

Ultrasound-guided assessment of gastric volume in fasting diabetic and non-diabetic patients undergoing elective surgery



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ABSTRACT

Background: Autonomic gastropathy despite standard fasting in diabetic patients increases the risk of aspiration. **Aims and Objectives:** This study compared ultrasound-guided measurement of residual gastric volume (GV) between diabetic and non-diabetic patients scheduled for elective surgery. **Materials and Methods:** The study was a prospective observational study carried out on 42 patients with similar demographic characteristics, having similar fasting intervals > 8 hours. Qualitative and quantitative ultrasonographic assessment of gastric antrum in supine and right lateral decubitus (RLD) was done 1 hour before induction of anesthesia using a curved array, low-frequency transducer. Ultrasonography grade, cross-sectional area (CSA) of the antrum, and GV were calculated. The gastric antral appearance was classified as Grade 0, 1, or 2, signifying empty antrum, fluid in RLD position only, and fluid in both supine and RLD positions, respectively. **Result:** Diabetic patient had higher median GV and a wider interquartile range than the non-diabetic patients suggesting delayed gastric emptying in diabetics. The mean diameters of both anteroposterior and craniocaudal and CSA calculated in both supine and RLD positions had a statistically significant difference with a higher value observed in the diabetic group as compared to the non-diabetic group ($P < 0.001$). **Conclusion:** Diabetic patients have higher GVs and gastric antral CSA than non-diabetic patients signifying delayed gastric emptying. Qualitative grading may be useful for screening purposes but quantitative analysis provides a more reliable estimate of GV. Gastric ultrasound is a valuable tool in identifying the risk of pulmonary aspiration thus helping in pre-operative decision-making.

Key words: Autonomic dysfunction; Diabetes mellitus; Ultrasound; Point of care ultrasound; Gastric

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INTRODUCTION

Gastric aspiration during the perioperative period is a critical complication with significant risk of both morbidity and mortality.¹ Individuals with diabetes are particularly vulnerable to this condition, as autonomic dysfunction can lead to delayed gastric emptying, making them more prone to aspiration compared to the general population.²

American Society of Anesthesiologists (ASA) in 2017 fasting guidelines mentioned that the standard 8 hours fasting may need to be modified for patients with coexisting diseases or conditions that can affect gastric emptying or fluid volume.³

Recently, point-of-care (POC) gastric ultrasound has become more prominent and is now used in anesthesiology to aid clinical decisions. This technique is especially valuable

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when the fasting status of a patient is uncertain or in emergency situations where surgery is required.⁴

Ultrasonography (USG) can be done during the pre-induction evaluation to assess the patients' fasting gastric volume (GV) and to decide if it is more than the advised safe limit because these individuals with coexisting diseases are more susceptible to encountering insufficiently empty stomach despite an acceptable fasting period.⁵

In the present study, USG was done to compare the fasting GV in diabetic and non-diabetic patients scheduled for elective surgery.

Aims and objectives

To measure the craniocaudal (CC) and anteroposterior (AP) diameters of the gastric antrum, enabling calculation of the gastric antral cross-sectional area (CSA) and gastric volume (GV) in fasting diabetic and non-diabetic patients as the primary outcome. In addition, gastric appearance between fasting diabetic and non-diabetic patients is compared.

MATERIALS AND METHODS

The study was a prospective observational study conducted in the Department of Anesthesiology, Bankura Sammilani Medical College and Hospital, West Bengal, with a clearance from the Institutional Ethics Committee (No. BSMC/IEC/1065).

Patients planned for elective surgeries and following ASA 2017 Fasting Guidelines were examined using POC gastric USG before induction of anesthesia.

Patients were selected for this study on satisfying the following criteria:

Inclusion criteria

- Age: 18 years–75 years
- Male and female patients
- ASA Grade I to III
- Elective surgery
- Diabetic and non-diabetic patients
- Body mass index <35 kg/m².

Exclusion criteria

- Patients on medication for upper gastrointestinal tract (GIT) symptoms, chronic kidney disease, hypothyroidism
- Connective tissue disease affecting GIT motility
- Patients with paralytic ileus
- Recent smoking history
- Patients on anti-depressants

- Previous history of oesophageal or abdominal surgery
- Pregnant patients
- Patients with nasogastric tube *in situ*.

