ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 04 | April - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ULTRASONOGRAPHY AS A TOOL TO EVALUATE THE GASTRIC CONTENTS IN DIABETIC VS NON-DIABETIC PATIENTS POSTED FOR ELECTIVE SURGERIES

Anaesthesiology

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ABSTRACT

Background: Diabetic gastroparesis increases perioperative aspiration risk, but routine aggressive prophylaxis may be unnecessary. Point-of-care gastric ultrasound enables objective risk assessment.**Objective:** To compare gastric residual volume between diabetic and non-diabetic patients using preoperative point-of-care ultrasound and determine the need for anesthetic modifications.**Methods:** This prospective observational study included 80 adults (40 diabetic, 40 non-diabetic) scheduled for elective surgery. After standardized 8-hour fasting, gastric antral cross-sectional area was measured using ultrasound in semi-recumbent and right lateral decubitus positions. Gastric volume was calculated using validated Perlas formula. Perlas grading and qualitative content assessment were performed. Primary outcomes were gastric volume and Perlas grade. Secondary outcomes included need for prokinetic medication, surgical postponement, and anesthetic modifications.**Results:** Despite comparable age and fasting duration, diabetic patients (mean diabetes duration 12.70 years, HbA1c 8.09%) had significantly larger gastric antral CSA (6.85 vs 4.09 cm^2 in RLD, $p<0.001$) and higher gastric volume (56.09 vs 26.02 ml, $p<0.001$). Perlas Grade 2 was found exclusively in diabetics (12.5% vs 0%, $p=0.002$). However, 87.5% of diabetics had empty or clear fluid content. Only 12.5% required prokinetics, 7.7% of general anesthesia cases needed RSI, and no surgeries were postponed. HbA1c ($r=0.685$) and diabetes duration ($r=0.542$) correlated significantly with gastric volume.**Conclusion:** Long-standing diabetes causes measurable gastric dysfunction, but most patients have acceptable gastric status. Point-of-care ultrasound enables selective intervention, avoiding universal aggressive management while ensuring peri-operative safety.

KEYWORDS

Gastric ultrasound, diabetes mellitus, gastroparesis, aspiration risk, anesthesia

INTRODUCTION

Perioperative pulmonary aspiration of gastric contents remains a serious anesthetic complication associated with aspiration pneumonitis, acute respiratory distress syndrome, and mortality approaching 5%. Despite standard fasting guidelines, aspiration continues to occur in approximately 1 in 2,000–10,000 general anesthetics, particularly in patients with conditions that impair gastric emptying. Diabetes mellitus, affecting more than 537 million adults worldwide, accounts for 15–20% of elective surgical cases and is frequently associated with delayed gastric emptying due to autonomic neuropathy and hyperglycemia[(2)]. Diabetic gastroparesis, present in up to half of long-standing cases, results from vagal nerve injury, altered enteric function, and acute metabolic effects, producing unpredictable gastric emptying even in apparently well-controlled patients [(4)].

Point-of-care gastric ultrasonography has emerged as a reliable bedside technique for assessing gastric contents and volume in the perioperative period. Visualization of the gastric antrum enables qualitative classification of contents and quantitative estimation of gastric volume using validated mathematical models[(6)]. Ultrasound also distinguishes between, clear / thick fluid, solids and allows individualized anesthetic planning and real-time monitoring of gastric emptying. Incorporating gastric ultrasound into preoperative evaluation may identify high-risk patients requiring extended fasting, prokinetic therapy, or modified anesthetic techniques, while avoiding unnecessary surgical delays. However, technical limitations, training requirement, and lack of standardized cutoff values remain barriers to widespread adoption.

This study therefore aims to compare gastric antral cross-sectional area, volume, and content between diabetic and non-diabetic patients after standard fasting for elective surgery, and to assess the impact of ultrasound-guided interventions on perioperative safety.

AIMS AND OBJECTIVES

Aim:

To evaluate and compare gastric contents using ultrasonography in diabetic versus non-diabetic patients posted for elective surgeries.

