Original Research

A PROSPECTIVE, OBSERVATIONAL STUDY OF PREOPERATIVE GASTRIC CONTENTS AND GASTRIC VOLUME AMONG ADULT PATIENTS SCHEDULED FOR ELECTIVE SURGERY USING BEDSIDE ULTRASOUND

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ABSTRACT

Background and Objectives: Adequate fasting period according to the fasting guidelines and a normal, predicted gastric emptying period are the prerequisites before the anesthesia induction to avoid pulmonary aspiration (PA). Gastric emptying period can be altered in systemic disorders like diabetes mellitus (DM), chronic kidney disease (CKD), hypothyroidism etc. PA can be a serious perioperative complication associated with significant morbidity and mortality. To avoid these consequences it is better to be thorough of gastric contents and its volume preoperatively. There are radiological aided studies assuring if the fasting period can clear the gastric contents or not. Recently there are literature showing the advantage of ultrasonographic (USG) detection of gastric contents in antrum and to correlate it with gastric emptying time after different kind of food intake. But there are limited studies to know the effect of adequate fasting period in gastric antrum, especially in the patients associated with the comorbidities delaying the gastric emptying. The primary objective of the study is to examine the type of gastric contents after fasting period and to determine if there is variation of gastric contents with the associated comorbidities among fasting patients posted for elective surgery by using bedside ultrasound. The secondary objective is to assess if there is any correlation between fasting time and estimated gastric volume.

Methods: The study was conducted in 80 adult patients aged between 18 to 60 years of age belonging to ASA class I, II, III optimized with comorbid diseases posted for elective surgery. A thorough history was taken. The presence of any comorbidities were noted and the fasting period for solids and liquids were noted. A preoperative bedside gastric ultrasound scan was done in supine and right lateral decubitus (RLD) position. Gastric content was noted and cross sectional area (CSA) was measured at the level of gastric antrum in (RLD) position if the content was liquid. Through this CSA gastric volume was derived. Data was collected, tabulated and then analyzed.

Results: Among 80 patients; the gastric antrum was empty in 25(31.25%), liquids <1.5ml/kg body weight in 29(36.25%), liquids >1.5ml/kg body weight in 11(13.75%), semisolids in 11(13.75%) and solids in 4(5%) of patients. Different comorbidities were present among 48% and it was absent in 32% patients. The association of comorbidities like DM, CKD, hypothyroidism, ischemic heart disease and obesity with the risk of aspiration was significantly very high. There was weak correlation between the fasting period and estimated gastric volume.

Conclusion: Our study showed that fasting more than 6 hours do not guarantee an empty stomach. Patient with co morbidities appear to have significantly high risk for aspiration as compared to those with no comorbidities.

Keywords: Fasting, Gastric Content, Gastric Volume, Gastric Antrum, Ultrasonography, Gastric Ultrasound.

www.ajmrhs.com
eISSN: 2583-7761

Date of Received: 14-02-2026
Date Acceptance: 10-04-2026
Date of Publication: 20-04-2026

INTRODUCTION

Pulmonary aspiration though rare, but is potentially a serious complication of airway management in patients undergoing general anesthesia which is associated with prolonged mechanical ventilation and increased mortality.[1] It can result in severe pneumonia requiring mechanical ventilator support in up to one-third of patients with mortality of 5%,

representing up to 9% of all anesthesia-related deaths.[2]

The main risk factor for aspiration are the gastric content with particulate matter and also sedation and general anesthesia which reduces the tone of lower esophageal sphincter and upper protective airway reflexes.[3] To reduce the preoperative gastric contents, adequate fasting and normal gastric emptying time is prerequisite. This has led to the development of fasting guidelines, which can apply to healthy individuals and are unreliable in patients undergoing emergency surgery or associated with co-morbid conditions that alters the gut motility. The American Society of Anesthesiologists (ASA) guidelines for healthy adults (not associated with conditions that delay gastric emptying or increase gastric volume) consider a minimum fasting duration of 2 hrs for clear fluids, 6 hrs for a light meal and 8 hrs for a fatty meal, fried foods or meat to be safe.[4]

In fasting state, gastric acid production is maintained at a low basal rate by the tonic inhibition of acid secretion by somatostatin from gastric D cells. In fed state, gastric acid secretion occurs in three phases: cephalic, gastric and intestinal phase. Most of the gastric acid secretion occurs in the gastric phase.[5] Here, when food enters the gastric lumen, chemical and mechanical factors act on vagal stimulation which was generated from the cephalic phase. In the intestinal phase, gastric acid secretion is returned to its basal level.[6]

The gastric emptying rate is regulated by gastric load, neural and hormonal regulation like ghrelin and glucagon like peptide-1. Co-morbidities can cause gastroperesis.[7]

Despite ASA fasting recommendations, pulmonary aspiration in healthy fasted individuals is about 1:4000.[8] Hence assessing the nature of gastric content and quantifying it preoperatively by an inexpensive yet effective test is important.

