ISSN: 0975-3583,0976-2833 VOL14, ISSUE 04, 2023

Pre-Operative Assessment of Gastric Contents and Volume Using Bedside Ultrasound- A Prospective Observational Study

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Received Date: 28/01/2023 Acceptance Date:09/04/2023

Abstract

Background: Gastric volume is influenced by the rate of gastric secretions (approx. 0.6ml/kg/hour), swallowing of saliva (1ml/kg/hour), ingestion of solids/liquids, and the rate of gastric emptying. In anaesthesiology and acute care medicine, there is a growing interest in bedside evaluation of gastric fullness to assess pulmonary aspiration risk. With the advent of portable ultrasound machines, performing point-of-care ultrasound has become relatively easy and feasible. **Methodology:** The study was done in all operation theatres of a tertiary medical college and hospital and the duration of the study was from November 2019 to August 2021. The sample size taken was 111 patients. All consenting patients fulfilling the inclusion criteria were included in the study. After taking a written informed consent and noting down relevant comorbidities the patient`s epigastrium was scanned in supine as well as right lateral decubitus position with a curvilinear ultrasound probe to note the gastric antral cross-sectional area. **Result:** Our study showed that fasting for more than 6–10 hours does not guarantee an empty stomach irrespective of whether they have co- morbidities. Those with comorbidities like DM, CKD and obesity appear more prone to have increased gastric volume and contents. The obese patients with diabetes were found to be at greatest risk of having a full stomach. **Conclusion:** Bedside ultrasound is an important tool in determining the status of stomach contents and could prove to be a tool used for stratification of aspiration risk.

Keywords: Gastric, ultrasound, comorbidities, bedside, aspiration

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Introduction

Perioperative pulmonary aspiration of gastric contents is a serious complication of anaesthesia and is associated with high morbidity and mortality. [1] Aspiration can be defined as the inhalation of material into the airway below the level of the true vocal cords. It is linked with a range of clinical outcomes, being asymptomatic in some instances and resulting in severe pneumonitis and ARDS in others. It requires mechanical ventilator support in up to one-third of patients with a mortality of 5%, representing up to 9% of all anaesthesia-related deaths. [2-3] One of the main risk factors for aspiration is the presence of gastric content. The critical volume threshold of gastric fluid that by itself increases aspiration risk is controversial, but healthy, fasted patients frequently have residual gastric volumes (GVs) of up to 1.5 ml kg^{-1} without significant aspiration risk. [4–8] Assessment of perioperative

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 04, 2023

aspiration risk relies almost exclusively on clinical history that may not be reliable. The severity of the resulting respiratory compromise is thought to be related to both the volume and nature of the aspirate, with particulate matter carrying the highest risk. [9] Preoperative fasting guidelines help limit the risk in elective patients with minimal comorbidities. However, fasting intervals are not applicable or reliable in urgent or emergency surgeries or for patients with certain medical conditions that are known to delay gastric emptying. The rate of gastric emptying for non-caloric clear fluids is rapid – the half-time being about 12 minutes. Solids however, require six hours or more to be cleared from the stomach, displaying zero-order kinetics.

In anaesthesiology and acute care medicine, there is a growing interest in bedside evaluation of gastric fullness to assess pulmonary aspiration risk. Gastric ultrasound examination is finding a place as a point-of-care tool for aspiration risk assessment. It can identify the nature of the gastric content, i.e., empty, clear fluid and solid and when clear fluid is present; its volume can be quantified. [10] This study was conducted to pre- assess the gastric contents and volume using bedside ultrasound.

Materials And Methods

This prospective observational comparative study was carried out in the preoperative holding areas of all operation theatres of a tertiary medical college and hospital after receiving clearance from the Institutional ethics committee. The duration of the study was from November 2019 to August 2021. The sample size taken for this study was 111 patients. Patients aged between 18 and 80 years posted for elective surgery who fasted for more than 6 hours for solids and more than 2 hours for clear fluids and those who gave consent for performing preoperative gastric ultrasound were included in the study. Pregnant women, patients with unreliable or unclear fasting history (e.g. language barrier, cognitive dysfunction, altered sensorium), oesophageal or stomach pathology like achalasia cardia, hiatus hernia, CA oesophagus, CA stomach, patients who have undergone gastrectomy, gastric bypass surgery, patients who are unable to turn or lie down in lateral position and those on drugs such as prokinetics which alter gastric motility or gastric emptying times were excluded from the study. Written informed consent was taken. Comorbidities were checked. History, Investigations and Treatment taken were noted. Patients were made to lie in supine position. Epigastrium was exposed. The epigastrium was scanned by the curvilinear probe of Ultrasound machine in a sagittal plane sweeping the transducer from the left to right subcostal margins. Scanning was first done in the supine position followed by scanning in the right lateral position. The gastric antrum was identified just below the left lobe of liver and pancreas where the aorta/superior mesenteric artery acts as important landmarks. A still image of the antrum between peristaltic contractions was identified and captured in ―freeze mode, Cross-sectional area (CSA) -measured using the freehand tracing tool of the callipers software of the ultrasound machine.

