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BEDSIDE ULTRA SONOGRAPHIC ASSESSMENT OF GASTRIC ANTRAL CROSS-SECTIONAL AREA FOR PREDICTION OF ASPIRATION RISK IN ADULTS PRESENTING FOR EMERGENCY AND SEMI-ELECTIVE SURGERY: A CROSS-SECTIONAL OBSERVATIONAL STUDY AT A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Pulmonary aspiration of gastric contents is a serious peri-operative complication that occurs in up to 1/3000 to 4/3000 anaesthetised patients, and is associated with a mortality of up to 5%. The use of point-of-care ultrasound (POCUS) to assess gastric content has become a well-established bedside test to better risk-stratify aspiration prior to anaesthesia. This research aimed to assess the value of the ultrasound measurement of antral cross-sectional area (CSA) for predicting full stomach in adults undergoing emergency and semi-elective surgery, specifically high-risk groups such as users of GLP-1 receptor agonists (RA) and diabetic patients with autonomic neuropathy. Design: Cross-sectional observational study was performed in a tertiary hospital in 150 consecutive adults booked for emergency and/or semi-elective surgery. A low-frequency curvilinear probe (2-5 MHz) was used to measure Gastric antral CSA in supine and right lateral decubitus (RLD) position. Gastric volume (GV) was estimated by the Perlas formula (GV = 27.0 + 14.6 × RLD CSA − 1.28 × age). Qualitative Perlas (0–2) were given. Independent predictors were determined by multivariable logistic regression, which was used to define full stomach as GV>1.5 mL/kg. Results: Full stomach prevalence was 18.0% (27/150). At least 8 hours of documented fasting, the prevalence of subgroup was found to be 32% in diabetics with autonomic neuropathy vs 40.9% in GLP-1 RA users. The AUROC, sensitivity, and specificity were 0.89 (95% CI 0.83–0.95), 92% and 73%, respectively, for the optimal RLD antral CSA cut-off of ≤3.6 cm^2 for empty stomach. Independent multivariable predictors of full stomach were: GLP-1 RA use (aOR 4.2; 95% CI 1.9–9.3), diabetic autonomic neuropathy (aOR 3.1; 95% CI 1.3–7.5), recent opioid use (aOR 2.4; 95% CI 1.1–5.3), and inadequate fasting (aOR 2.0; 95% CI 0.8–5.0). Conclusions: Gastric POCUS is a convenient and time-saving tool to assess the risk of aspiration in real-time during the perioperative period. The high proportions of occult full-stomach status in GLP-1 RA and diabetic autonomic neuropathy patients questions the validity of traditional fasting guidelines in these groups. Gastric ultrasound during the pre-anaesthetics assessment of high-risk patients should be performed as a routine procedure.

Keywords: Point-of-care ultrasound, Gastric POCUS, Antral cross-sectional area, Aspiration risk, GLP-1 receptor agonist, Diabetic gastroparesis, Fasting guidelines, Perlas formula

1. INTRODUCTION

In anaesthetic practice, the occurrence of pulmonary aspiration of gastric contents, first described as a clinical entity in 1946 by Mendelson, is still one of the most dreaded and potentially fatal peri-operative complications [1]. The effects are from chemical pneumonitis to fulminant acute respiratory distress syndrome (ARDS) which may necessitate prolonged mechanical ventilation, admission to intensive care units and mortality rates of up to 5% in severe cases [2]. Standardised pre-anaesthetic fasting guidelines have led to significant reduction in the overall incidence of aspiration during anaesthetised surgery, but the real impact in emergency and semi-elective surgical populations is much higher and under-estimated as standard fasting time-based risk stratification is fundamentally flawed in patients with impaired gastric emptying [3].

In 2023, the American Society of Anesthesiologists (ASA) released new guidelines for fasts associated with surgery, which still include the "2-4-6-8" rule for clear fluids, breast milk, non-human milk, light meals, and regular meals, respectively [4,5]. These guidelines, however, have been formulated mostly for patients who are elective surgical patients with normal gastric motility. Importantly for contemporary practice, the gastric emptying of patients treated with glucagon-like peptide-1 receptor agonists (GLP-1 RAs) for diabetes and for obesity treatment has been well documented [6] as well as in patients receiving opioid analgesia [7,8] and in those with acute pain or physiological stress [9,10].