Recently there has been growing interest in bed side ultrasound (USG) over complex radiological methods to inform the aspiration risk. It can identify the nature of gastric and quantify its volume.[9]

Stomach has four parts: cardiac, fundus, body and pylorus which is divided into pylorus antrum and canal.[10] Antrum is ideal for scanning by USG as it is easily located at epigastrium the distal part of the stomach and is constantly located in epigastrium and has the least amount of air.[11] Right lateral decubitus (RLD) position is better for USG because gastric content descends to antrum in this position.[11]

The primary objective of the study was to examine the type of gastric contents after fasting period. The secondary objective was to determine if there was variation of gastric contents with the associated co-morbidities among fasting patients posted for elective surgery by using bedside USG.

MATERIALS & METHODS

After obtaining the ethical committee approval, the present study includes 80 subjects aged between 18-60 years age of either sex belonging to ASA I and II and III optimized with comorbid diseases undergoing elective surgeries under general or spinal anaesthesia between September 2019 and June 2021. These patients were fasting overnight. Minimum fasting period was 8 hours and maximum was 12 hours. Randomization of selected patients was done using sealed envelope technique. Patients were excluded if they refused for the study, pregnant if they underwent upper gastrointestinal surgery previously and belonged to ASA grade III (not optimized) or greater than it.

We did practice gastric content and volume identification on normal volunteers with varying fasting times for nearly 3 months. We also took the help of ultrasound trained expert anaesthesiologist and intensivist in performing the USG abdomen and confirming our findings for the first 30 cases.

Patients satisfying the inclusion and exclusion criteria were identified. They were given information about the gastric USG examination study and written informed consent was obtained. A brief history was taken from each patient regarding their comorbidities like diabetes mellitus (DM), hypertension (HTN), chronic kidney disease (CKD), ischemic heart disease (IHD) and medication consumption. Patient's age, heights, body weight, ASA grading and number of fasting hours were also noted.

The USG examination was done with Mindray system M7/M71 with a curvilinear probe (2-5 MHZ), in abdominal scan mode setting. USG was performed in the pre operating holding area before being shifted into the operation theatre. For USG examination, patient was positioned first in the supine position followed by the RLD position. During these positions, curvilinear probe was kept on sagittal section below xiphisternum in supine and RLD respectively. In RLD position, the transducer was swept from the left to the right subcostal margins. Gastric antrum was identified in the sagittal plane in the epigastric region. The liver was identified at the cephaloid position to the gastric antrum and aortic pulsation was identified posterior. Study was conducted in two steps qualitative and quantitative assessment. Qualitative assessment was done by classifying the gastric antral contents into empty, liquids, semisolids or solids. The USG differentiation of gastric contents is done as follows[11]: 1) Empty - antrum appears small and collapsed (about 2-3 cm in diameter). Its appearance sometimes resembles "bull's eye". 2) Liquid - anechoic to hypoechoic appearance in antrum which

represents baseline gastric secretions to clear fluid. 3) Semisolid- hyperechoic and homogeneous appearance in antrum which is due to thick fluids. 4) Solids- "frosted glass" appearance at antrum indicating a recent solid meal mixed with air. This appearance impairs visualization of the posterior wall of the antrum and deeper structures (figure-1).[11]

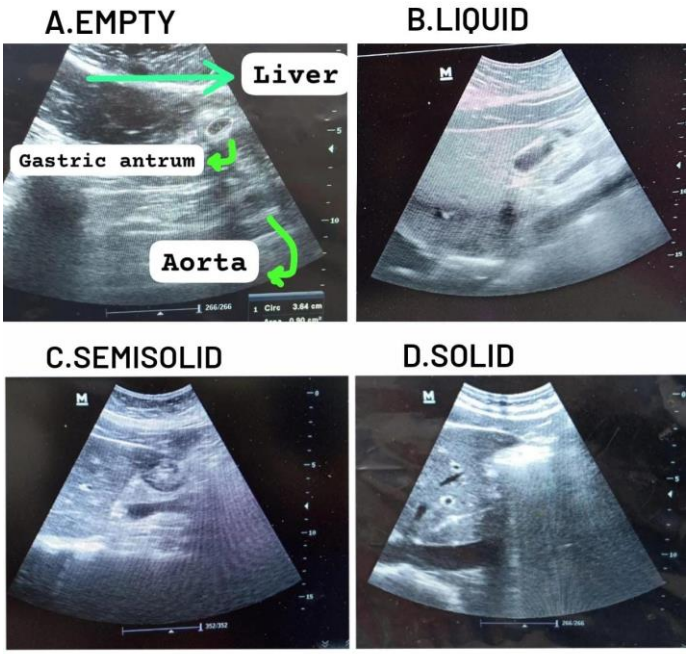

Figure 1: USG Images of the Different Gastric Contents for Qualitative Assessment

