Original Article

Ultrasound Assessment of Residual Gastric Content in Patients Fasted for Elective Surgery- A Prospective Observational Study

Manju Dhandapani[1], Balasubramanian Shanmugam[2], Udhaya sankar Sethuraman[3], Dilip Chandar Desingh[2]

[1]Assistant professor, Department of Anaesthesiology, Sri Lakshmi Narayana institute of Medical Sciences, Pondicherry, India. [2]Professor, Department of Anaesthesiology, Sri Manakula Vinayagar medical college and Hospital, Pondicherry, India. [3]Assistant Professor, Department of Anaesthesiology, Sri Manakula Vinayagar medical college and Hospital, Pondicherry, India

Abstract

Background: Aspiration pneumonia is a dreadful complication with significant morbidity and mortality. Preoperative fasting help to reduce the risk of aspiration or regurgitation. This study aimed to assess the residual gastric content in patients posted for elective surgery using ultrasound. We also evaluated the association between fasting period and residual gastric content and correlation of co-morbidities in gastric emptying in terms of residual gastric content. Setting and design a prospective observational study done in a tertiary care teaching hospital in south India. **Material and Methods:** The study was carried out in 210 patients. Using systematic random sampling, every second patient on the elective OT list was selected for the study. Before induction of anaesthesia, patients were examined in the preoperative waiting room using ultrasound. Patients were scanned in supine followed by right lateral position. For qualitative assessment, gastric antrum classified under 3 point grading system- Grade 0, 1 and 2. Using validated mathematical formula, CSA = (CC × AP × π) / 4, Gastric Volume (ml) = 27.0 + 14.6 × (Right lateral CSA) – (1.28 × Age) quantitative assessment done. For the statistical analysis, the association was analyzed using ANOVA test. **Results & Conclusion:** Out of 210 patients, 16 patients had Grade 2 antrum and in quantitative assessment, one patient had high gastric volume > 1.5 ml/kg with a potential risk for aspiration. We also found that patients with risk factors like overweight, diabetes mellitus and elderly adults had high gastric volume compared to healthy adults. We conclude, adequate fasting time doesn't guarantee a zero gastric volume mainly due to some predisposing factors which delays gastric emptying or increase in antral size.

Keywords: Gastric ultrasound, preoperative fasting, residual gastric volume.

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Introduction

Full stomach prior to surgery is considered one of the greatest risks for aspiration during perioperative period. In 1946, it was first described by Mendelson as Mendelson's syndrome or Acid aspiration syndrome.[1-8] Mendelson's syndrome is the major cause for morbidity and mortality in obstetric anaesthesia. Gastric aspiration during the perioperative period is still a serious complication that is associated with higher mortality and morbidity, often needing an intensive care admission with mechanical ventilator assistance.[1,3] The nature and volume of the gastric aspirate determines the patient outcome. American Society of Anaesthesiologists (ASA) have recommended preoperative fasting before surgery to prevent aspiration during anaesthesia.[3] The preoperative fasting guidelines by ASA is designed in such a way to prevent aspiration during anesthesia and to reduce the virulence of the aspirate.

Gastric emptying period varies with every individual remarkably based on their pre-existing comorbidities. Research in the past has shown that conditions like diabetes mellitus, renal impairment, morbid obesity, scleroderma and various drugs impair normal gastric emptying.[6-10] A decrease in gastric motility is noted in elderly individuals. Obese patients may present with large antral size and larger baseline gastric volume compared to non-obese individuals.[7]

Till the recent past the clinical evaluation of preoperative fasting is very limited, of late with the ubiquitous penetration of ultrasonography in perioperative medicine has given a method to evaluate it by means of antral sonography. Antral sonography can help in both qualitative and quantitative analysis of gastric content in a non-invasive way.[1,3]

This study was done to evaluate the effectiveness of fasting guidelines in perioperative period in Indian population. The study was done because of paucity of evidence in the Indian population and the ASA guidelines are based on findings from western population.

Materials and Methods

The study was designed as per good clinical practice (GCP)

Address for correspondence: Dr. Dilip Chandar Desingh, Professor, Department of Anaesthesiology, Sri Manakula Vinayagar medical college, Pondicherry, India.
E-mail: dilipchandar2000@gmail.com

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guidelines by World Health Organization (WHO), a prospective observational study, done in a tertiary care teaching hospital in South India from a period of November 2019 to March 2021. The primary objective of the study was to evaluate the association between fasting period and residual gastric content. And the secondary objective was to determine the association between co-morbidities and gastric emptying in terms of residual gastric content. Using Systematic Random sampling, every second patient on the elective OT list was selected for the study.

