al[11] found that term pregnant women following traditional fasting guidelines for elective cesarean deliveries had a similar gastric volume and similar proportions of antral grades (0, 1, and 2) to the nonobstetric population,[11,17] suggesting that current fasting guidelines are effective to ensure an empty stomach in otherwise healthy, nonlaboring pregnant women.[11]

EVALUATION OF THE PEDIATRIC PATIENT

Questions regarding gastric fullness are common in pediatric anesthesia practice. A reliable fasting history can be difficult to ascertain, and many interventions, including regional anesthesia, are performed under deep sedation or general anesthesia without endotracheal intubation.

The gastric antrum and qualitative antral contents are readily visualized in children.[24,48,49] For optimal imaging of children less than 40 kg, a linear high-frequency transducer is recommended (Fig. 10), whereas a low-frequency large curvilinear transducer is typically required for children weighing more than 40 kg.[48] The distribution of antral grades and gastric volume per unit of body weight are surprisingly similar in fasting children and adults.[13,24,48] As in adults, a linear correlation has been described between antral CSA and gastric volume, and it is the basis of a mathematical model of gastric volume in children: volume = $-7.8 + (3.5 \times \text{RLD CSA}) + (0.127) \times \text{age (months)}$.[13] Of note, this model was developed based on a cohort of 100 fasted children between the ages of 11 and 216 months and has not yet been validated in children with gastric volumes larger than 1.5 mL/kg.

Several special applications of gastric US have been reported in pediatrics. Gagey et al[49] used gastric US to assess stomach

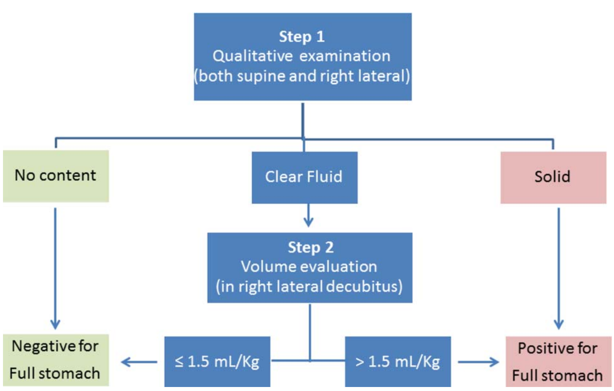


FIGURE 8. Interpretation of gastric PoCUS findings. Adapted and modified with permission from gastricultrasound.org.

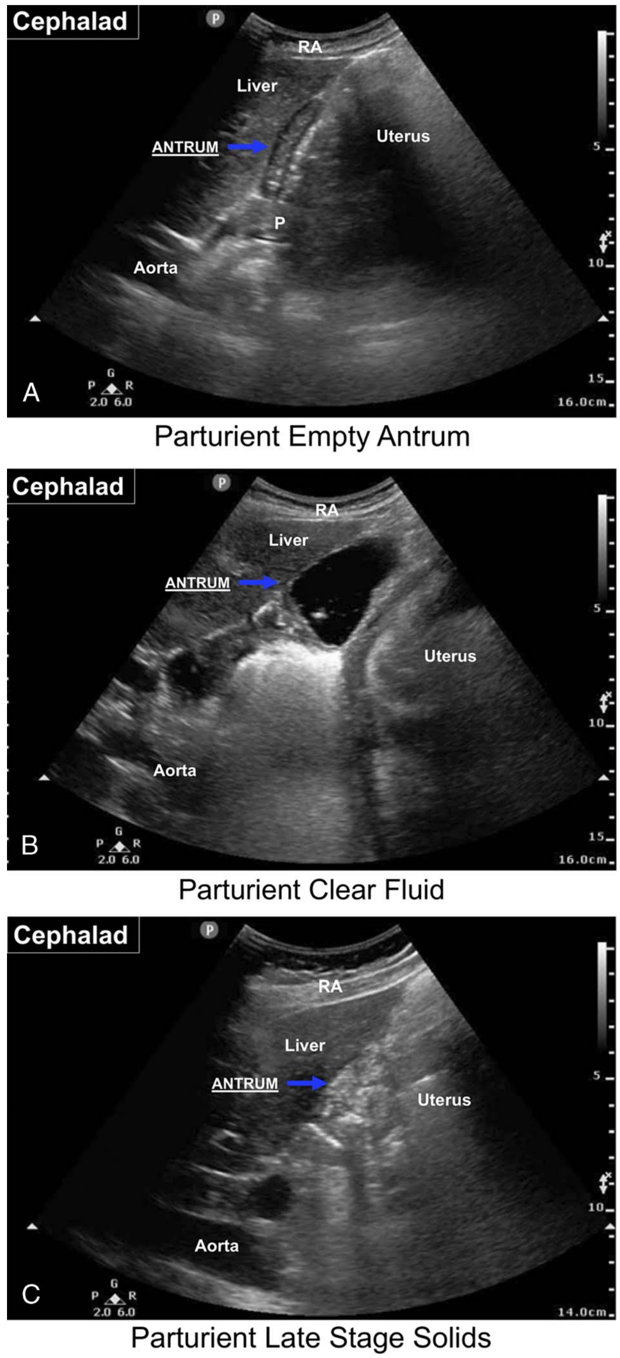


FIGURE 9. Sonographic images of the gastric antrum in third-trimester obstetric subjects imaged at 38 weeks' gestation. The uterus is visible caudal to the gastric antrum. A, Empty antrum. B, Clear fluid content. C, Late-stage solid contents. P indicates pancreas; RA, rectus abdominis.

