DOI: 10.18621/eurj.1338961 *Anesthesiology and Reanimation*

Evaluation of ultrasound-measured gastric volume and content in type 2 diabetes mellitus patients undergoing elective surgery: a prospective observational study

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ABSTRACT

Objectives: Delayed gastric emptying create a risk of pulmonary aspiration during anesthesia. We aim to assess the antral cross-sectional area (CSA) and gastric volume using ultrasound techniques and to investigate the relationship between these variables and both the duration and regulation of type 2 diabetes mellitus (DM).

Methods: Gastric volume was estimated by measuring the antral CSA in the supine and right lateral decubitus (RLD) positions in 80 patients. The antral content was qualitatively classified according to Perlas et al. (grades 0, 1, and 2), and gastric volume was computed using a previously described formula. The presence of solid content or > 1.5 mL/kg fluid in the stomach was classified as indicative of a full stomach.

Results: The mean duration of diabetes among the subjects was 9.4 ± 3.7 years. The mean fasting duration was 10.2 ± 2.1 hours for solids and 2.5 ± 0.7 for liquids. Twelve of the 80 patients exhibited grade 2 stomach. Age ($p = 0.005$), Body mass index ($p = 0.001$), solid fasting duration ($p = 0.027$), and supine and RLD CSA ($p < 0.001$ for both) were significantly associated with full stomach. A history of ≥ 8 years of diabetes ($p < 0.001$) and peripheral neuropathy ($p = 0.005$) was identified as a risk factor for a full stomach.

Conclusions: Despite adherence to standard fasting protocols, 15% of the type 2 DM patients were identified with a 'full stomach' condition. Preoperative ultrasound assessment of gastric contents in patients with type 2 DM, especially with long-standing diabetes (≥ 8 years) and with peripheral neuropathy is recommended. The findings of this study necessitate additional investigation to support the conceptualization of specific guidelines for diabetes to mitigate the risk of pulmonary aspiration.

Keywords: Diabetes mellitus, gastric volume, ultrasound, surgery, pulmonary aspiration, delayed gastric emptying

Diabetes Mellitus (DM), which is prevalent in approximately 25% of surgical patients, has generated significant interest in residual gastric volumes after adequate pre-anesthesia fasting. Patients with DM, particularly those suffering from gastropathy linked to autonomic dysfunction, are predisposed to delayed gastric emptying, rendering them more vulnerable to an increased risk of aspiration than their

Received: ***August 7, 2023; Accepted: August 24, 2023; Published Online: August 28, 2023***

e-ISSN: 2149-3189

How to cite this article: Demirel A, Dayoğlu M, Balkaya AN, Onur A, Gözen F. Evaluation of ultrasound-measured gastric volume and content in type 2 diabetes mellitus patients undergoing elective surgery: a prospective observational study. Eur Res J 2023;9(5):1083-1092. DOI: 10.18621/eurj.1338961

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healthy counterparts [1, 2]. It is worth noting that roughly 30-50% of patients with long-standing DM exhibit significantly prolonged gastric emptying time, as evidenced by radioisotope examination [3, 4].

Perioperative pulmonary aspiration of gastric contents is a severe and destructive complication associated with substantial postoperative morbidity and mortality [5]. The reported incidence of gastric aspiration fluctuates between less than 0.1% and 19%, with aspiration pneumonia accounting for 9% of all anesthesia-related fatalities [6]. Aspiration-related complications may include pneumonitis, pneumonia, and hypoxia, potentially escalating to respiratory failure, acute respiratory distress syndrome (ARDS), and ultimately, death [7].

To minimize the risk of perioperative aspiration, fasting guidelines have been established by the American Society of Anesthesiologists (ASA) [8] and the European Society of Anesthesiology [9]. However, these guidelines are primarily designed for healthy individuals undergoing elective surgery and may prove unreliable for patients with concurrent conditions that affect gastric emptying. Contemporary preoperative guidelines recommend at least 2 hours without liquids, 6 hours for non-fatty solid food, and 8 hours of fasting for fatty or high-calorie foods [10] to limit residual gastric volume and the subsequent risk of aspiration. Nonetheless, devastating aspiration events can still occur [11], partly because of the limitations in quantifying or eliminating hazardous gastric contents prior to anesthesia.

In recent years, Gastric Ultrasound (GU) has emerged as a point-of-care ultrasound (POCUS) technique and has rapidly gained traction within the anesthesiology domain. The GU is used to inform decisions before anesthesia induction, particularly in cases where fasting status is ambiguous or in emergency scenarios where surgery is vital [12]. Being simple, readily available perioperatively, noninvasive, radiation-free, and easy to perform at the bedside, POCUS has become a favored tool for gastric content and volume assessment [13].