A sample size of 210 patients were calculated using Open Epi software version 3.3, considering the mean value of Grade 0 antrum from a similar study1 with 95% of confidence interval 80% of power and alpha error less than 0.05. The association was analyzed using ANOVA test and a p value of less than 0.05 was taken as significant.

Patients posted for elective surgeries who were fit under ASA-Physical status I, II and III, Patients of either sex and Age group of 18 to 65 years were included in the study. Pregnant women, Patients with Gastric outlet obstruction and abnormality in upper gastrointestinal tract like Gastro Esophageal Reflux Disease (GERD) and hiatus hernia were excluded from the study.

Before including the patient to the study, a thorough preoperative examination was done on each patient for matching up with both inclusion and exclusion criteria. And the nature of study and procedure was explained to each participant and a written consent was taken from them. Patient demographic data like Age, Sex, Height, Weight, BMI were recorded. All patients were premedicated with anxiolytics oral tablet Alprazolam 0.25 mg or 0.5mg, Proton pump inhibitor like tablet Pantoprazole 40mg, prokinetic agent- tablet Metoclopramide 10mg on the night before surgery as per institutional protocol.

Before induction of anaesthesia, examination was performed in the preoperative waiting room using an ultrasound machine. Sono Site M- Turbo portable machine, with curvilinear array, low frequency (5-2 MHz) and linear high frequency (13 - 6 MHz) transducers were used depending upon patient's requirement. Patients were scanned in supine position followed by right lateral position. In supine position, larger gastric volume was easily identified but smaller quantities were evasive to visualize. Right lateral position favoured gravitational drainage which increased the sensitivity to detect even smaller quantities. Just below the xiphoid process in the epigastric area, the transducer was positioned perpendicular to skin. The transducer was tilted from right to left to scan the antrum and body of the stomach. The left and caudal lobes of the liver, which are located posteriorly, defined the antrum, which was often seen in the parasagittal plane immediately right to the midline.[1,9] The quantitative assessment was completed after obtaining the best view of the antrum, either it was empty or with gastric content.

On the basis of qualitative assessment of the antrum, patients were classified into 3 grades.[1]

Grade 0- Empty antrum on both supine and right lateral decubitus position.

Grade 1- Gastric fluid visible on right lateral decubitus position only, suggestive of minimal fluid volume.

Grade 2- Gastric fluid visible on both supine and right lateral decubitus position suggestive of large fluid volume.

The gastric antrum appeared to be flat and gave an appearance of "bull's eye" or "target", if the stomach was empty. "Starry night" appearance if the antrum contains only liquid as content and "frosted glass" pattern if it contains solid content.

Quantitative assessment of gastric content- After qualitative assessment, Patient placed in right lateral decubitus position, transducer placed perpendicular to the skin just below the xiphisternum, can be tilted and moved for optimal view. Once antrum was visualized, craniocaudal diameter was measured. Then the transducer was placed in transverse plane and anteroposterior diameter was recorded.

With the help of two diameter method, Antral Cross-sectional area (CSA) was calculated using the formula.[1,6]

$CSA = (CC \times AP \times \pi) / 4$

Where CC – Craniocaudal, AP – Antero-posterior diameter.

On the basis of antral CSA, total gastric volume was predicted using a formula which was given by Perlas et al as follows:1,4,9

Gastric Volume (ml) = 27.0 + 14.6 × (Right lateral CSA) – (1.28 × Age) This formula was easy to apply clinically with age.

This formula was applicable to non-pregnant individuals, adults, patients with BMI < 40kg/m2. It can predict gastric volume (GV) of up-to 500ml.3

Low Risk - < 1.5ml/kg, High Risk - > 1.5ml/kg.

Results

A total of 210 patients posted for elective surgery based on predetermined inclusion and exclusion criteria were selected for the study. Demographic variables like age, sex, BMI and ASA physical status were summarized below.

110 (52.6%) patients were males and 100 (47.4%) were females, 44 (21.1%) patients belong to age group of 18-29 years, 113 (53.6%) patients aged 30-50 years, 53 (25.4%) patients aged 51-65 years, 7 (3.3%) patients were underweight, 152 (72.2%) patients fall within normal limit and 51 (24.4%) patients were overweight. 159 patients belong to ASA 1, 48 patients in ASA 2 and 3 patients in ASA 3.