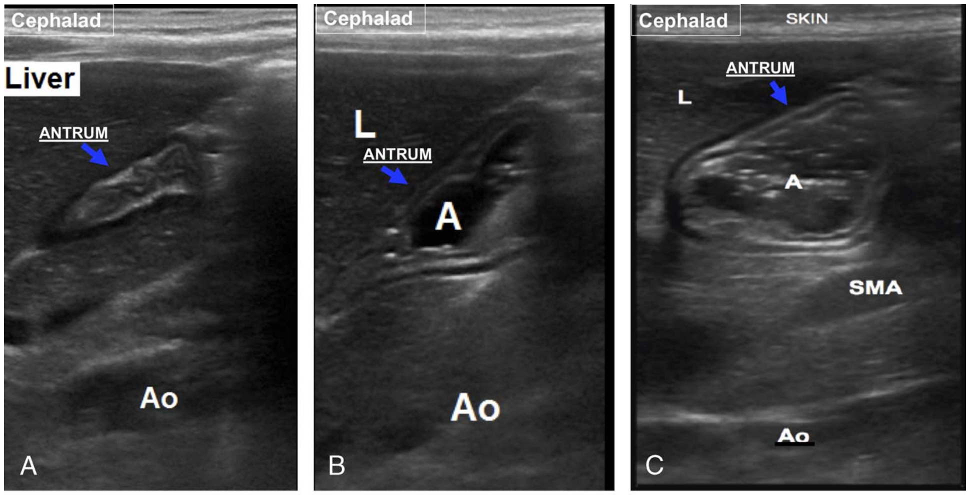


FIGURE 10. Sonographic image of the gastric antrum in a 5-year-old child imaged with a high-frequency linear probe in the RLD position. A, Empty antrum. B, Clear fluid (fasting). C, Solid (particulate). A indicates antrum; Ao, aorta; L, liver. Images are courtesy of Dr Adam Spencer from Calgary Children's Hospital.

contents in infants undergoing pyloromyotomy for pyloric stenosis to inform the decision between a rapid versus a nonrapid induction technique for anesthetic management. In a follow-up study, preoperative US assessment of gastric contents in a cohort of nonelective pediatric surgical patients resulted in changes in management in approximately 50% of cases.[50] Gastric US has been used to assess for the intraoperative accumulation of gastric content (ie, ingested blood) during elective ear, nose, and throat surgery in children[24] and to identify and monitor ingested foreign bodies in children presenting to the emergency department.[51–54]

EVALUATION OF THE SEVERELY OBESE PATIENT

Gastric US has also been applied in the severely obese, an increasing proportion of the population[55] considered at increased risk of aspiration.[19,56–60] Also, this is a patient group where regional anesthesia is a desirable alternative or addition to general anesthesia because of the higher prevalence of comorbidities such as sleep apnea, obesity hypoventilation syndrome, and difficult airway. In many anesthetic practices, regional anesthesia techniques are enhanced with intravenous sedation for patient comfort; thus, aspiration is a very relevant concern.

Although the antrum is located at greater depth compared with non–severely obese subjects (7 vs 3 cm from the skin approximately),[12] imaging the antrum is feasible in the vast majority of severely obese subjects (>95%).[12,35] Also, the mathematical model built for non–severely obese subjects has been shown to perform well in severely obese individuals with a clinically acceptable level of measurement error (mean of 35 mL).[12,35] Fasted severely obese subjects have significantly larger antral CSAs and total gastric volumes compared with non–severely obese subjects. However, the volume per unit of body weight (mean of 0.7 mL/kg) and the distribution of antral grades (grade 0: 42.1%, grade 1: 52.6%, grade 2: 5.3%) are similar to those of the non–severely obese.[12,17,35]

CONCLUSIONS

Point-of-care gastric US is one of the most recently described PoCUS applications. However, given that regional anesthesiologists are often managing patients without a secured airway, the ability to evaluate and document gastric contents and stratify the pulmonary aspiration risk may be clinically useful. One particular advantage of gastric US relative to other more complex PoCUS skills such as focused cardiac ultrasound is that gastric US is a relatively simple skill to learn. Obtaining, interpreting, and guiding management based on qualitative US images (empty vs clear fluid vs solid) is relatively simple. While visualization of liquids in the gastric antrum may require the additional step of quantitative assessment of gastric volume, measuring antral CSA is also relatively simple, accomplished using a free-tracing tool in 2-dimensional mode, without the need of more advanced modalities such as Doppler or M mode. Moreover, point-of-care gastric US is still reliable and reproducible when evaluating patient populations that often create difficulty with image acquisition for other PoCUS techniques (ie, pediatrics, bariatrics, and obstetrics).

Although enthusiasm for gastric PoCUS is growing, and the current research demonstrates a clear current and future role in the perioperative setting, the authors strongly advocate that gastric PoCUS should not be an alternative to or replace strict adherence to current fasting guidelines, nor should it be used routinely to screen gastric content in situations when the risk is clearly low or clearly high based on clinical grounds. Rather, gastric US is most useful when used in a true point-of-care spirit, to decrease "diagnostic uncertainty" when gastric content is unknown or uncertain, and the risk-benefit ratio of different clinical interventions is questionable. Additional research is needed to further validate the indications and clinical application of this emerging tool. Large clinical trials are required to determine if gastric PoCUS can potentially become a new standard for evaluation of preoperative NPO status.

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