On the basis of exclusion and inclusion criteria total of 42 cases were enrolled for this study. 21 patients were included in each group ND (non-diabetic) and group D (diabetic). Informed consent was obtained from the participants before enrolment for the study.

Study type

Analytical study.

Study design

Prospective observational cross-sectional study.

Sample size

The sample size was calculated based on a study conducted by Garg et al.⁶ They observed that in the supine position CC diameter in non-diabetic group and diabetic group was (1.96±0.41 cm) and (2.28±0.05 cm). In the present study expecting to get similar result with 80% power and 95% confidence level, the study required a minimum of 21 patients in each group.

Study tools

A GE LOGIQ V₂ COLOR portable ultrasound machine along with a curved array low-frequency (2–5 MHz, 60 mm) transducer providing a scan depth up to 30 cm.

Study techniques

- Individual interview of the patient regarding duration and control of diabetes and their fasting status
- USG done before induction of anaesthesia.

Pre-operative assessment

Detailed history of the patients regarding any co-morbid condition, previous anesthetic exposure, medications, allergy to any drugs, and personal habits were noted followed by POC Gastric Ultrasonographic assessment 1 hour before induction of anesthesia after a minimum fasting interval of 8 hours. A curved array, low frequency (2–5 MHz, 60 mm) transducer with a scan depth up to 30 cm was used. Patients were scanned in the supine position and in the right lateral decubitus (RLD) position (Figure 1).

Based on the appearance in both the positions (Figure 2) as defined by Perlas et al.,⁷ the sonographic appearance of the gastric antrum was classified as

- Grade 0-Empty antrum
- Grade 1-Fluid detected in RLD position only
- Grade 2-Fluid detected in both supine and RLD.

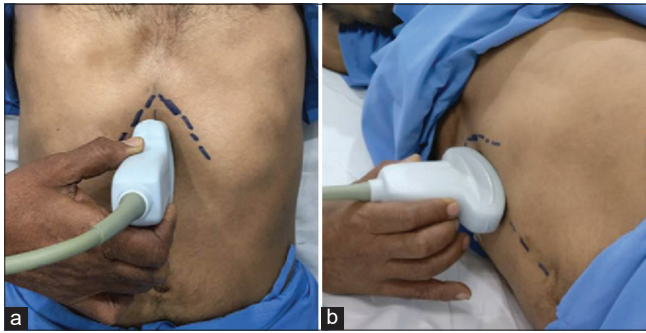


Figure 1: Depicting scanning position, (a) Supine, (b) Right lateral decubitus

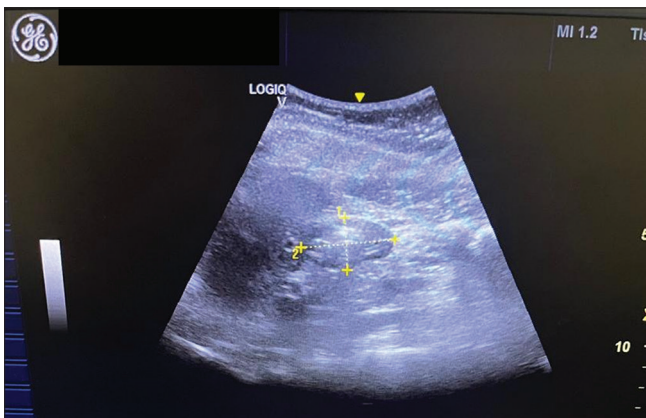


Figure 2: Depicting ultrasonographic appearance of the antrum and the measured perpendicular diameters

CSA was calculated using two perpendicular diameters AP and CC (Figure 2) and the formula for area of an ellipse.

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

The GV was calculated using the previously validated formula.⁷

$$GV \text{ (mL)} = 27.0 + 14.6 \times \text{right lateral CSA} - 1.28 \times \text{age}$$

After evaluating the CSA, GV, and no risk of aspiration, the patients were pre-oxygenated for 5 min with 100% O₂ and premedicated with Inj. Midazolam 0.1 mg/kg, Inj. Fentanyl 2 µg/kg, Inj. Glycopyrrolate 10 µg/kg. General anesthesia was induced using Inj. Propofol 2 mg/kg and Inj. Succinylcholine 1.5 mg/kg followed by the introduction of appropriate-sized cuffed endotracheal tube.