Quatitative assessment was done with the liquid gastric content, by measuring gastric volume. The gastric volume was assessed via cross sectional area (CSA) of gastric antrum. CSA was measured by drawing an ellipse (tool built into the USG machine) to include the visualized gastric antrum circumferentially, including the serosa (figure-2). The value was rounded off to nearest odd number. Then gastric volume was obtained from CSA versus age table (figure-3). [12] The gastric volume obtained was further divided with respect to the body weight of the patients as lesser than or greater than1.5ml/kg.

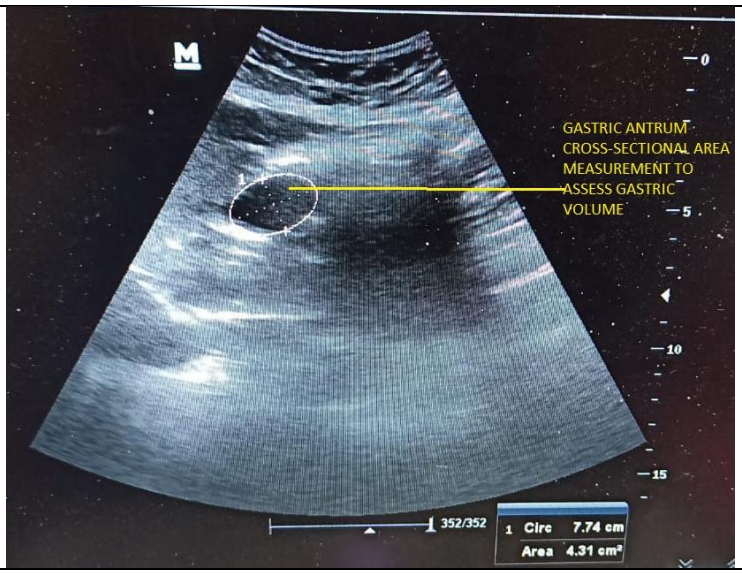

Figure 2: Measurement of Gastric Antrum Cross-Sectional Area to Estimate the Gastric Volume

Right lat CSA (cm^2)	Age (years)						
	20	30	40	50	60	70	80
3	45	32	20	7	0	0	0
5	74	62	49	36	23	10	0
7	103	91	78	65	52	40	27
9	133	120	107	94	82	69	56
11	162	149	136	123	111	98	85
13	191	178	165	153	140	127	114
15	220	207	194	182	169	156	143
17	249	236	224	211	198	185	173
19	278	266	253	240	227	214	202
21	307	295	282	269	256	244	231
23	337	324	311	298	285	273	260
25	366	353	340	327	315	302	289
27	395	382	369	357	344	331	318
29	424	411	398	386	373	360	347

Shaded cells represent low volume states usually considered within the range of baseline gastric secretions for an average adult.

Figure 3: Predicted Gastric Volume (Ml) Based on Measured Gastric Antral Csa (Cm^2) and Patients's Age in Right Lateral Decubitus Position.[12]

Patients with gastric contents as solids, semisolids and liquids of >1.5ml/kg of body weight were considered as having higher risk of gastric aspiration and patients with empty gastric antrum and liquids of <1.5ml/ kg body weight were considered as lower risk as it signifies baseline gastric secretions.

We assessed the relation of these gastric contents obtained by USG signifying the risk of aspiration with different co-morbidities among fasting patients. Also we assessed if there was any correlation between fasting periods with the gastric volume among the patients having liquid as gastric content.

Sample size was calculated using the equation where 'α' is level of significance (type 1 error) and Zα is the corresponding table value 'β' is type 2 error and Zβ is the corresponding table value. 'σ' is pooled standard deviation. 'D' is the size of the effect that is clinically worthwhile to detect the calculated sample size was 60. Taking into consideration the errors we did study on 80 patients. We fixed α as 0.05(5%), β as 0.20(20%) so that power (1-β) is 80%. Data was analyzed using SPSS 21.0 software. Descriptive parameters were represented as mean, standard deviation, frequency and percentage. Association between the categorical variables was asses using chi-square test. Pearson's correlation was assessed between the fasting period of solids and liquids and calculated gastric volume. A p-value of <0.05 was considered statistically significant.