According to the appearance on the ultrasound, the contents were identified as either empty, clear liquids, or solids. With increasing volume, the antrum becomes round and distended, with thin walls (Figure 1). Air or gas bubbles appear as multiple mobile punctuate echoes, giving the appearance of a starry night. [11-12] Milk, thick fluids, or suspensions have increased echogenicity. [11, 13]

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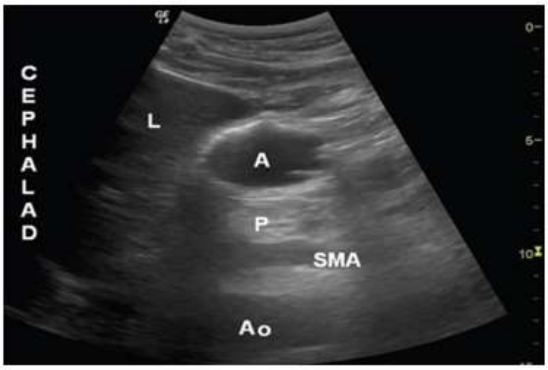

Figure 1. Sonographic image of the gastric antrum containing clear fluid.
Note the antrum appears distended with hypoechoic/anechoic content. A antrum; L, liver; P, Pancreas; Ao, Aorta; SMA, Superior mesenteric artery. [2,17-18]

Grade 0, indicates that the stomach is completely empty and the ultrasound image shows empty antrum in both supine as well as right lateral decubitus position
Grade 1 corresponds to low gastric fluid volume wherein the antrum looks empty in supine position but shows presence of clear fluid in right lateral decubitus position
Grade 2, suggests a high gastric fluid volume with increased risk for pulmonary aspiration and here the antrum shows presence of clear fluid in supine as well as right lateral decubitus positions on the ultrasound image
We have noted the grade of the antrum based on this score.
Data was entered into Microsoft Excel (Windows; version 2007) and analysis was done using the Statistical Package for Social Sciences (SPSS) for Windows software (version 22.0; SPSS inc, Chicago).

Results
Body Mass Index: In the present study we assessed body mass index among the study subjects. Out of 111 subjects 69 had BMI in the range of 18 to 25. 24 had their BMI in the range of 25 to 30 and hence classified as overweight. 16 patients had BMI between 30 and 40 as obese. Table 1 shows Body Mass Index.

Table 1: Body Mass Index

BMI	Number of subjects	Percentage
18 to 25	69	62.16
25 to 30	24	21.62
30 to 40	16	14.42
Total	111	100.00

Correlation of Body Mass Index with Antral Cross Sectional Area: In the present study we assessed the correlation of Body Mass Index with CSA among the study subjects. We observed that majority of the study subjects belonged to BMI 18-25 (63.30%), followed by 25-30 (22.01%), followed by 3040 (14.67%). Table 2 shows correlation of BMI with CSA. We found that as BMI increases there is increase in Antral CSA as well as Gastric volume in both supine and right lateral decubitus.

Table 2: Correlation of BMI with CSA

BMI	Supine		Right Lat. Decubitus	
	Antral CSA(cm^2) (Mean)	Gastric Vol(ml) (Mean)	Antral CSA(cm^2) (Mean)	Gastric Vol(ml) (Mean)
18-	4.07	36.55	5.23	53.43

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25*(n=69)*				
25-30*(n=24)*	6.95	71.47	8.71	97.24
30-40*(n=16)*	7.75	76.25	9.44	100.97

Comorbidities: In the present study we assessed Comorbidities among the study subjects. We observed that 22.93% cases were diabetics, 5.5% cases had chronic kidney disease, 2.75% cases had Psychiatric disorders and were on the drug Clozapine and 3.67% cases were hypothyroid. Table. 3 shows comorbidities.