Objectives:

Primary objective: To compare the gastric antrum cross-sectional area, volume and content in diabetic and non-diabetic patients scheduled for elective surgery

Secondary objective: To evaluate the effectiveness of using prokinetics, postponement of surgery and change in plan of anesthesia

MATERIALS AND METHODS

This prospective comparative study evaluated gastric contents using ultrasonography in diabetic and non-diabetic patients undergoing elective surgery at a tertiary care hospital. The study included 80 patients aged more than 40 years with ASA physical status II or III who were posted for elective procedures under general anesthesia.

Sample Size Calculation

The sample size for two different groups of equal sizes was calculated using the following formula:

$n = 2 \times (Z\alpha/2 + Z(1-\beta))^2 \times \sigma^2 / d^2$

Where:

- n = Required sample size per group
- $Z\alpha/2$ = Standard normal distribution value for 95% confidence interval = 1.96
- $Z(1-\beta)$ = Standard table value for 80% power = 0.84
- σ = Standard deviation (average of two standard deviations) = 15.885
- d = Expected difference between groups = 10

Calculation: $n = 2 \times (1.96 + 0.84)^2 \times (15.885)^2 / (10)^2$ $n = 2 \times (2.8)^2 \times 252.331 / 100$ $n = 2 \times 7.84 \times 252.331 / 100$ $n = 39.61$

The calculated sample size was rounded off to 40 patients in each group.

Total Sample Size = 80 patients (40 diabetic patients and 40 non-diabetic patients)

Selection Criteria

Inclusion Criteria:

- Age group more than 40 years
- Patients with type 2 diabetes with minimum duration of 5-10 years (for diabetic group)
- ASA grade II and grade III
- Both genders
- Posted for elective surgeries

Exclusion Criteria:

- Pregnancy
- Patients who had pre-existing neurological disease, recent upper gastrointestinal bleed, upper gastrointestinal surgery

Methodology

All patients were kept nil per oral before surgery in accordance with standard fasting guidelines and were advised to take oral pantoprazole 40 mg on the morning of surgery. After obtaining written informed consent, preoperative gastric ultrasound examinations were performed in the preoperative area prior to transfer to the operating theatre using a low-frequency (2–5 MHz) curvilinear transducer, with patients assessed in both the semi-recumbent and right lateral decubitus positions.

Measurement of Gastric Antral Cross-Sectional Area

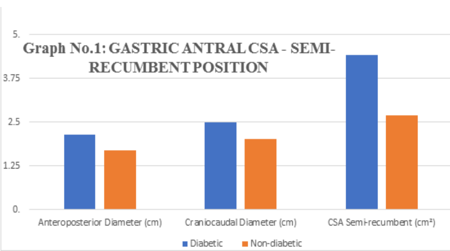
The gastric antral cross-sectional area (CSA) was measured using the standardized technique described by Perlas et al[6] with the antrum identified in the epigastrium in the sagittal or parasagittal plane using the liver anteriorly and the pancreas with the aorta or superior mesenteric artery posteriorly as landmarks; images were optimized at maximal antral diameter and measurements taken between peristaltic contractions. CSA was calculated either by the two-diameter method-measuring anteroposterior (D_1) and craniocaudal (D_2) diameters from serosa to serosa and applying the formula ($D_1 \times D_2$) $\pi/4$ or by free tracing of the serosal border, with three measurements averaged in both semi-recumbent and right lateral decubitus positions. Gastric volume was estimated using the validated Perlas formula [27 + (14.6 × RLD CSA) − (1.28 × age)], and antral contents were graded qualitatively using the Perlas system (Grades 0–2) and categorized as empty, clear fluid, thick fluid, or solid based on echogenicity to assess aspiration risk. When residual gastric volume exceeded 1.5 mL/kg, patients received prokinetics, surgery was deferred for four hours, repeat ultrasound was performed, and the anesthetic plan was modified accordingly, including rapid sequence induction, awake intubation, or regional anesthesia when appropriate.

RESULTS.