Patients were examined in the preoperative waiting room using ultrasound. We studied the qualitative assessment of gastric antrum by 3point grading system which was described in the previous studies. The gastric volume was assessed both in supine and right lateral position. In supine position, 194 (92.3%) patients had empty antrum and 16 (7.7%) patients showed the presence of gastric content. In right lateral position, 71 (33.5%) patients had empty antrum and 139 (66.5%) patients had gastric content. Most of the patients were classified as Grade 0 and Grade 1 antrum. Out of 210 patients, 71 (33.5%) patients had Grade 0 antrum and 123(58.9%) patients had Grade 1 gastric antrum (Fig2). Only 16 (7.7%) patients had Grade 2 antrum, which indicate high gastric volume compared to Grade 1 antrum. We came to a conclusion that adequate pre operative fasting does not guarantee an empty stomach. The above finding may be due to gastric acid secretion and conditions, that predispose to delayed gastric emptying.

Association of age with CC- Craniocaudal diameter, AP- Anteroposterior diameter, CSA- Cross sectional area of gastric antrum, GV- Gastric volume, Statistically significant [Table 1]. 53 patients were between the age group of 51 to 65 years. The predicted gastric volume in this group of patients was 0.5 + 0.4 ml/kg, which was little high when compared to other age groups. So, we found that as age increases so does the gastric volume.

Association of Body mass index (BMI) with gastric sonological parameters were statistically significant [Table 2]. The predicted mean gastric volume (ml) for overweight group was 29.3 + 26.4 ml with a significant P value of 0.0001. The gastric volume was found to be higher in patients with increasing BMI.

We found that, the gastric volume was significantly higher in patients with diabetes when compared to non- diabetic patients with a statistically significant P value of 0.0001 [Table 3].

Out of 210 patients, only one patient had gastric volume > 1.5 ml/kg which indicate high volume who has a potential risk for aspiration. The gastric volume was higher in patients with co existing morbidities, when compared to healthy adults, with statistically significant P value (0.05).

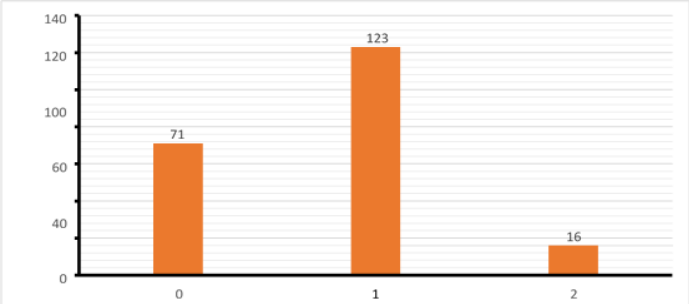

Figure 1: Qualitative assessment of antral grading among study participants. 0- Grade 0 antrum, 1- Grade 1 antrum, 2- Grade 2 antrum.

Table 1: Measured Sonological gastric parameters of patients Calculated using ANOVA test. Association of age with CC- Craniocaudal diameter, AP- Anteroposterior diameter, CSA- Cross sectional area of gastric antrum, GV- Gastric volume, statistically significant.

Age(Yrs)	Number	AP diameter (cm)		CC Diameter (Cm)		CSA (cm2)		GV (ml/Kg)	
		Mean(SD)	P value	Mean(SD)	P value	Mean(SD)	P value	Mean(SD)	P value
18-29	44	0.7(0.8)	0.0	0.8(0.9)	0.0001	1.0(1.2)	0.0001	0.2(0.3)	0.001
30-50	113	1.3(1.1)		1.4(1.1)		2.3(2.3)		0.3(0.4)	
51-65	53	2.3(0.9)		2.3(0.9)		4.7(2.3)		0.5(0.4)	
Total	210	1.4(1.1)		1.5(1.2)		2.6(2.4)		0.3(0.4)	

Table 2: Association of BMI with CC- Craniocaudal diameter, AP- Anteroposterior diameter, CSA- Cross sectional area of gastric antrum, GV- Gastric volume, statistically significant.