RESULT AND ANALYSIS

Following data collection, all the inputs were put into computer software (Microsoft Word and Microsoft Excel 2019) to generate the result in tabular and graphical formats. Statistical software (SPSS version 22) was used for the analysis of the outcome variables. The continuous variables were compared using Student's unpaired t-test and

Table 1: Demographic characteristics

Demographic data	Group ND (n=21) Mean±SD	Group D (n=21) Mean±SD	P-value
Age (year)	44.9±7.95	48.2±7.69	0.181
Sex			0.746
Male	14	15	
Female	7	6	
Height (in meter)	1.7±0.08	1.68±0.08	0.440
Weight (in kg)	64.2±8.38	66.6±7.61	0.332
BMI (kg/m ²)	22.1±2.38	23.5±2.40	0.067
ASA			<0.001
1	15	0	
2	6	19	
3	0	2	
Fasting interval (hour)	10.95±1.43	11.19±1.47	0.598

ASA: American society of anesthesiologists, BMI: Body mass index

Table 2: Ultrasound grading of gastric appearance

Gastric appearance	Group ND (n=21) (%)	Group D (n=21) (%)	Total (%)
Grade 0	11 (52.4)	6 (28.6)	17 (40.5)
Grade 1	6 (28.6)	8 (38.1)	14 (33.3)
Grade 2	4 (19.0)	7 (33.3)	11 (26.2)
Total	21 (100)	21 (100)	42 (100)

categorical variables were compared using the Chi-square test as appropriate, between groups. $P < 0.05$ was considered as statistically significant.

- The demographic data of the two groups is presented in Table 1.

Both the groups were found comparable regarding demographic characteristics except for their ASA grade as Group D had all diabetic patients compared to Group ND having non-diabetic patients. The mean duration of diabetes mellitus (DM) was 5.67 ± 4.07 years (Table 1).

- Differences in ultrasound grading between the groups are presented in Table 2.

Nearly half of the non-diabetic patients had empty stomach and showed Grade 0 whereas the diabetic patients had fluid either in RLD or both RLD and supine position, that is, Grade 1 and Grade 2 (Table 2).

- Relationship of gastric appearance with the groups is presented in Table 3.

However, there was no significant difference ($P > 0.05$; Chi-square test) in gastric appearance in diabetic and non-diabetic groups after fasting for ≥ 8 hours (Table 3).

- Measured diameters and calculated CSA in the supine position are represented in Table 4.

In the supine position, the diabetic group had considerably higher CC and AP diameters thus the calculated CSA was significantly higher than non-diabetic group (Table 4 and Figure 3).

- Measured diameters and calculated CSA in the RLD position are represented in Table 5.

In the RLD position, the diabetic group had considerably higher CC and AP diameters thus the calculated CSA was significantly higher than non-diabetic group (Table 5 and Figure 4).

- GV in the groups represented in Table 6.

Table 3: Relationship between diabetic status and gastric appearance

Chi square test	Value	df	P-value
χ^2	2.57	2	0.276
n	42		

Table 4: Diameters in supine position

Diameter	Group ND Mean±SD	Group D Mean±SD	P-value
Craniocaudal (CC) diameter (cm)	1.82±0.36	2.20±0.30	<0.001
Anteroposterior (AP) diameter (cm)	1.03±0.30	1.39±0.20	<0.001
Cross-sectional area (CSA) (cm ²)	1.51±0.62	2.42±0.58	<0.001

