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Gastric Point-of-Care Ultrasound (POCUS)

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Continuing Education Activity

Gastric point-of-care ultrasonography is a bedside diagnostic examination used to evaluate gastric contents before anesthesia induction and support individualized aspiration risk assessment. This activity reviews gastric anatomy, scanning techniques, interpretation of qualitative findings, and quantitative assessment of gastric volume in patients with uncertain fasting status or conditions associated with delayed gastric emptying. The existing practice gap is that clinicians may inconsistently identify patients with increased aspiration risk, apply fasting guidance to higher-risk populations, or use gastric point-of-care ultrasonography findings to guide procedural timing and airway planning. This activity addresses that gap by strengthening learners' ability to recognize relevant indications, obtain appropriate parasagittal views, distinguish solids, thick liquids, clear liquids, and an empty stomach, and estimate gastric volume when indicated. Participants will gain actionable skills to improve perioperative decision-making, reduce aspiration-related complications, and support patient-centered anesthetic care.

Objectives:

- Assess the contents of the stomach and the anatomy of adjacent organs.
- Identify the necessary equipment and the proper technique to perform a point-of-care gastric ultrasonography examination.
- Evaluate the ultrasonography findings associated with an empty stomach, liquid in the stomach, and solid food in the stomach.
- Communicate gastric point-of-care ultrasonography findings and aspiration risk considerations with the interprofessional healthcare team to support coordinated perioperative care.

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Introduction

A gastric point-of-care ultrasonography examination is performed to evaluate gastric contents before induction of anesthesia. Aspiration of gastric contents occurs in approximately 1 in every 900 surgical procedures using general anesthesia and accounts for significant perioperative morbidity and an inpatient mortality incidence of 20%.[1] Aspiration can lead to hypoxia, bronchospasm, pneumonitis, pneumonia, acute respiratory distress syndrome, and death. As a result, aspiration pneumonia among surgical patients is associated with a 4-fold increased risk of intensive care unit admission, a 9-day increase in length of stay, and a 7.6-fold increased risk of in-hospital mortality.[2]

Food or liquids in the stomach before anesthesia induction are among the greatest risk factors for perioperative pulmonary aspiration.[3][4][5] Conversely, fasting before planned procedures can reduce the risk of gastric aspiration. The American Society for Anesthesiologists Practice Guidelines for Preoperative Fasting are intended to reduce the risk of gastric aspiration, and recommend that healthy patients fast for at least 2 hours for clear liquids, 4 hours for human breast milk, 6 hours for nonhuman milk, infant formula, or light meals, and 8 hours for fried foods, fatty foods, and meat.[6][7] Anesthesia societies in Canada, Brazil, Europe, India, Australia, and New Zealand have recommended time frames that differ slightly from those published by the American Society for Anesthesiologists and address other preanesthesia dietary factors, such as carbohydrate-rich beverages and gum chewing.[8] However, clear guidance is lacking on appropriate fasting periods for patients at increased risk of delayed gastric emptying or pulmonary aspiration (see **Indications** below).

Gastric POCUS is a simple, fast, noninvasive bedside diagnostic test that provides a qualitative and quantitative assessment of gastric contents.[3][9] This examination allows anesthesia clinicians to differentiate between a full and an empty stomach, determine the consistency of gastric contents (solids, thick liquids, clear liquids), and estimate the volume of gastric fluid (See **Image**. Gastric Ultrasound, Assessment of Gastric Contents). Gastric content assessment helps determine the most appropriate timing for elective procedures, anesthetic choice, and airway management approach.[10]