Table 3: Comorbidities

Comorbidities	**Number of subjects**	**Percentage**
DM	25	22.93
CKD	6	5.5
Psychiatric disorder	3	2.75
Hypothyroidism	4	3.67

Study of co-morbidities: In the present study we assessed gastric antral area and gastric volume among the 109 study subjects Table.5

Table 4: Comparison of gastric volumes and gastric contents in patients with and without significant co‑ morbidities

Parameters		**Supine (mean levels)**		**Right Lat. Decubitus (mean levels)**	
		Antral CSA(cm^2)	**Gastric Vol(ml)**	**Antral CSA(cm)**	**Gastric Vol(ml)**
Diabetes Mellitus	**Diabetes Mellitus**	7.64	75.54	9.40	101.10
	No Diabetes Mellitus	4.53	42.55	5.79	60.84
	Significance	<0.0001	<0.0001	<0.0001	<0.0001
CKD	**CKD**	8.23	85.24	9.83	108.68
	No CKD	5.07	48.02	6.42	67.80
	Significance	0.0003	0.0001	0.0004	0.0004
Psychiatric disorder	**Psychiatric disorder**	6.00	64.30	7.24	82.31
	No Psychiatrics disorder	5.22	49.66	6.59	69.70
	Significance	0.274	0.15	0.328	0.228
Hypothyroidism	**Hypothyroidism**	5.52	47.00	6.49	61.16
	No Hypothyroidism	5.23	50.15	6.61	70.30
	Significance	0.412	0.41	0.46	0.29
Body Mass Index	**Normal BMI**	4.07	36.68	5.20	53.17
	Overweight / obese	7.269	73.3834	9.005	98.729
	Significance	<0.0001	<0.0001	<0.0001	<0.0001

The change in gastric volume from supine to RLD position was statistically significant in each subgroup as well as when they were analysed together. The *P* value being <0.0001 in

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 04, 2023

patients with DM, 0.004 in patients with CKD-chronic kidney disease, <0.0001 in patients with increased BMI and <0.0001 when all the patients were analysed together. Table. 4 depicts the comparison of gastric volumes and gastric contents in patients with and without significant co‑ morbidities.

Correlation of gastric volumes and gastric content with respect to fasting hours and grade of antrum:

Table 5: Correlation of gastric volumes and gastric content with respect to fasting hours and grade of antrum

Fasting times (h)	Gastric volume (average) (ml)	ANTRAL CONENTS			ANTRAL SCORE		
		Empty	Clear Fluid	Soli d	Grade1 (G0)	Grade (G1)	Grade (G2)
8-10*(n=60)*	66.73±29.64	41	13	6	41	8	11
>10-12*(n=24)*	75.72±30.06	14	09	1	14	08	2
>12*(n=25)*	72.59±25.01	24	01	0	24	01	00

In our study, 55% patients had fasted between 8 and 10 h, 22% had fasted between 10 and 12 h and 23% patients had fasted for more than 12 h.

Table. 5 depicts the correlation of gastric volumes and gastric content with respect to fasting hours. In our study 41 patients had empty and Grade 0 antrum at 8 to 10 hours of fasting. 14 patients had similar findings at 10 to 12 hours. 24 patients were received in preoperative holding area when they had fasted overnight for over 12 hours. These patients too had empty antrum with antral score of grade 0. However, we found that 7 patients had solid gastric content with antral score grade 2. Of them 6 had fasted for 8 to 10 hours and 1 had fasted between 10-12 hours. However, all these 7 patients had consumed fatty meal prior to becoming nil by mouth for their scheduled surgery. 13 of our patients who had fasted for 8 to 10 hours had significant clear fluid (> 1.5ml/Kg). 9 patients had fasted for 10 to 12 hours also had significant clear fluid (> 1.5 ml/Kg), 5 of these 9 patients were diabetic and overweight with BMI 25-30 kg/m^2. 1 who had fasted for more than 12 hours had significant clear fluid (>1.5 ml/kg). This patient was an uncontrolled diabetic with BMI 37Kg/m^2.