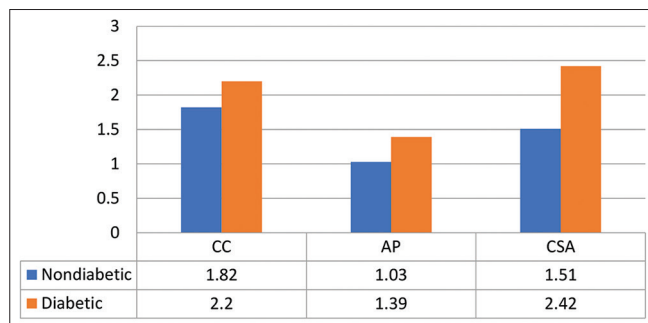


Figure 3: Measurements in supine position

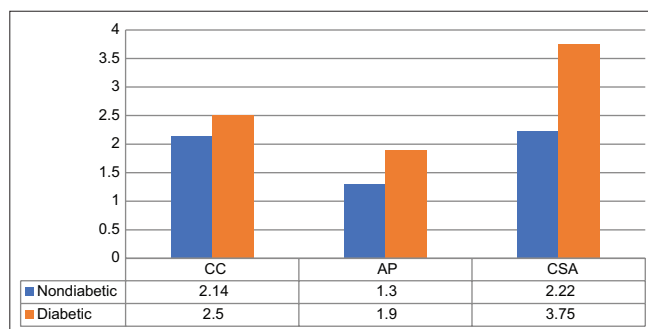


Figure 4: Measurements in the right lateral decubitus position

Diabetic patient had higher median GV (18.344 mL) and a wider interquartile range (49.36) than the non-diabetic patients with median GV (−0.182 mL) and interquartile range (28.20) suggesting delayed gastric emptying in diabetics. The smaller interquartile range in non-diabetic patients might indicate more consistent gastric emptying compared to diabetics (Table 6, Figures 5 and 6).

Table 5: Diameters in right lateral decubitus

Diameter	Group ND Mean±SD	Group D Mean±SD	P-value
Craniocaudal (CC) diameter (cm)	2.14±0.31	2.50±0.28	<0.001
Anteroposterior (AP) diameter (cm)	1.30±0.24	1.90±0.24	<0.001
Cross-sectional area (CSA) (cm ²)	2.22±0.60	3.75±0.79	<0.001

Table 6: Gastric volume

GV	Group ND median	Group D Median
Gastric volume (mL)	−0.182	18.344

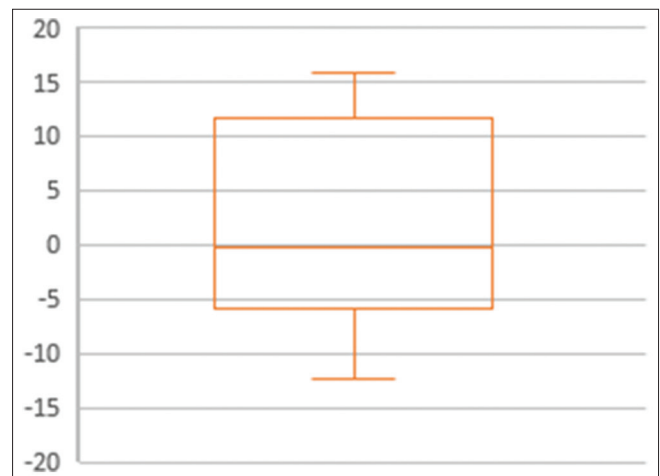


Figure 5: Gastric volume in non-diabetic patients

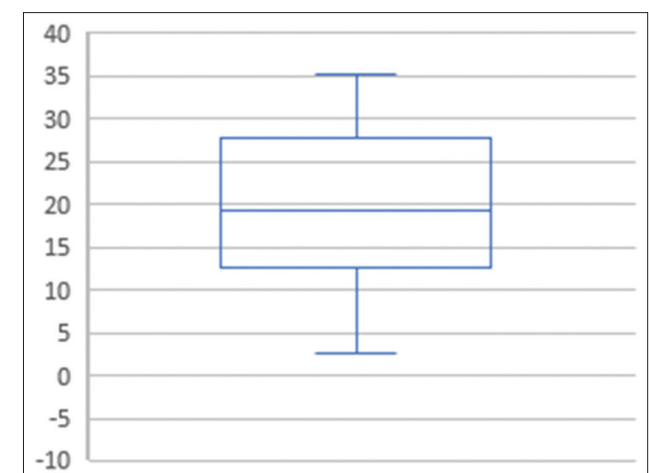


Figure 6: Gastric volume in diabetic patients

However, 100% of the patients who participated in this study were found to have the value of GV/kg less than the cutoff value for high risk of aspiration, that is, 1.5 mL/kg.^{8,9}