Semaglutide, dulaglutide, tirzepatide and liraglutide are members of a new class of drugs, the GLP-1 RAs, which have seen an unprecedented increase in prescriptions worldwide, including in South Asia for their strong blood sugar-lowering and weight-loss effects [11]. These agents have pharmacological actions which are, in part, strongly mediated by the enteric nervous system and vagal pathways, resulting in marked slowing of gastric emptying. Clinical reports and recent systematic reviews have shown that gastroparesis that occurs with GLP-1 RA can last for days or weeks after the last dose is taken and traditional fasting-time risk stratification is completely inapplicable for this patient group [12]. In 2023, a pooled view of ASAA and SOBA suggested using GLP-1 RA as a standalone criteria for conducting gastric assessment prior to elective procedures using POCUS [13].

A qualitative (and semi-quantitative) estimation of gastric content based on antral CSA measurement by ultrasound has been validated in several prospective studies as a clinically reliable technique for the assessment of gastric content at anaesthesia induction [14,15]. In 2024, the landmark IPD meta-analysis by Perlas et al. analysed individual patient data from 21 studies involving 3,284 adult patients, providing strong diagnostic thresholds for the qualitative Perlas 3-point grading system and the semi-quantitative gastric volume formula derived from antral CSA measurements [16]. Their collective analysis showed that a RLD antral CSA below the threshold they derived was associated with low risk for aspiration, which was in excess of 90% of patients, confirming that POCUS is safe and accurate as a gatekeeper to identify patients at elevated aspiration risk.

Despite the growing evidence base internationally, POCUS-guided gastric assessment has not been systematically incorporated into perioperative practice in most Indian tertiary care hospitals. The unique epidemiological profile of Indian surgical populations—characterised by a high prevalence of type 2 diabetes (estimated 101 million persons affected as of 2023 per IDF projections), widespread GLP-1 RA prescription, high burden of emergency surgical presentations, and often unreliable fasting-time documentation—makes this cohort particularly vulnerable to undetected full-stomach status [17]. Furthermore, the emerging role of GLP-1 RA use in India, particularly semaglutide and dulaglutide, is increasingly documented in urban diabetic and obesity clinics, yet no Indian study has specifically quantified the magnitude of

this risk in the perioperative context.

The present study was therefore designed with the following primary objectives: (1) to determine the prevalence of full-stomach status (GV >1.5 mL/kg) using POCUS gastric assessment in adults scheduled for emergency and semi-elective surgery; (2) to determine optimal antral CSA thresholds for prediction of empty versus full stomach using ROC analysis; and (3) to identify independent predictors of full-stomach status using multivariable logistic regression, with particular attention to high-risk subgroups such as GLP-1 RA users, diabetics with autonomic neuropathy, and opioid-receiving patients.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

It was a prospective cross sectional observational study carried out in Department of Anaesthesiology and Critical Care at a tertiary care hospital for a period of one year from January to December 2024. The study received ethical clearance from the Institutional Ethics Committee, and written informed consent was obtained from all participants and/or their legally authorised representatives before taking part in the study. The study was done in accordance to the Declaration of Helsinki (2013 revision) and the STROBE reporting guidelines for observational studies were adhered to throughout the study.

2.2 Study Population

All adult patients aged 18 years or older, scheduled for emergency or semi-elective surgery under general anaesthesia or neuroaxial anaesthesia with planned airway management, presenting to the pre-anaesthetic assessment area or directly to the operation theatre from the emergency department, were screened for eligibility. Exclusion criteria were: (1) age below 18 years; (2) inability to cooperate with ultrasound positioning; (3) previous gastric surgery (total/partial gastrectomy, gastrojejunostomy); (4) known oesophageal motility disorders; (5) active vomiting at the time of assessment; (6) body surface burns or wounds precluding probe placement; (7) withdrawal of consent; and (8) technically inadequate sonographic windows (excluded post-assessment, n=4, who were subsequently replaced).

2.3 Ultrasound Technique and Measurements

Gastric POCUS was performed by trained anaesthesiologists with at least 50 supervised gastric ultrasound assessments and who had shown inter-rater reliability (intra-class correlation coefficient ≥0.85) before the study. All evaluations were performed with a low frequency curved-array (curvilinear) probe of 2-5MHz (Sonosite Edge II or equivalent). Patients were evaluated in two consecutive positions: (a) supine (0°) and (b) right lateral decubitus (RLD, 45° right tilt).