TABLE 1: GASTRIC ANTRAL CSA - SEMI-RECUMBENT POSITION

Parameter	Diabetic (n=40)	Non-diabetic (n=40)	p-value
Anteroposterior Diameter (cm)	2.15 ± 0.52	1.69 ± 0.18	<0.001*
Craniocaudal Diameter (cm)	2.49 ± 0.57	2.01 ± 0.20	<0.001*
CSA Semi-recumbent (cm²)	4.41 ± 2.21	2.68 ± 0.49	<0.001*
Mean difference in CSA	1.73 cm²		
Cohen's d	1.08 (Large effect size)		

*Statistically significant (p<0.05); Independent t-test



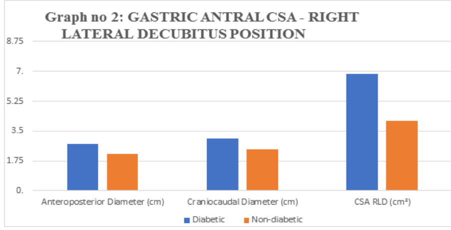
ANALYSIS:

In the semi-recumbent position, diabetic patients demonstrated significantly larger gastric antral cross-sectional area compared to non-diabetics. The mean CSA was 64.6% larger in diabetics (4.41 ± 2.21 cm² vs 2.68 ± 0.49 cm², p<0.001), with a mean difference of 1.73 cm². Both anteroposterior diameter (2.15 ± 0.52 cm vs 1.69 ± 0.18 cm, p<0.001) and craniocaudal diameter (2.49 ± 0.57 cm vs 2.01 ± 0.20 cm, p<0.001) were significantly larger in the diabetic group. The effect size (Cohen's d = 1.08) was large, indicating a clinically meaningful difference..

TABLE 2: GASTRIC ANTRAL CSA - RIGHT LATERAL DECUBITUS POSITION

Parameter	Diabetic (n=40)	Non-diabetic (n=40)	p-value
Anteroposterior Diameter (cm)	2.73 ± 0.68	2.14 ± 0.22	<0.001*
Craniocaudal Diameter (cm)	3.05 ± 0.64	2.43 ± 0.19	<0.001*
CSA RLD (cm²)	6.85 ± 3.31	4.09 ± 0.69	<0.001*
Mean difference in CSA	2.75 cm²		
Cohen's d	1.15 (Large effect size)		

*Statistically significant (p<0.05); Independent t-test



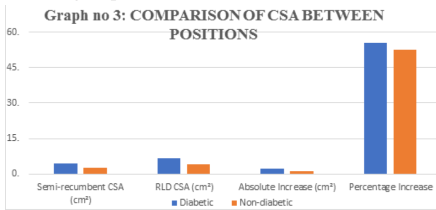
ANALYSIS:

In the right lateral decubitus (RLD) position, the differences between groups remained highly significant. Diabetic patients showed markedly larger gastric antral CSA (6.85 ± 3.31 cm² vs 4.09 ± 0.69 cm², p<0.001), with a mean difference of 2.75 cm², representing a 67.5% increase. Both diameters were significantly larger: anteroposterior (2.73 ± 0.68 cm vs 2.14 ± 0.22 cm, p<0.001) and craniocaudal (3.05 ± 0.64 cm vs 2.43 ± 0.19 cm, p<0.001). The large effect size (Cohen's d = 1.15) confirms clinical significance. The RLD position, which causes gravitational pooling of gastric contents in the antrum, revealed greater residual volume in diabetics. Comparison between positions shows that CSA increased from 4.41 cm² (semi-recumbent) to 6.85 cm² (RLD) in diabetics—a 55.3% increase—compared to 52.6% increase in non-diabetics, suggesting impaired adaptive gastric accommodation in diabetes.