Anatomy and Physiology

Mastery of gastric POCUS requires knowledge of the anatomy of the stomach and nearby organs (see **Image**. Gastric Ultrasound, Anatomy). The stomach is a J-shaped organ divided into 4 named regions: the cardia, fundus, body, and pylorus (see **Image**. Diagram of the Stomach). The cardia is the region immediately distal to the esophagus. The fundus is the most cephalad portion of the stomach, lying above the cardiac notch. The body is the largest part of the stomach, providing space for food to mix with digestive enzymes. The funnel-shaped pylorus is the distal portion of the stomach, consisting of the antrum and the pyloric sphincter. The antrum lies between the gastric body and the pyloric sphincter, storing food before release through the pyloric sphincter into the duodenum. The antrum is the most important anatomical structure to visualize when performing gastric POCUS.[11]

The stomach wall consists of 3 layers of alternating echogenicity that are frequently distinguishable on ultrasonography. The outermost layer is the serosa, which appears as a thin hyperechoic line. The muscularis propria, immediately deep to the serosa, appears as a thick, hypoechoic line and is easy to see on ultrasonography (see **Image**. Gastric Ultrasonography, Hypoechoic Muscular Layer of the Stomach). The mucosa is the innermost layer of the stomach, which appears as a thin hyperechoic line. Occasionally, 5 layers of alternating echogenicity can be appreciated. The 2 innermost layers are considered artifactual due to the interface between the mucosal layer and the gastric lumen fluid.[12]

Gastric POCUS is performed in the parasagittal imaging plane; therefore, understanding the relationships of adjacent organs to the stomach in this plane is crucial. The liver is easily recognizable because of its large size and highly vascular appearance. The liver should be located on the left of the screen (cephalad). The pancreas is located posterior to the stomach and appears hyperechoic. The bowel is difficult to visualize on ultrasonography due to gas in the lumen, but it is generally located on the right side of the screen (caudad to the stomach).[13]

During gastric POCUS, several major blood vessels, including the aorta, the superior mesenteric artery (SMA), and the inferior vena cava (IVC), can be visualized. All appear anechoic (black) because they are filled with blood. The pulsatile SMA is the most superficial, located posterior to the stomach but anterior to the aorta. The aorta and IVC can be challenging to distinguish because both are large and located at similar depths. In the parasagittal plane, only one should be visible at a time because they run parallel to one another. Conversely, the aorta has a thick wall, is pulsatile, and usually has a smaller diameter than the IVC. The IVC has a thin, often compressible wall, and its diameter changes with the respiratory cycle, decreasing during inspiration and increasing during expiration. The aorta is anterior to the vertebral bodies and to the left of the midline, whereas the IVC is at a similar depth but to the right.[6]

Indications

Gastric POCUS provides a qualitative and quantitative assessment of gastric contents. This examination is most useful when fasting status is uncertain or when physiologic states associated with delayed gastric emptying are present.[14] Information obtained from gastric ultrasonography is used by anesthesia clinicians to determine whether elective surgical procedures should be postponed and to select the optimal induction and airway treatment technique for urgent or emergent procedures.[15]

Uncertain Fasting Status

Uncertain fasting status may be present in patients with unclear histories, cognitive dysfunction, dementia, language barriers, or who cannot reliably follow fasting instructions. Patients at increased risk of delayed gastric emptying or pulmonary aspiration include those with the following conditions:

- Acute pain
- Gastroparesis [16]
- Diabetes mellitus
- Gastroesophageal reflux disease
- Chronic kidney disease
- Obesity [16]
- Pregnancy [16]
- Cannabis use, a risk factor for delayed gastric emptying, cyclical vomiting, and hyperemesis, and its interactions with many other drugs [17]
- Recent use of a glucagon-like peptide-1 receptor agonist (which can delay gastric emptying)[18]
- Opioid use [*Best Practice & Research Clinical Anaesthesiology. Point-of-care gastric ultrasound: Redefining aspiration risk assessment in anesthesia*]

Contraindications

Absolute contraindications to gastric POCUS have not been identified. Relative contraindications include abdominal wounds and epigastric bandages. Patients who cannot be safely positioned in the right lateral decubitus position should not undergo gastric POCUS.