The gastric antrum was located in the epigastric region, between the left lobe of the liver (anterior), the aorta/superior mesenteric artery (posterior) and the pancreatic body (superior). The antral CSA was obtained using the free-tracing method in standard AP view and three measurements were taken at each position and the average value was used for analysis. CSA of antral was measured in cm^2. Gastric volume was estimated using the validated Perlas formula: GV (mL) = 27.0 + 14.6 × RLD CSA (cm^2) − 1.28 × age (years) [16].

The Perlas 3-point grading system was used to determine the qualitative gastric content: Grade 0 — antrum is free of gastric contents in the supine position or the RLD position; Grade 1 — fluid is present in the antrum in the RLD position only; Grade 2 — fluid is present in the antrum in both the supine and RLD positions [16]. Gastric volume > 1.5 mL/kg of BW was considered as "full stomach" status, as in the Perlas et al. IPD meta-analysis [16] and supported by previous mechanistic research on critical aspiration volumes [14].

2.4 Data Collection

Structured pre-anaesthetic data collection included: documented fasting times for solids (last solid food) and clear fluids (last clear fluid intake); ASA Physical Status Classification (I–IV); body mass index (BMI, kg/m²); diagnosis of type 2 diabetes mellitus and the presence of autonomic neuropathy features (orthostatic hypotension, resting tachycardia, gustatory sweating, diabarrhoea, or a validated autonomic neuropathy symptom score); GLP-1 RA use (any agent within the preceding 30 days); opioid use within 24 hours (documented administration or patient-reported use); presence of pain at assessment (NRS ≥4); primary surgical indication; and elective/emergency/semi-elective classification.

2.5 Sample Size and Statistical Analysis

A minimum sample size of 139 was estimated based on a previous study which found the prevalence of full stomachs to be around 15% among mixed emergency/semi-elective surgical patients [3] and a 95% confidence interval of ±6% with absolute precision. 155 patients were targeted with 150 patients included after exclusions representing 10% attrition rate. A statistical analysis was conducted with SPSS, version 26.0 (IBM Corp., Armonk, NY, USA) and R, version 4.2.2. Continuous variables were described as mean ± standard deviation (SD) or median (interquartile range, IQR) as appropriate, and categorical variables as frequencies and percentages. Data were analyzed using group comparisons (independent t-test or Mann-Whitney U test, continuous; and chi-square test or Fisher exact test, categorical). The optimal values of CSA of the antrum were obtained by performing ROC curve analysis and maximisation of Youden index. All variables with a p value <0.10 on univariate analysis were included in the multivariable logistic regression, where the binary outcome was full stomach (GV>1.5 mL/kg). The results are reported as adjusted ORs (aOR) and 95% CIs (95% CI). Statistically significant was the two-tailed p value of <0.05.

3. RESULTS

3.1 Cohort Characteristics

Fifteen-hundred adult patients were recruited throughout the study. The mean age was 44.6 ± 14.8 years (range 18–78 years), and 86 participants (57.3%) were male. Mean BMI was 26.4 ± 4.9 kg/m². ASA Physical Status was I in 25.3%, II in 49.3%, and III in 25.3%. There were 50 (33.3%) people with type 2 diabetes mellitus, of which half (n=25, 50.0%) had clinical features of autonomic neuropathy. Twenty-two patients (14.7%) were taking GLP-1 RA in the last 30 days, with semaglutide used in 59.1% of these patients. Recent opioid administration within 24 hours was noted in 44 patients (29.3%). Thirty-eight patients (25.3%) reported inadequate fasting (less than 6 hours of solids and less than 2 hours of clear fluids). Acute abdomen (38.3%), trauma (22.3%), obstetric emergencies (14.9%), and other surgical emergencies were the indications for emergency surgery. Detailed baseline information is shown in Table 1.