BMI (kg/m2)	No.	AP diameter (cm)		CC Diameter (Cm)		CSA (cm2)		GV (ml)	
		Mean(SD)	P value	Mean(SD)	P value	Mean(SD)	P value	Mean(SD)	P value
<18.5	7	1.6(1.2)	0.044	1.7(1.3)	0.043	3.3(2.9)	0.017	20.9(18.4)	0.0001
18.5-24.9	152	1.3(1.1)		1.4(1.1)		2.3(2.3)		14.7(20.1)	
25.0- 29.9	51	1.8(1.1)		1.8(1.1)		3.4(2.6)		29.3(26.4)	
Total	210	1.4(1.1)		1.5(1.2)		2.6(2.4)		18.5(22.5)	

Table 3: Calculated using ANOVA test. Association of gastric volume in patients with diabetes mellitus. CC- Craniocaudal diameter, AP- Anteroposterior diameter, CSA- Cross sectional area of gastric antrum, Statistically significant.

	Diabetic	Number	Mean	Std. Deviation	P value
AP DIAMETER (cm)	Yes	27	2.6085	.51114	0.001
	No	183	1.2444	1.08603	
CC DIAMETER (cm)	Yes	27	2.6352	.51003	0.0001
	No	183	1.3250	1.13601	
CSA (cm2)	Yes	27	5.4862	1.91245	0.0001
	No	183	2.2102	2.22909	
GASTRIC VOLUME (ml)	Yes	27	36.5915	27.97902	0.0001
	No	183	15.7080	20.33761	
GASTRIC VOLUME (ml/kg)	Yes	27	0.6870	.50910	0.0001
	No	183	0.2600	.32759	

Discussion

We observed that by following recommended fasting guidelines per say does not precludes aspiration of gastric contents. We observed residual gastric content in significant number of study subjects. Our observation is amplifying the results of Ohashi et al.[4]

In the present study, we observed that the mean antral cross-sectional area and mean gastric volume was comparatively higher in obese patients, which was statistically significant. Though still there is an ongoing debate over the effect of body mass index on gastric emptying. Our observation in overnight fasted patients vindicated the theory that obesity impairs gastric emptying time.[11] This may be attributed to coexisting other diseases in obese patients like diabetes, OSA etc., And our observation was similar to that of Sharma et al.[8] The limitation of the above observation is that we excluded patients with BMI

>35 kg/m^2.

The mean gastric volume in properly fasted study subjects showed an increasing trend with increase in age, which was statistically significant in patients of age group between 51 to 65 years compared to their younger sub groups. This may be attributed to other coexisting disease and predisposing factors which delays gastric emptying which are frequent in elderly patients.[12]

The antral cross-sectional area and mean gastric volume was used for quantify the ultrasound observation. On analyzing the Antral CSA and MGV in study subjects, the MGV was comparatively more in subset of patients who had preexisting diabetes. And the observation was statistically significant (P= 0.0001). the above observation can be attributed to gastroparesis secondary to autonomic neuropathy with diabetes. The observations were congruent to that of made by Sabry et al,[13] and Vandemergel et al.[14] But in Sabry et al, the measured antral cross- sectional area was done, post endotracheal intubation during general anaesthesia in which the observation could had been falsely exaggerated due to gastric inflation during mask ventilation of the patient, which was negated in the present study by assessing in the preoperative period itself.

Based on observation made in the present study, we conclude that the following standard ASA fasting guidelines per-se does not result in a zero gastric volume on the notion of precluding gastric aspiration, it was consistent with the result published by Van de Putte et al.[15] and the patients with diabetes, obesity and elderly are more prone for delayed gastric emptying. And we suggest an addition of prokinetic agent as a part of premedication for these subsets of patients for achieving minimal gastric volume in the perioperative period. And we recommend routine usage of gastric ultrasound as a new tool in point of care ultrasound in the perioperative period for preventing unwanted pulmonary aspiration.

Limitations of the present study is all the patients were uniformly premedicated with a prokinetic agent (metoclopramide) following institutional protocol which may have impacted to a extent in gastric sonological measurements.

Conclusion

Bedside gastric ultrasound is a non-invasive, simple screening tool to diagnose the aspiration risk.

The qualitative and quantitative assessment of gastric antrum and gastric volume helps to differentiate between the low risk and high-risk stomach which has a potential risk of aspiration.

We also conclude that the adequate fasting time doesn't guarantee an empty stomach mainly due to some predisposing factors which delays gastric emptying or increase in antral size.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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