Equipment

Virtually any diagnostic ultrasonography machine can be used to perform gastric POCUS. Ideally, the machine should be able to measure the cross-sectional area.[19] When available, abdominal imaging settings should be selected. An appropriate imaging depth should be chosen to visualize the abdominal aorta. A low-frequency (2-5 MHz) curvilinear transducer is suitable for most patients. A higher-frequency (5-13 MHz) linear transducer may be suitable for small children, although care should be taken to ensure sufficient penetration to image the abdominal aorta.

Personnel

A single, qualified clinician or technician can perform the examination, and a trained clinician can interpret the findings. However, additional help may be required to properly position small children or patients who are unable to cooperate, immobile, or sedated.

Preparation

The purpose of the examination should be explained to the patient before the examination begins. The epigastrium should be exposed, with the patient's chest and pelvic region covered. Clean towels should protect the patient's gown, clothing, and sheets from soiling with the gel. The ultrasonography machine should be positioned so the screen is visible during the examination. Ideally, the examiner should stand on the patient's right side, with the ultrasonography machine opposite the examiner on the patient's left side.

Technique or Treatment

All imaging is performed in the parasagittal plane. The curvilinear transducer should be held in the epigastrium so the orientation marker points toward the head (cephalad). If necessary, the screen should be adjusted to display the orientation marker and cephalad structures on the left. The liver is easily recognized as the cephalad structure on the left of the screen. With the patient supine, the epigastrium should be exposed. The cephalad tip of the transducer should be positioned immediately inferior to the xiphoid process. Correct transducer orientation can be confirmed once the liver is identified.

The inferior vena cava and abdominal aorta must be identified, and the image depth should be adjusted so that the posterior vessel border or vertebral bodies are visible at the bottom of the screen. Required depth varies significantly depending on the patient's body habitus. The abdomen is scanned by sweeping the transducer laterally from left to right, keeping it perpendicular to the skin. The stomach, liver, pancreas, SMA, aorta, and IVC should be identified. The stomach should be examined to observe the characteristics of any gastric contents, noting the presence of solids, thick liquids, or clear fluids.[6]

The supine gastric examination is qualitative only and must be accompanied by examination in the right lateral decubitus position. A full stomach containing solids or thick liquids can be confirmed in the supine position, but a full stomach cannot be excluded. Moreover, gastric volume assessment cannot be performed accurately while the patient is supine. After completing the examination in the supine position, the clinician should place the patient in the right lateral decubitus position. This position facilitates the gravitational flow of gastric contents to the antrum, increasing the sensitivity of the examination and facilitating gastric volume measurement. With the patient in the right lateral decubitus position, the abdomen should be

scanned to identify the previously discussed anatomic structures. Occasionally, image depth must be increased to obtain adequate views of the great vessels of the abdomen. The contents of the stomach must be assessed, again noting thick liquids or solids.[20][21]

- **Solids:** Solids have a heterogeneous, frosted glass appearance on ultrasonography. Structures located posterior to solid food (eg, aorta) may not be visible because of poor penetration of ultrasound waves beyond solid food.
- **Thick liquids:** Thick liquids (eg, yogurt) appear hyperechoic and homogeneous on gastric ultrasonography.
- **Clear liquids:** Clear fluids appear hypoechoic (black) and homogeneous. If the fluid was recently ingested, air bubbles (hyperechoic) may be present, giving it a *starry-night* appearance. Clear liquids in the stomach should be measured by measuring the antral cross-sectional area (CSA) in the right lateral decubitus position and calculating the estimated gastric volume.
- **Empty:** The empty stomach has a *bulls-eye* appearance, with a small or collapsed antrum surrounded by the sonographically distinct layers of the stomach wall. A small volume of clear liquid, representing baseline gastric secretions, often exists within a physiologically empty stomach.[3][9]