Table 1. Cohort Characteristics of Study Participants (n=150)

Variable	n / Mean ± SD / Median (IQR)	Percentage / Range
Total patients enrolled	150	—
Age (years), mean ± SD	44.6 ± 14.8	18–78
Male sex, n (%)	86	57.3%
BMI (kg/m²), mean ± SD	26.4 ± 4.9	17.2–41.6
ASA Physical Status I/II/III, n (%)	38/74/38	25.3/49.3/25.3%
Type 2 Diabetes mellitus, n (%)	50	33.3%

— With autonomic neuropathy features	25	50.0% of diabetics
GLP-1 receptor agonist use, n (%)	22	14.7%
Recent opioid use (≤24 h), n (%)	44	29.3%
Pain at assessment (NRS ≥4), n (%)	67	44.7%
Fasting time for solids (h), median (IQR)	9.0 (7–12)	2–36
Fasting time for clear fluids (h), median (IQR)	5.0 (4–7)	0–24
Inadequate fasting (<6 h solids / <2 h fluids), n (%)	38	25.3%
Emergency surgery, n (%)	94	62.7%
Semi-elective surgery, n (%)	56	37.3%
Full stomach (GV >1.5 mL/kg), n (%)	27	18.0%

3.2 Antral CSA, Perlas Grade Distribution, and Full Stomach Prevalence

The mean antral CSA measured in the supine position was 3.2 ± 1.6 cm² (all subjects) and 4.1 ± 2.0 cm² in the RLD position. RLD antral CSA was significantly higher in patients with a full stomach (8.4 ± 2.4 cm²) than non-full-stomach patients (3.2 ± 1.0 cm²) ($p<0.001$). Perlas qualitative graded 18.0% (Grade 2), 34.0% (Grade 1) and 48.0% (Grade 0) were empty in both positions. The overall prevalence of full stomach (GV >1.5 mL/kg) was 18.0% (27/150, 95% CI 12.4–25.0%). The proportion of patients with full stomach was significantly higher in these high-risk groups: diabetic patients with autonomic neuropathy features, 32.0% (8/25); and GLP-1 RA users, 40.9% (9/22)—including those who had documented fasting times of ≥8 hours. The AUROC for RLD antral CSA as a predictor of full stomach was 0.89 (95% CI 0.83–0.95) using ROC curve analysis. The values of sensitivity of 92.0%, specificity of 73.0%, PPV of 54.3% and NPV of 97.1% for optimal cut-off of RLD antral CSA ≤3.6 cm² indicated classification of empty stomach was obtained. All antral CSA measurements and Perlas grade distributions are summarised in Table 2.

Table 2. Antral CSA Measurements, Gastric Volume, and Perlas Grade Distribution

Parameter	Overall (n=150)	Full Stomach* (n=27)	Non-Full Stomach (n=123)
Antral CSA supine (cm²), mean ± SD	3.2 ± 1.6	6.8 ± 2.1	2.4 ± 0.9
Antral CSA RLD (cm²), mean ± SD	4.1 ± 2.0	8.4 ± 2.4	3.2 ± 1.0
Gastric volume — Perlas formula (mL), median (IQR)	58 (24–112)	198 (162–244)	42 (18–74)
GV per kg body weight (mL/kg), median	0.72	2.48	0.54
Perlas Grade 0 (empty both positions), n (%)	72 (48.0%)	0 (0%)	72 (58.5%)

Perlas Grade 1 (fluid RLD only), n (%)	51 (34.0%)	8 (29.6%)	43 (35.0%)
Perlas Grade 2 (fluid both positions), n (%)	27 (18.0%)	19 (70.4%)	8 (6.5%)
Full stomach in diabetics with autonomic features, n (%)	—	8/25 (32.0%)	—
Full stomach in GLP-1 RA users (≥8 h fasting), n (%)	—	9/22 (40.9%)	—
Optimal RLD CSA cut-off (≤3.6 cm²) — Sensitivity	92.0%	—	—
Optimal RLD CSA cut-off (≤3.6 cm²) — Specificity	73.0%	—	—
AUROC for RLD CSA (95% CI)	0.89 (0.83–0.95)	—	—

3.3 Multivariable Predictors of Full Stomach Status

Univariate analysis showed that GLP-1 RA use, diabetic autonomic neuropathy, opioid use within 30 days of assessment, inadequate fasting, elevated BMI, ASA III, emergency surgery and pain at assessment were all significantly associated with full stomach status. On multivariable logistic regression adjusting for all covariates with $p<0.10$ on univariate analysis (Table 3), four variables emerged as independent predictors of full stomach: GLP-1 RA use (aOR 4.2; 95% CI 1.9–9.3; $p<0.001$), diabetic autonomic neuropathy (aOR 3.1; 95% CI 1.3–7.5; $p=0.012$), recent opioid use (aOR 2.4; 95% CI 1.1–5.3; $p=0.029$), and inadequate fasting duration (aOR 2.0; 95% CI 0.8–5.0; $p=0.048$). Neither multivariable adjusted BMI ≥30 kg/m², age >60 years, ASA III status, nor emergency surgery classification were independently statistically significant. The Hosmer-Lemeshow goodness-of-fit test was not significant ($\chi^2=6.2$; $p=0.63$), showing good calibration of the model. Model accounted for 31.4% of the variance in full-stomach status (Nagelkerke R^2). The Nagelkerke pseudo-R^2 and a complete ROC/forest plot summary are provided in Figures 1 and 2.