Discussion

Our study was undertaken to see whether the assumption of 6 hours providing adequate time for the stomach to empty was valid both in patients who had no co‑ morbidities and in those with co‑ morbidities like DM, CKD, Hypothyroidism and obesity. When we co-related gastric volume and gastric content with respect to fasting hours and grade of antrum, we found that patients who had fasted more than 12 hours had greater CSA and gastric volume than patients who had fasted between 8 to 10 hours. Therefore, there is no relationship between prolonged fasting and safe gastric environment. Other authors have found that with prolonged fasting there is a decrease in the pH of gastric contents (pH <2.5) with increased gastric volumes due to increased secretion of gastric acid. [14-16]

The American College of Gastroenterology states that patients suffering from diabetes, especially long standing diabetics, have gastroparesis. [17] In our study there were 25 diabetic patients and 84 non‑ diabetics. When we compared these two subgroups, both of whom had similar fasting times, Antral CSA and gastric volume in patients with diabetics was statistically higher (P < 0.0001 and <0.0001) both in supine and right lateral decubitus when compared to non- diabetics.

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Heena Garg *et-al* [18] in their study ―Comparison of fasting gastric volume using ultrasound in diabetic and non-diabetic patients in elective surgery: An observational study showed that diabetes patients have higher antral CSA and gastric volume than the non- diabetes patients. Their study of 103 patients suggested that diabetic patients have higher gastric antral cross-sectional area and gastric volumes as observed by gastric ultrasound than the non-diabetic patients signifying delayed gastric emptying. While the qualitative grading may be used for screening, quantitative assessment provides a more reliable estimate of gastric volume.
Patients suffering from chronic kidney disease show significant gastroparesis due to uraemia and they are expected to have increased gastric volumes despite fasting, making them prone to aspiration during sedation or general anaesthesia. [19] In our study, we found only 6 patients suffering from chronic kidney disease all of whom had a statistically significant increase in the CSA and gastric volume in both supine and right lateral positions.
Garima Sharma *et-al* [20] in their study ―Preoperative assessment of gastric contents and volume using bedside ultrasound in adult patients: A prospective, observational, correlation study has observed that chronic kidney disease had statistically significant increase in CSA in both supine and RLD. B Van Vlem *et-al* [21] in their study ― concluded that dysmotility-like dyspeptic complaints and delayed gastric emptying are highly prevalent in CRF patients.
In our study, we found only 3 patients were suffering from Psychiatric disorder and were on long term therapy with the antipsychotic drug Clozapine. All of them had a statistically insignificant increase in the CSA and gastric volume from supine position to right lateral positions. Susanna Every-Palmer *et-al* [22] in their study ―Effects of Clozapine on the Gut: Cross-Sectional Study of Delayed Gastric Emptying and Small and Large Intestinal Dysmotility ― Clozapine-treated participants had significant 'slow gut', with dysmotility in at least one region of the gastrointestinal tract evident in 82%, with 59% experiencing multi-regional dysmotility. Delayed gastric emptying was diagnosed in 41% patients.
In our study, we found 4 patients with Hypothyroidism. We studied CSA and gastric volume among these subjects with adequate fasting. We found that there is increase in antral area and gastric volume in right lateral position but it was statistically insignificant. Olga Yaylali *et-al* [23] in their study ― “Does Hypothyroidism Affect Gastrointestinal Motility?” found that the mean oesophageal transit time and gastric emptying time was markedly increased in cases of hypothyroidism.
Obese patients have increased gastric volumes despite fasting for more than 6 hrs. [24] In our study, 16 patients were obese (BMI 30-40 kg/m2). We found that as the BMI increased > 25Kg/m^2 there was a steady rise in the CSA in both supine and right lateral position. S J Jackson*et-al* [25] in their study showed that there is a prolonged lag phase and delayed gastric emptying in obese women when compared to lean women. This delay may be as a consequence of high-fat diets, a sedentary lifestyle and increased gastric distension associated with obesity, or a contributing factor in the pathogenesis of obesity resulting from the inactivation of gastrointestinal satiety signals and in an increase in food intake.

Conclusion

Our study showed that fasting for more than 6–10 hours does not guarantee an empty stomach irrespective of whether they have co‑ morbidities. Those with comorbidities like DM, CKD and obesity appear more prone to have increased gastric volume and contents. The obese patients with diabetes were found to be at greatest risk of having a full stomach.
Thus, it is suggestive that bedside ultrasound is an important tool in determining the status of stomach contents and could prove to be a tool used for stratification of aspiration risk. Gastric ultrasound could help alleviate the stress of an anaesthetist in many situations and lead to better planning and safer outcomes. It would thus be useful in many clinical situations in

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 04, 2023

which aspiration risk is unclear or undetermined and we hope it will eventually become a standard of care.

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