DISCUSSION

DM is regarded as a high-risk condition, presenting significant challenges to anesthesiologists. The most dreaded complication is the aspiration of gastric contents since diabetics are often considered to have a full stomach due to autonomic gastropathy.^{10,11} Autonomic neuropathy affects the vagus nerve which controls stomach motility and when it is damaged by chronic hyperglycemia, gastric emptying slows down. Camilleri et al., observed that delayed gastric emptying due to gastroduodenal motor abnormalities was the major highlight of DM.²

With the advent of enhanced recovery after surgery protocols and liberal fasting guidelines, USG may be useful in our daily perioperative practice to assess the GV in patients with diabetes.⁶

This study was done to find out the role of ultrasound in the assessment of fasting GV in diabetic and non-diabetic patients undergoing elective surgery.

Our study found that in both supine position and RLD position, the mean AP diameter, CC diameter, and CSA in diabetic patients were significantly higher than in non-diabetic patients ($P < 0.001$; unpaired student's t-test) which correlated with observational studies by Garg et al.,⁶ and Haramgatti et al.¹²

The diabetic group in our study had a higher median value of GV and with a wider interquartile range suggesting higher GV in diabetics than non-diabetics similar to a study by Sabry et al.,¹³ who measured CSA and calculated GV with USG and found diabetic patients have significantly higher median cross-section area and calculated GV compared to non-diabetic patients.

There were negative values derived in the calculation of GV using the standard formula for quantitative estimation of GV by Perlas et al.⁷ This was seen in patients having a lesser CSA leading to negative value. Previous studies by Garg et al.,⁶ and Haramgatti et al.,¹² evaluating the GV with the formula derived by Perlas et al., have also elicited negative values. Thus, when the stomach is empty, small values of RLD CSA give a negative volume value, which only indicates an empty state.

Our study further found that NPO of 8 hours as suggested by ASA 2017 fasting guidelines did not ensure a

completely empty stomach in diabetic patients since fluid was detected in RLD position (Grade 1 gastric appearance) and in both supine and RLD position (Grade 2 gastric appearance). This coincides with the results of Sharma et al.,¹⁴ who found fasting for 10 hours did not ensure an empty stomach and that comorbidities such as diabetes; made patients more likely to have hazardous gastric contents when utilizing bedside gastric USG on adult patients coming for elective surgery. Thus, bedside USG may be utilized to assess the status of stomach contents and may be used to stratify aspiration risk as well. It could also be useful in a variety of therapeutic situations where the risk of aspiration is unknown or uncertain. However, no patients in our study were found to have GV > 1.5 ml/kg which is usually considered as a cutoff value for risk of aspiration^{9,10} such a finding could be attributed to the shorter duration of diabetes and glycemic control in the study population.¹⁵

Limitations of the study

There are limitations in our study. The study was conducted over a short period of time with the sample size being relatively small to draw conclusions. Our patients were Type 2 DM patients only. Variation of diet among the patients which can influence gastric emptying and surgery which itself is a stress factor influencing gastric motility has not been evaluated. Ryles tube insertion was not performed in unindicated cases to check the pH of gastric content. An already published reference standard was chosen for quantitative analysis.

CONCLUSION

- This study suggests that diabetic patients have higher GVs and gastric antral CSA than the non-diabetic patients signifying delayed gastric emptying as observed by gastric ultrasound.
- While qualitative grading may be useful for screening purposes, quantitative analysis provides a more reliable estimate of GV.
- Quantitative assessment of GV using POC gastric ultrasound is a valuable tool in identifying patients at risk of pulmonary aspiration of gastric contents and helps the perioperative decision-making.
- Studies with larger sample size are required to stratify fasting volume in diabetic patients so that a pre-operative protocol for avoiding aspiration can be made.

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ETHICAL APPROVAL

The study was approved by the Institutional Ethical Committee.

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SD- Manuscript preparation, editing and manuscript revision, data collection, data analysis; **DG**- Concept design and clinical protocol; **SC**- Design of study, statistical analysis and interpretation; **SR and NK**- Definition of intellectual content, implementation of study protocol, editing, and manuscript revision; **DS**- Review manuscript.

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