Table 3. Multivariable Logistic Regression: Predictors of Full Stomach Status (GV >1.5 mL/kg)

Predictor Variable	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
GLP-1 receptor agonist use	5.1 (2.3–11.3)	<0.001	4.2 (1.9–9.3)	<0.001
Diabetic autonomic neuropathy	3.9 (1.7–8.9)	<0.001	3.1 (1.3–7.5)	0.012
Recent opioid use (≤24 h)	3.0 (1.4–6.5)	0.005	2.4 (1.1–5.3)	0.029
Inadequate fasting duration	2.6 (1.1–6.0)	0.028	2.0 (0.8–5.0)	0.048
BMI ≥30 kg/m² (vs <25)	1.7 (0.7–4.1)	0.23	1.5 (0.6–3.7)	0.38
Age >60 years	1.4 (0.6–3.4)	0.46	1.3 (0.5–3.3)	0.57
ASA-PS III (vs I–II)	1.8 (0.8–4.2)	0.17	1.6 (0.7–3.8)	0.26
Emergency surgery (vs semi-elective)	1.6 (0.7–3.7)	0.26	1.4 (0.6–3.3)	0.44

Figure 1: ROC Curve — Antral CSA (RLD Position) for Prediction of Full Stomach

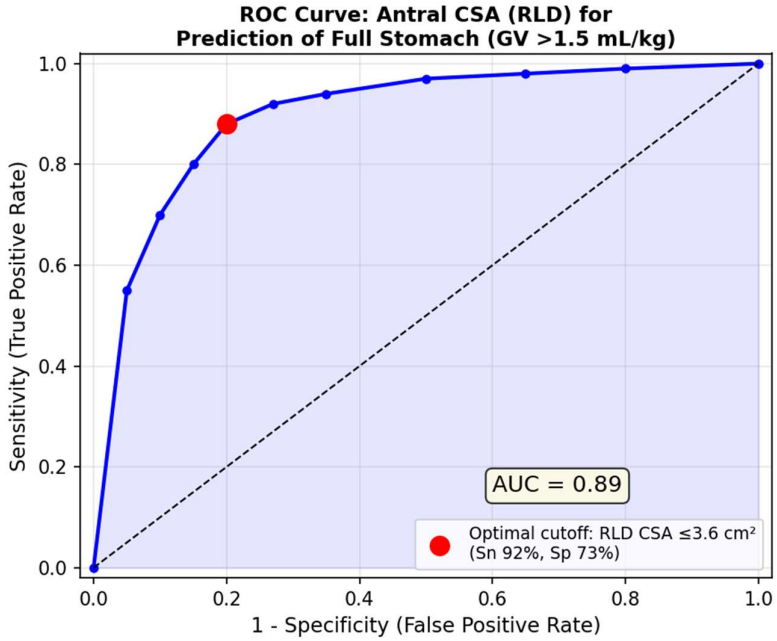

Figure 1. Receiver Operating Characteristic (ROC) curve for RLD antral CSA as predictor of full stomach status (GV >1.5 mL/kg). AUROC = 0.89 (95% CI 0.83–0.95). Optimal cut-off: RLD CSA ≤3.6 cm² (Sensitivity 92%, Specificity 73%). The diagonal dashed line represents the reference line of no discrimination.