RESULT

Sl. No	Parameters	Mean ±*SD	
1.	Age	42.53 ±13.7	
2	Sex (N=80)	Female	23 (28.7%)
		Male	57 (71.25%)
3	weight (kg)	63.83 ±11.16	
4	#BMI-kg/m^2	24.61 ±3.55	

Table 1: The Demographic Characteristics of Adequately Fasting Patients Posted for Elective Surgeries

* - Standard Deviation
# - Body Mass Index

In our study among 80 patients who fasted were posted for elective surgeries. Mean age was 42.53±13.7. More were males compared to females. The mean body mass index (BMI) was 24.61±3.55. (Table-1).

Supine	N (%)	*Rld		N (%)	Aspiration Risk
Empty	35(43.75%)	Empty		25(31.25%)	Low risk 54 (67.5%)
Liquid	33(41.25%)	Total patients		40 (50%)	
		1.	<1.5ml/kg of liquids	29(36.25%)	

		2.	>1.5ml/kg of liquids	11(13.75%)	High risk 26 (32.5%)
Semisolid	8(10%)	Semisolid		11(13.75%)	
Solid	4(5%)	Solid		4(5%)	
Total	80 (100%)	Total		80 (100%)	80 (100%)

Table 2: Composition of Gastric Contents Among Patients in Supine and RLD Position After Adequate Fasting Period

***-** Right Lateral Decubitus

There was slight variation in gastric contents among fasting patients in supine and RLD position. Higher number of patients had empty and liquid gastric contents in supine position (43.75% and 41.25% respectively) compared to RLD position (31.25% and 50% respectively). On RLD position liquid contents were quantified as <1.5ml/kg of liquids among 36.25% patients and >1.5ml/kg of liquids among 13.75% of patients. Also higher number of patients had semisolid gastric content in supine position than in RLD position (10% and 13.75%). Solid gastric contents were similar in both the positions (5%). 67.5% of patients had lower risk of aspiration with either empty or less than1.5ml/kg of liquids gastric contents after adequate fasting period as detected in RLD position. 32.5% patients had high risk of aspiration with either more than1.5ml/kg of liquids or only solid gastric contents after adequate fasting period as detected in RLD position. Thus after adequate fasting was lower risk of aspiration.

Co-morbidities in fasting patients.		**Gastric contents**					**Total (N=80)**
		Empty (N=25)	**<1.5ml/kg liquid (N=29)**	**>1.5ml/kg liquid (N=11)**	**Semisolid (N=11)**	**Solid (N=4)**	
Comorbidities absent		21(84%)	9(31.03%)	1(9.09%)	0(0%)	1(25%)	32(40%)
Comorbidities present		4(16%)	20(68.97%)	10(90.91%)	11(100%)	3(75%)	48(60%)
1.	*DM	1	6	5	9	3	24(30%)
2.	**HTN	2	5	0	5	0	12(15%)
3.	#CKD	0	0	0	1	0	1(1.25%)
4.	Hypothyroidism	0	0	0	0	1	1(1.25%)
5.	##IHD	0	1	1	0	0	2(2.5%)
6.	Overweight/obesity	1	13	7	9	0	30(37.5%)

Table 3: Distribution of Gastric Volumes and Gastric Contents in Fasting Patients with or without Co-Morbidities

*****-Diabetes Mellitus
**- Hypertension
#- Chronic Kidney disease
##- Ischemic Heart Disease

In our study with 80 patients, more number of fasting patients had comorbidities (60%). Most observed co-morbidity was overweight or obesity followed by DM and then HTN (table-3). Each patient had either one or more than one co-morbidities.

Low risk of aspiration was lower among patients without co-morbidities (93.75%) compared to patients with co-morbidities (50%). High risk of aspiration was higher among patients with co-morbidities (50%) compared to patients without co-morbidities (6.25%). Thus the risk of aspiration is statistical significantly very high among fasting patients with co-morbidities according to USG scanning (table-4).