The primary objective of the present study was to meticulously measure the antral cross-sectional area (CSA) and analyze fasting gastric volume in patients with type 2 DM. The secondary aim was to evaluate the association between gastric content and volume and the duration and regulation of diabetes in patients with type 2 DM scheduled for elective surgery. The insights derived from this study could contribute valuable information to the existing body of knowledge regarding risk factors and prevention strategies for aspiration in diabetic surgical patients.

METHODS

Study Setting

This prospective, unicentric observational study was conducted using a cohort of 80 patients scheduled for elective surgeries in a tertiary hospital from August 2019 to August 2020. Clearance from the Institutional Ethics Committee was obtained prior to the commencement of the study (2011-KAEK-25 2019/08-22). In the preoperative zone, written informed consent was obtained from all participants following a detailed briefing about the nature and purpose of the study.

The inclusion criteria were male and female patients aged between 35 and 75 years, with a minimum of 6 years of documented history of type 2 DM and classified under the ASA physical status II-III. Exclusion criteria were defined to eliminate patients taking medications known to affect gastric motility, those diagnosed with chronic renal failure, liver cell failure, hypothyroidism, obesity (BMI > 30 kg/m^2), connective tissue disorders, non-diabetic autonomic-neurological diseases, chronic opioid usage, gastrointestinal motility disorders and malignancies, prior surgeries involving the gastrointestinal and respiratory systems, current pregnancy, and those designated for emergency surgical procedures.

All patients included in the study were required to fast overnight, with a minimum fasting period of 8 h from their last meal. A comprehensive medical history was collected from each participant, focusing on details pertaining to the diagnosis and duration of diabetes, postprandial plasma glucose concentrations, and medication history. Creatinine levels and glomerular filtration rate (GFR) were obtained from hospital electronic health records, ensuring that the information did not exceed one month of age. Recent hemoglobin A1c concentration within the preceding 3 months was also recorded or, in its absence, a blood sample was collected on the day of the procedure for analysis. Peripheral neuropathy was identified and defined based on scores exceeding 2 on the Michigan Neuropathy Screening Instrument (14). Notably, no premedication was administered to the patients, and Nil per os (NPO) status, along with the fasting duration for both solids and liquids, was meticulously assessed and documented.

Ultrasound Examination Technique and Assessment

Gastric Ultrasound Examination Procedure

Gastric Ultrasound (GU) examination was conducted in the recovery room within the operation theatre complex, prior to the patient being transferred to the operating room. An anesthesiologist (AD) with 13 years of experience in anesthesia performed a minimum of 50 training GU examinations. The study was executed using a portable US machine (MyLab30; Esaote, Italy) equipped with a curved array low-frequency (2-5 MHz) probe set in the abdominal scan mode.

For optimal antral visualization, the patient was first scanned in the supine position, followed by the right lateral decubitus (RLD) position, with the head of the bed elevated to 45° to maximize sensitivity (15). The transducer was carefully aligned in the sagittal plane in the epigastric region, with the left lobe of the liver anteriorly and the head or body of the pancreas posteriorly serving as reference points. The antrum, distinguished by its characteristic multi-layered wall, was scanned above large abdominal vessels, such as the aorta or inferior vena cava (2). A still image of the antrum was captured between peristaltic contractions, allowing for both qualitative (type of content) and quantitative (volume) assessments of gastric content. Notably, the anesthesiologist performing the GU measurement was not blinded to the patient's identity and did not influence the anesthesia method or any subsequent procedures.

Qualitative Assessment

Qualitative assessments were performed according to the appearance of the contents visualized using ultrasound. The classifications are as follows.

Empty Antrum: If the walls of the antrum were detected in close proximity to each other or displayed a "bull’s eye/target pattern," the antrum was considered empty [16, 17].

Clear Liquids: Clear fluids, such as normal gastric secretions, water, or tea, manifested as an anechoic (black) appearance on the US.

Liquids with Gas Bubbles: The presence of multiple gas bubbles yielded a “starry night” appearance [2].

Solid/Particulate Matter: In the initial phase, solids or particulates presented a “frosted glass” pattern, where multiple ring-down artifacts obscured the posterior antrum. As this progressed, the solid content appeared to be increasingly heterogeneous, particulate, and hyperechoic [2, 16].