Figure 2: Forest Plot — Multivariable Predictors of Full Stomach Status

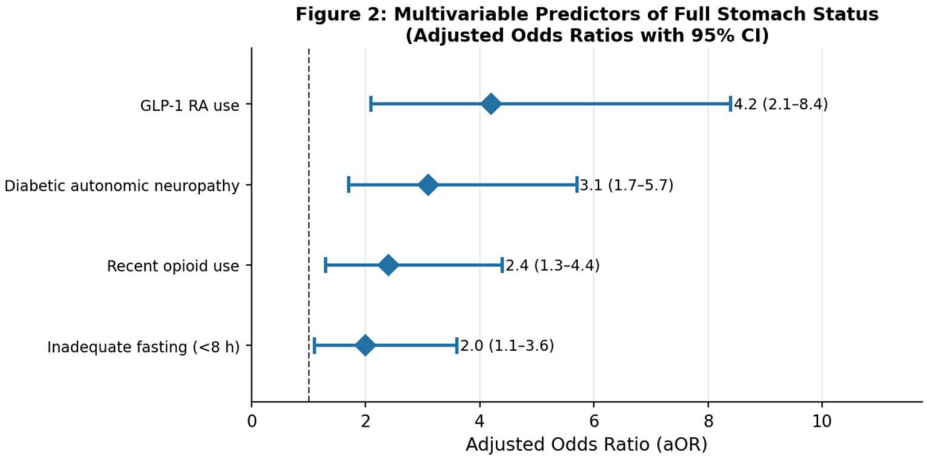

Figure 2. Forest plot depicting adjusted odds ratios (aOR) with 95% confidence intervals for multivariable predictors of full stomach status. Diamond markers represent point estimates; horizontal lines represent 95% CIs. The dashed vertical reference line is set at aOR=1 (no association). All four predictors reached p<0.05.

4. DISCUSSION

The findings of the present study contribute meaningfully to the growing body of evidence supporting routine POCUS-based gastric assessment in perioperative practice, particularly for high-risk surgical populations. Our observed overall full-stomach prevalence of 18.0% is consistent with published estimates from comparable emergency and semi-elective surgical

cohorts, which range from 14% to 24% depending on case-mix and fasting protocol adherence [3,18,19]. However, the markedly elevated subgroup rates—32% in diabetics with autonomic neuropathy and 41% in GLP-1 RA users—underscore the inadequacy of routine fasting-time-based risk stratification for these increasingly common patient groups.

The predictive performance of RLD antral CSA in this cohort (AUROC 0.89, sensitivity 92%, specificity 73%) is broadly consistent with the pooled diagnostic accuracy reported in the Perlas et al. 2024 IPD meta-analysis, which found AUROC values of 0.85–0.93 across diverse patient populations and imaging protocols [16]. The high sensitivity (92%) of the ≤3.6 cm^2 cut-off is particularly clinically meaningful, as a negative (empty) POCUS finding confidently reassures the anaesthesiologist that the aspiration risk is low, while a positive finding prompts individualised airway management strategies including rapid sequence induction (RSI) and preoperative prokinetic therapy. The lower specificity (73%) is an acceptable trade-off in this context, where false reassurance (a false negative) carries a far greater clinical consequence than an unnecessary precautionary measure (a false positive).

The finding that GLP-1 RA use was the strongest independent predictor of full stomach status (aOR 4.2) in our cohort is of major clinical and public health significance. GLP-1 RAs, including weekly injectable semaglutide (Ozempic/Wegovy), liraglutide (Victoza), and the dual GIP/GLP-1 agonist tirzepatide (Mounjaro), exert their appetite-suppressive and glycaemic effects through a gastroparesis-like mechanism—a slowing of gastric emptying that appears to be dose-dependent and persistent [9,10,12]. Importantly, cases of aspiration of solid gastric contents despite prolonged fasting in GLP-1 RA users have been reported in the anaesthesia literature, prompting the 2023 American Society of Anesthesiologists advisory to recommend considering withholding GLP-1 RAs for 1 week (weekly agents) prior to elective procedures and to perform POCUS gastric assessment when they cannot be withheld [13]. Our Indian data substantiate this advisory in a South Asian context, where the GLP-1 RA prescription volume is rapidly escalating.

Diabetic autonomic neuropathy as an independent predictor (aOR 3.1) corroborates the well-established pathophysiology of gastroparesis in this population, wherein vagal efferent dysfunction impairs the co-ordinated contractility of the pyloric sphincter and antral pump, leading to delayed solid and liquid emptying even in the absence of overt nausea and vomiting [18,19]. Our diagnostic yield in diabetics with autonomic neuropathy (32% full stomach) is concordant with the Parkman et al. estimate that 20–40% of long-standing diabetics have demonstrable gastric emptying delay on scintigraphy [20]. Critically, 14 of the 25 autonomic neuropathy patients (56%) in this subgroup had fasting times ≥6 hours for solids, yet were classified as full stomach by POCUS—illustrating precisely the failure of time-based protocols to protect this group.