Co-Morbidities	**Aspiration Risk**		**p-value**
	Low Risk	**High Risk**	
No (N=32) (40%)	30 (93.75%)	2(6.25%)	<0.01
Yes (N=48) (60%)	24 (50%)	24 (50%)	
Total (N=80)	26 (100%)	54(100%)	

Table 4: Association between Co-Morbidities Present among Fasting Patients and Risk of Aspiration

DISCUSSION

A full stomach prior to general anesthesia has been a concern ever since Mendelson, in 1946, described his dreaded 'Mendelson's acid aspiration syndrome which can lead to severe aspiration pneumonia.[13]

In the past there were several methods for the gastric content assessment. Gastric scintigraphy is the gold standard for assessing gastric contents. In Vasavid et

al. study gastric scintigraphy was done among 192 fasting patients who received a test meal having a blend of steamed rice with microwaved egg.[14] Gastric emptying time was noted and the conclusion was derived that it was affected with smoking, gender and menstrual status.[14] Similarly there are several scintigraphic studies with gastric emptying time as prime interest compared to evaluating gastric volume in perioperatively fasting patients. Besides, shifting the already apprehensive, preoperative, fasting patients for scintigraphy would have been a cumbersome procedure. Unlike this, bedside USG can be comfortably accepted by the patients to know the gastric condition.

The efficiency of USG to assess different gastric contents like solids and liquids, qualitatively and quantitatively among patients after consumption of different food items like clear fluids, milk and solids are well documented in Cubillo et al. and Bisinotto et al. studies.[15,16]

Similarly, in our study, using USG for qualitative and quantitative assessment of gastric contents, we noticed different types of gastric contents. Despite of adequate period of fasting, there were gastric contents like solid, semisolids and liquid gastric contents more >1.5ml/kg body weight among 32% of fasting patients which indicates high risk of aspiration.

There are also studies showing gastric contents representing high risk of aspiration. Chang et al. in their study observed that 13% of fasting patients scheduled for elective cholecystectomy had a full stomach due to liquid >1.5ml/kg body weight and solid components at antrum in USG.[17] Sharma G et al. conducted an observational study to determine, USG based gastric volume and contents among 100 preoperatively fasting adult patients. Around 22% of the fasting patients had increased risk of aspiration with 6% patients showing solids and 16% showing liquid >1.5 ml/kg body weight.[18]

High gastric volume and the contents creating the caution vibes were found even in non-USG based studies. Phillips et al. examined the residual gastric contents of 255 fasted patients undergoing gastrointestinal endoscopy. They were considered to have high risk of aspiration, if residual gastric content collected by suction during gastroscopy was volume >25 ml and its pH <2.5. Using multiple logistic regression analysis, they concluded that there was risk of aspiration in fasted patients especially in males, without any antacids.[19]

In our study, risk of aspiration was significantly higher with patients associated with co-morbidities especially with obese/overweight and with DM.

Garg et al. study also revealed higher gastric volume among preoperatively fasting patients with DM than with non-DM enhancing their risk of aspiration using USG antral scanning.[20] In Darwiche et al. study USG antral CSA was detected post-prandially followed by gastric emptying rate.[21] Their study concluded the presence of gastroperesis among patients with DM due to delayed gastric emptying rate after taking a semisolid meal compared to healthy patients without DM.[21]

There are limited studies to assess gastric content association with obesity. In Ramadan et al. study, they did comparison of qualitative and quantitative USG gastric volume among 100 fasting patients preoperatively. Fifty of them were obese and fifty were non obese. They concluded that obese patients had risky gastric contents than the non-obese patients with significant variation in gastric contents and volume. However, the mean gastric volume per kg body weight was lesser than 1.5. More studies are needed in obesity for a deeper interpretation.[22]

There were some limitations in our study. There are possibilities of inter individual variation in USG observations. The association of various demographic factors with the gastric contents could also have been assessed. But we focused on our primary and secondary objectives to know gastric contents after fasting period and its relation with co-morbidities present in fasting patients.

CONCLUSION

In our study, even after adequate fasting, there were gastric contents remaining as detected by USG. Patients with co-morbidities had significantly higher risk of gastric aspiration as compared to those without co-morbidities. Hence extra aspiration precautions have to be taken among these patients especially with DM and obesity. More studies are needed to know the efficacy of USG to detect risk of aspiration in patients with specific co-morbidities.

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How to cite this article: Dr. Priyanka Patil, Dr. H.G. Manjunath, Dr. Greeshma N. Murdeshwar, A PROSPECTIVE, OBSERVATIONAL STUDY OF PREOPERATIVE GASTRIC CONTENTS AND GASTRIC VOLUME AMONG ADULT PATIENTS SCHEDULED FOR ELECTIVE SURGERY USING BEDSIDE ULTRASOUND, Asian J. Med. Res. Health Sci., 2026; 4 (1):1245-1251.
Source of Support: Nil, Conflicts of Interest: None declared.