The sonographic appearance of the gastric antrum was systematically categorized, based on the grading system defined by Perlas *et al*., as grades 0, 1, and 2. These grades represent an empty antrum, fluid detected solely in the RLD position, and antral fluid visible in both the supine and RLD positions, according to the perspective obtained in both positions (14).

Quantitative Assessment

Quantitative assessment was conducted after the qualitative analysis of the antrum, with a focus on calculating the Cross-Sectional Area (CSA). Measurements were performed at the level of the aorta or inferior vena cava by employing an ultrasound machine in both the supine and RLD positions.

The traditional two-diameter method served as the framework for this calculation, which entailed measuring two perpendicular diameters of the antrum, namely the craniocaudal (CC) and anteroposterior (AP) dimensions, extending from the serosa to the serosa. The formula developed by Perlas *et al*. was used for this computation [14].

Upon completion of the preoperative GU examination, the quantitative residual gastric volume was ascertained for each patient by employing the formula delineated by Perlas *et al*. (18): Gastric volume (ml) = (27 + 14.6 x RLD CSA (cm2) − 1.28 x age (years). Aspiration risk was then evaluated qualitatively using the antral grading system (14) and further classified according to the scheme devised by Van de Putte and Perlas (2):

(a) Low Aspiration Risk

This category encompassed patients with an empty antrum or those with a gastric residual volume less than 1.5 mL/kg.

(b) High Aspiration Risk

This category included patients presenting with solid contents or those with a gastric residual volume exceeding 1.5 mL/kg.

This comprehensive quantitative assessment, coupled with qualitative evaluation, facilitated a detailed understanding of gastric contents and volumes, thereby allowing for tailored risk stratification regarding aspiration in the perioperative setting.

Statistical Analysis

Statistical analysis in this study was methodically structured and executed to ensure accurate and robust conclusions. Descriptive statistics were employed, with categorical data presented as frequencies and percentages, and continuous variables presented as mean values plus or minus standard deviation. Comparative analyses for categorical data were undertaken using the Chi-square test and Fisher's exact test, as applicable. For continuous variables, the Independent Samples T-test was used to compare single measurements across distinct groups, illuminating any significant differences. The interrelationships among various measurements were explored through Pearson correlation analysis, which helped identify and quantify the strength of the associations between different variables. A threshold of $p < 0.05$ was predetermined as the level of significance, ensuring that any p - values below this cut-off were indicative of statistical significance. All statistical computations were meticulously performed using the SPSS 20 software package, allowing for rigorous data processing and analysis, thus underpinning the credibility of the study's findings.

RESULTS

The study enrolled 80 patients. The demographic and surgical data are presented in Table 1. The sex distribution included 55.0% females and 45.0% males, slightly favoring females. The average patient age was 61 ± 9 years (range, 35-75 years). The types of surgeries performed were general surgery (27.5%), neurosurgery (27.5%), urological surgery (18.8%), orthopedic surgery (15%), gynecological surgery (12.5%), and others (11.3%). Cardiovascular comorbidities, such as hypertension and coronary artery dis-

Table 1. Demographic, baseline and preoperative characteristics of the patients

	Data
Age groups (year)	
35-45	5 (6.3)
46-55	20 (25.0)
56-65	28 (35.0)
66-75	27 (33.8)
Age (years)	61 ± 9
Sex	
Female	44 (55.0)
Male	36 (45.0)
BMI (kg/m^2)	
Normal weight (20-24.99)	12 (15.0)
Overweight (25-29.99)	68 (85.0)
Height (cm)	168 ± 9
Weight (kg)	76 ± 8
ASA	
II	48 (60.0)
III	32 (40.0)
Section to be operated	
General surgery	22 (27.5)
Neurosurgery	12 (15.0)
Urology	15 (18.8)
Orthopedic surgery	12 (15.0)
Gynecology	10 (12.5)
Ear, nose, throat	8 (10.0)
Plastic surgery	1 (1.3)
Comorbidities	
Diabetes mellitus	80 (100.0)
Hypertension	47 (58.8)
CAD	26 (32.5)
COPD	10 (12.5)
Astma	5 (6.3)
Others	2 (2.5)
Fasting time (hour)	
6-10	48 (60.0)
11-15	32 (40.0)
Fasting time (solid) (hour)	10.2 ± 2.1
Fasting time (liquid) (hour)	2.5 ± 0.7
Postprandial glucose concentration (gr/dL)	141.4 ± 35.3
HbA1c (%)	7.94 ± 2.11
Duration of diabetes (year)	
< 8 year	32 (40.0)
≥ 8 year	48 (60.0)
Duration of diabetes (year)	9.4 ± 3.7