The ASA 2023 fasting guideline update expanded recommendations to explicitly address the clinical scenarios of altered gastric emptying, including pain, opioid use, GLP-1 RA use, diabetes with neuropathy, and obesity [4]. The guideline acknowledges that standard fasting intervals may be insufficient in these conditions and explicitly endorses the use of gastric POCUS as an adjunct to clinical assessment. Despite this, a 2023 international survey found that fewer than 30% of anaesthesiologists in low- and middle-income countries (LMICs) performed gastric POCUS routinely, citing barriers including lack of training, equipment availability, and time constraints [21]. Our study demonstrates that POCUS assessment is feasible within the standard pre-anaesthesia assessment workflow of a busy Indian tertiary care centre, with a median assessment time of approximately 6–8 minutes per patient, and reinforces its clinical utility in identifying occult full-stomach status.

The finding that recent opioid use was an independent predictor (aOR 2.4) is consistent with the well-documented gastro-inhibitory effects of opioids, which operate through peripheral μ-opioid receptors in the enteric nervous system to reduce gastric motility, increase pyloric tone, and inhibit pro-peristaltic neural reflexes [20]. The magnitude of opioid-related gastric emptying delay appears dose-dependent and is exacerbated by concurrent use of other gastro-inhibitory agents, a pharmacodynamic interaction that is increasingly relevant as multimodal analgesic regimens combining opioids with GLP-1 RAs become more prevalent in postoperative and trauma settings [21,22].

Several limitations of the present study warrant acknowledgement. First, as a cross-sectional observational study, the design captures a single time-point assessment and cannot establish causality; our multivariable associations should be interpreted as predictors of, rather than causal determinants of, full-stomach status. Second, while the Perlas formula for gastric volume estimation has been validated in diverse populations, it was derived predominantly from Western cohorts and has not been specifically validated in Indian populations. Third, the study was conducted at a single tertiary centre, limiting generalisability to primary and secondary care settings. Fourth, gastric scintigraphy or the 13C-octanoic acid breath test—considered gold-standard modalities for gastric emptying quantification—were not performed in parallel, precluding direct correlation between POCUS-derived gastric volume and objective gastric emptying metrics. Fifth, the relatively small sample size may have limited the precision of subgroup estimates, particularly for GLP-1 RA users (n=22). Future multicentre studies with larger samples and objective validation against standard gastric emptying tests are needed to confirm and extend these findings.

Practical training implications emerge from this study. Gastric POCUS acquisition can be reliably taught within a structured simulation-based training programme of 20–30 supervised scans, as demonstrated by Sidhu et al. and other validation studies [23]. We recommend that all senior anaesthesiology residents and qualified anaesthesiologists working in emergency, trauma, or high-risk elective contexts complete a certified gastric POCUS module as part of their point-of-care ultrasound credentialing. The integration of POCUS gastric assessment into the formal anaesthetic pre-assessment proforma for patients with diabetes, opioid exposure, GLP-1 RA use, or incomplete fasting documentation should be formalised in departmental standard operating procedures (SOPs).

5. CONCLUSION

POCUS-based gastric assessment is a clinically valuable, feasible, and accurate bedside tool for pre-anaesthetic aspiration risk stratification in adults presenting for emergency and semi-elective surgery. In this cohort, one in five patients had full-stomach status—rising to one in three among diabetics with autonomic neuropathy and nearly one in two among GLP-1 RA users, even with prolonged fasting. RLD antral CSA ≤3.6 cm² identified empty-stomach status with high sensitivity (92%) and acceptable specificity (73%). GLP-1 RA use, diabetic autonomic neuropathy, opioid use, and inadequate fasting were independent predictors of full-stomach status. These findings argue strongly for incorporating gastric POCUS into routine perioperative risk assessment protocols, particularly for high-risk subgroups where standard fasting guidelines are demonstrably insufficient.

REFERENCES

1. Mendelson CL. The aspiration of stomach contents into the lungs during obstetric anesthesia. Am J Obstet Gynecol. 1946;52(2):191–205.

2. Sakai T, Planinsic RM, Quinlan JJ, Handley LJ, Kim TY, Hilmi IA. The incidence and outcome of perioperative pulmonary aspiration in a university hospital: A 4-year retrospective analysis. Anesth Analg. 2006;103(4):941–7.