If the stomach contains only clear liquids, the volume can be estimated by measuring the antral CSA at the level of the aorta. Measurements must be taken at the level of the aorta rather than the IVC. Because of the funnel-shaped antrum, measurements at the level of the IVC underestimate gastric volume, leading to false-negative results for the presence of gastric contents.[22] The estimated gastric volume is calculated with the equation:

$$\text{Stomach Contents Volume (in mL)} = 27 + (14.6 \times \text{CSA}) - (1.28 \times \text{Age}),$$

For example, a 20-year-old, 80 kg patient with a CSA of 20 cm² would have an estimated gastric volume of $27 + (14.6 \times 20) - (1.28 \times 20) = 293$ mL. A gastric volume-to-body weight ratio of 1.5 mL/kg or less is considered normal, consistent with baseline secretions, and associated with a low risk of aspiration under anesthesia.[23] A ratio greater than 1.5 mL/kg predicts a high risk of aspiration. For the patient in the example, the volume of gastric contents is $293 \div 80$, or 3.7 mL/kg, signifying a full stomach. Results from a recent study confirmed these ratios in patients with gastric cancer who often have delayed gastric emptying. Gastric POCUS was performed before planned gastrectomy.[24] Results from one study found a consistent relationship between antral CSA and aspirated fluid volume after endotracheal intubation. A sensitivity of 91% and a specificity of 71% were observed when the cutoff value for antral CSA was 340 mm² for the diagnosis of a high-risk stomach.[23]

Clinical Significance

The clinical significance of gastric ultrasound depends on the urgency of surgery. For elective procedures, cases should be canceled or postponed if the stomach contains solids, thick liquids, or a volume of clear fluids exceeding 1.5 mL/kg.[23] In emergency procedures or when gastric emptying is unpredictable or may not improve over time (eg, gastroparesis), the risk of aspiration and the optimal timing of the case should be discussed with the patient and proceduralist. The anesthetic plan should include full aspiration precautions if the case must proceed. Options include reduced or no sedation to preserve airway-protective reflexes, or, if sedation is required,

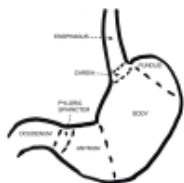
ideally, airway protection with a rapid-sequence induction and endotracheal intubation. Depending on the circumstances, the stomach can be decompressed with a nasogastric or orogastric tube either before induction of anesthesia or following intubation.[9]

Enhancing Healthcare Team Outcomes

Gastric POCUS is a useful diagnostic examination because it can reduce the risk of pulmonary aspiration of gastric contents. However, risk reduction requires effective communication and collaboration between all clinical members of each patient's care team. Surgical schedulers must ensure that patients receive instructions regarding appropriate fasting before surgery. On the day of a procedure, preoperative nurses should assess fasting status during the preoperative interview. The responsible clinician should ensure appropriate diet orders are placed the evening before a scheduled surgery for surgical inpatients. The anesthesiologist or nurse anesthetist is ultimately responsible for performing the final assessment and determining the most appropriate method for reducing the risk of aspiration. However, gastric POCUS can be performed and interpreted by any qualified clinician.

Review Questions

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Figure

Diagram of the Stomach. The diagram illustrates the cardia, fundus, body, antrum, and pyloric sphincter. Contributed by DN Flynn, MD



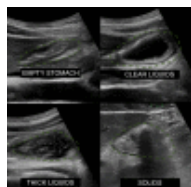
Figure

Gastric Ultrasound, Anatomy. The ultrasound image includes the liver, pancreas, stomach, superior mesenteric artery, aorta, and spine. Contributed by DN Flynn, MD



Figure

Gastric Ultrasound, Hypoechoic Muscular Layer of the Stomach. The ultrasound image highlights the hypoechoic muscular layer of the stomach. Contributed by DN Flynn, MD



Figure

Gastric Ultrasound, Assessment of Gastric Contents. This image is a sonographic appearance of an empty stomach, clear liquids, thick liquids, and solids. Contributed by J Schoenherr, MD, and DN Flynn, MD

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