TABLE 3: COMPARISON OF CSA BETWEEN POSITIONS

Group	Semi-recumbent CSA (cm²)	RLD CSA (cm²)	Difference	% Increase
Diabetic (n=40)	4.41 ± 2.21	6.85 ± 3.31	+2.44	55.3%
Non-diabetic(n=40)	2.68 ± 0.49	4.09 ± 0.69	+1.41	52.6%

p<0.001 for both groups (Paired t-test)



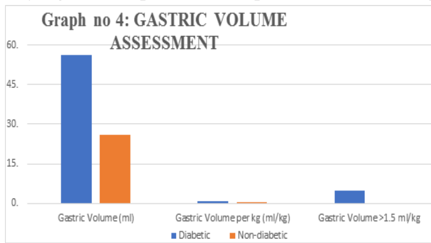
ANALYSIS:

Within-group analysis revealed that CSA increased significantly when moving from semi-recumbent to RLD position in both groups (p<0.001 for both). The magnitude of absolute increase was larger in diabetics (+2.44 cm²) compared to non-diabetics (+1.41 cm²). However, the percentage increase was similar (55.3% vs 52.6%), indicating that gravitational effects on gastric contents are proportional to baseline volumes.

TABLE 4: GASTRIC VOLUME ASSESSMENT

Parameter	Diabetic (n=40)	Non-diabetic (n=40)	p-value
Gastric Volume (ml)	56.09 ± 47.71	26.02 ± 11.99	<0.001*
Gastric Volume per kg (ml/kg)	0.76 ± 0.69	0.38 ± 0.18	0.001*
Gastric Volume >1.5 ml/kg	5 (12.5%)	0 (0%)	0.065

*Statistically significant (p<0.05); Independent t-test; Chi-square test



ANALYSIS:

Diabetic patients demonstrated elevated gastric residual volume ;however 87.5% had low-risk profiles. The mean absolute gastric volume was more than double in diabetics (56.09 ± 47.71 ml vs 26.02 ± 11.99 ml, p<0.001), representing a mean difference of 30.07 ml. When normalized for body weight, gastric volume per kilogram was also significantly higher in diabetics (0.76 ± 0.69 ml/kg vs 0.38 ± 0.18 ml/kg, p=0.001). Only 12.5% (5 patients) of diabetic patients exceeded the high-risk threshold of >1.5 ml/kg, while no non-diabetic patients crossed this critical cut-off, though this difference did not reach statistical significance (p=0.065) due to the small number of events..

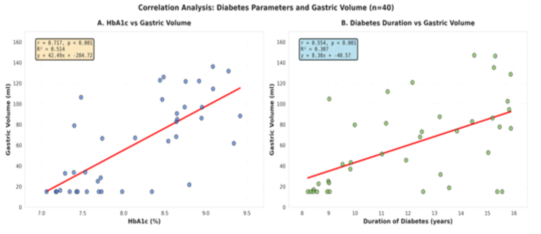


Table 5: PRIMARY AND SECONDARY OUTCOMES

Outcome Variable	Diabetic (n=40)	Non-diabetic (n=40)	p-value	Effect
Demographic				
Age (years)	55.40 ± 4.12	47.48 ± 6.99	<0.001*	Older
BMI (kg/m²)	27.63 ± 2.64	24.71 ± 2.60	<0.001*	Higher
ASA Grade II and III	32 (80.0%)	0 (0%)	<0.001*	Higher risk
Primary Outcomes				
CSA Semi-recumbent (cm²)	4.41 ± 2.21	2.68 ± 0.49	<0.001*	1.6× larger
CSA RLD (cm²)	6.85 ± 3.31	4.09 ± 0.69	<0.001*	1.7× larger
Gastric Volume (ml)	56.09 ± 47.71	26.02 ± 11.99	<0.001*	2.2× higher
Gastric Volume >1.5 ml/kg	5 (12.5%)	0 (0%)	0.065	Trend
Perlas Grade 2	5 (12.5%)	0 (0%)	0.002*	Higher risk
Thick Fluid Content	5 (12.5%)	0 (0%)	0.023*	Only in DM
Clinical Management				
Prokinetic Required	5 (12.5%)	0 (0%)	0.065	Trend
Surgery Postponed	0 (0%)	0 (0%)	-	None
RSI (among GA cases)	2/26 (7.7%)	0/34 (0%)	0.187	Small subset