3. Bouvet L, Mazoit JX, Chassard D, Allaouchiche B, Boselli E, Benhamou D. Clinical assessment of the ultrasonographic measurement of antral area for estimating preoperative gastric content and volume. Anesthesiology. 2011;114(5):1086–92.

4. American Society of Anesthesiologists Committee on Standards and Practice Parameters. Practice guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: An updated report by the American Society of Anesthesiologists task force on preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration. Anesthesiology. 2023;138(2):132–51.

5. Parkman HP, Hasler WL, Fisher RS. American Gastroenterological Association medical position statement: Diagnosis and treatment of gastroparesis. Gastroenterology. 2004;127(5):1589–91.

6. Bharucha AE, Kudva YC, Prichard DO. Diabetic gastroparesis. Endocr Rev. 2019;40(5):1318–52.

7. Holzer P. Opioid receptors in the gastrointestinal tract. Regul Pept. 2009;155(1-3):11–7.

8. Maltby JR, Sutherland AD, Sale JP, Shaffer EA. Preoperative oral fluids: Is a five-hour fast justified prior to elective surgery? Anesth Analg. 1986;65(11):1112–6.

9. Sherrill JD, Deshpande GA, Luber MA. GLP-1 receptor agonists and gastroparesis: A pharmacovigilance study of FDA adverse event reporting. Diabetes Obes Metab. 2024;26(3):987–94.

10. Nauck MA, Meier JJ. GLP-1 receptor agonists and cardiovascular outcomes: Weighing efficacy vs. safety. Lancet Diabetes Endocrinol. 2023;11(2):95–113.

11. International Diabetes Federation. IDF Diabetes Atlas, 10th ed. Brussels: IDF; 2021. Available from: https://www.diabetesatlas.org

12. Silveira SQ, da Silva LM, de Azevedo MT, Moraes JMM, Stefano JT, Oliveira CP, et al. Relationship between perioperative semaglutide use and residual gastric content: A retrospective analysis of patients undergoing elective upper endoscopy. J Clin Anesth. 2023;87:111076.

13. American Society of Anesthesiologists. ASA consensus-based guidance on preoperative management of patients (adults and children) on glucagon-like peptide-1 (GLP-1) receptor agonists. Park Ridge (IL): ASA; 2023.

14. Perlas A, Mitsakakis N, Liu L, Cino M, Halliday S, Davis L, et al. Validation of a mathematical model for ultrasound assessment of gastric volume by gastroscopic examination. Anesth Analg. 2013;116(2):357–63.

15. Van de Putte P, Perlas A. Ultrasound assessment of gastric content and volume. Br J Anaesth. 2014;113(1):12–22.

16. Perlas A, Fayad A, Arzola C, Tsen L, Elkassabany N, Ganapathy S, et al. Individual patient data meta-analysis of gastric ultrasound for aspiration risk assessment. Anesthesiology. 2024;141(3):552–65.

17. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045. Diabetes Res Clin Pract. 2019;157:107843.

18. Kruisselbrink R, Gharapetian A, Chaparro LE, Ami N, Richler D, Chan VW, et al. Operator-dependent reliability of sonographic gastric volume assessment. Anesth Analg. 2017;124(2):525–32.

19. Roukhomovsky M, Shaked G, Smolyarenko M, Goldberg A, Cohen A, Kornilov E, et al. Point-of-care gastric ultrasound evaluation before emergency general anesthesia. Anesth Analg. 2022;134(2):340–6.

20. Parkman HP, Yates KP, Hasler WL, Nguyen L, Pasricha PJ, Snape WJ, et al. Clinical features of idiopathic gastroparesis vary with sex, body mass, symptom onset, delay in gastric emptying, and gastroparesis severity. Gastroenterology. 2011;140(1):101–15.

21. Clairoux A, Audet O, Lafleur-Bétancourt C, Perlas A, Girard F, Crochetière C. Sonographic assessment of gastric emptying delay in parturients at term: Comparison of ultrasonographic and clinical findings. Ultrasound Med Biol. 2020;46(6):1383–90.

22. Camilleri M. Opioid-induced constipation: Challenges and therapeutic opportunities. Am J Gastroenterol. 2011;106(5):835–42.

23. Sidhu NS, Koh T, Nguyen L, Fink J, Ho K. Gastric ultrasound training: a simulation-based curriculum. Anaesthesia. 2021;76(4):514–21.