Outcome VariableDiabetic (n=40)Non-diabetic (n=40)p-valueEffectDemographic

Age (years)55.40 ± 4.1247.48 ± 6.99<0.001*OlderBMI (kg/m²)27.63 ± 2.6424.71 ± 2.60<0.001*HigherASA Grade II and III32 (80.0%)0 (0%)<0.001*Higher riskPrimary Outcomes

CSA Semi-recumbent (cm²)4.41 ± 2.212.68 ± 0.49<0.001*1.6× largerCSA RLD (cm²)6.85 ± 3.314.09 ± 0.69<0.001*1.7× largerGastric Volume (ml)56.09 ± 47.7126.02 ± 11.99<0.001*2.2× higherGastric Volume >1.5 ml/kg5 (12.5%)0 (0%)0.065TrendPerlas Grade 25 (12.5%)0 (0%)0.002*Higher riskThick Fluid Content5 (12.5%)0 (0%)0.023*Only in DMClinical Management

Prokinetic Required5 (12.5%)0 (0%)0.065TrendSurgery Postponed0 (0%)0 (0%)-NoneRSI (among GA cases)2/26 (7.7%)0/34 (0%)0.187Small subset

*Statistically significant (p<0.05); DM = Diabetes Mellitus; GA = General Anesthesia

DISCUSSION

This prospective study demonstrates that long-standing, poorly controlled diabetes mellitus is associated with significantly increased gastric antral dimensions and residual gastric volume despite adequate fasting, yet the majority of diabetic patients as shown in table no 4(87.5%) had low-risk gastric profiles . Sabry et al. evaluated 80 fasted diabetic patients using gastric ultrasound and reported qualitative gastric content assessment showing 52.5% with Grade 0 (empty), 33.8% with Grade 1, and 13.7% with Grade 2 Perlas classification[35] Notably, Sabry et al. found that all 11 patients classified as Grade 2 had HbA1c >8.5%, which supports our observed strong correlation between poor glycemic control and gastric retention .Khan et al. studied 60 patients (30 diabetic, 30 non-diabetic) and found mean gastric antral CSA in RLD position of 8.2 ± 3.1 cm² in diabetics versus 4.1 ± 1.2 cm² in non-diabetics (p<0.001)[31], remarkably similar to our findings of 6.85 ± 3.31 cm² versus 4.09 ± 0.69 cm² (as shown in table no 5.) Their study also reported that 36.7% of diabetic patients had gastric volume >1.5 ml/kg compared to 0% of non-diabetics. Only a small subset (12.5%) required perioperative intervention, with no surgeries postponed. Gastric volume correlated strongly with HbA1c, disease duration, and gastroparesis symptoms, identifying these factors as key predictors of aspiration risk, while comparisons with prior ultrasound-based studies suggest that differences in glycemic control, disease severity, positioning, and proactive management explain variability in reported high-risk prevalence. Our findings challenge blanket assumptions that all diabetics have "full stomach" and instead support selective, ultrasound-guided risk stratification, allowing most patients to proceed safely under standard fasting protocols while reserving prokinetics, modified induction techniques, or regional anesthesia for truly high-risk individuals. The feasibility of rapid bedside gastric ultrasound, its validated diagnostic accuracy, and its minimal disruption to workflow reinforce its value in routine perioperative care for high-risk diabetics, particularly those with poor metabolic control or long-standing disease duration.

LIMITATIONS

Although limited by sample size, single-center design, and exclusion of severe gastroparesis, these results underscore the need for larger randomized trials to determine whether ultrasound-guided strategies reduce aspiration-related morbidity, refine diabetes-specific volume thresholds, and evaluate cost-effectiveness, while supporting incorporation of gastric ultrasound into preoperative assessment algorithms to balance patient safety with avoidance of unnecessary interventions.

CONCLUSION

Point-of-care gastric ultrasound is a valuable tool for individualized risk stratification, enabling selective rather than universal aggressive aspiration prophylaxis in diabetic surgical patients. Routine preoperative gastric ultrasound assessment in diabetic patients is a useful tool to guide appropriate anesthetic management without causing unnecessary delay in interventions.

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