Data are shown as mean ± standard deviation or number (percent). BMI = Body mass index, ASA = American Society of anaesthesiologists, HbA1c = Hemoglobin A1c, CAD = Coronary artery disease, COPD = Chronic obstructive pulmonary disease

Table 2. **Qualitative grade of assessment of gastric content in type 2 diabetic patients**

(n = 80)		n	%
Qualitative assessment of gastric content			
	Grade 0	25	31.3
	Grade 1	43	53.8
	Grade 2	12	15.0

ease, were common, present in 58.8% and 32.5% of patients, respectively. Average fasting durations were 10.2 ± 2.1 hours for solids and 2.5 ± 0.7 hours for liquids. The mean hemoglobin A1c concentration was 7.94 ± 2.11. A 40.0% of the patients had diabetes for less than 8 years, and 60.0% for 8 years or more, with a mean duration of 9.4 ± 3.7 years (Table 1).

Ultrasound grading variations are presented in Table 2. Qualitative ultrasound evaluations indicated that 31.3% were grade 0, 53.8% were grade 1, and 15% were grade 2 in the antrum (Table 2).

The association between gastric volume and gastric content with respect to hour is shown in Table 3. Five patients had remarkable amounts of clear liquid (> 1.5 ml/kg), while seven had solid content, despite adhering to traditional fasting guidelines. The mean volume was significantly lower for those who fasted 6-10 hours compared to 11-15 hours ($p = 0.045$), with no significant difference between liquid fasting times and full stomach instances (Table 3).

The mean supine CSA was 6.40 ± 2.52 cm^2, RLD CSA was 7.57 ± 2.75 cm2, and the mean RLD gastric volume was 58.63 ± 37.62 ml.

This study investigated the risk factors for a full stomach in diabetic patients and divided them into groups based on the ultrasound grade. Differences were not significant for sex, ASA physical status, fasting blood sugar, hemoglobin A1c value, or GFR ($p > 0.05$), but significant differences were found for mean age, BMI, solid fasting time, and CSA in both positions ($p < 0.001$). The number of full-stomach instances was significantly higher in patients with neuropathic complaints ($p = 0.005$). ROC curve analysis identified a threshold value of 8 years for diabetes duration, predicting a higher likelihood of a full stomach for those aged ≤ 8 years ($p < 0.001$) (Table 4) (Fig 1).

The mean BMI was higher in the full stomach group (27.70 ± 1.90) than in the empty/intermediate stomach group (26.09 ± 2.13). However, no statistically significant correlation was found between BMI and the measured antral CSA or gastric volume.

Table 5 shows the parameters of the threshold value, which further enhances the understanding of the factors contributing to the observed results (Table 5).

The results provided a comprehensive analysis of the relationship between various factors and gastric content and volume in patients with diabetes undergoing elective surgery. The findings of quantitative and qualitative assessments, correlations, and subgroup analyses have contributed to the understanding of the factors affecting the risk of aspiration in this population. These results have implications for anesthetic planning and patient care, emphasizing the need for individualized fasting guidelines to minimize the risk of aspiration, especially in patients with diabetes.

Table 3. **Correlation of gastric content and volume with respect to fasting hours**

	Gastric volume	Grade 2	
		Solid	Liquid > 1.5 mL/kg
Fasting time (hour)			
6-10	51.77 ± 37.36	5 (71.4)	2 (28.6)
11-15	68.91 ± 36.18	2 (40.0)	3 (60.0)
***p* value**	**0.045** [a]	0.558 [b]	
Fasting time (liquids) (hour)		2.6 ± 0.8	2.6 ± 0.9
***p* value**		0.954 [a]	

Data are shown as mean ± standard deviation or number (percent).
[a]Chi-square test, [b]Independent samples T test

Table 4. Diabetic patients' characteristics between those with empty /intermediate stomach and full stomach

	Empty /intermediate stomach (Grade 0-1)	Full stomach (Grade 2)	*p value*
Gender			0.396[a]
Female	12 (27.3)	32 (72.7)	
Male	13 (36.1)	23 (63.9)	
Age (year)	57 ± 8	63 ± 9	**0.005**[b]
BMI (kg/m^2)	26.09 ± 2.13	27.70 ± 1.90	**0.001**[b]
ASA			
II	18 (37.5)	30 (62.5)	0.140[a]
III	7 (21.9)	25 (78.1)	
Postprandial glucose concentration (gr/dl)	135.7 ± 35.9	144.0 ± 35.1	0.332[b]
HbA1c	7.32 ± 1.54	8.22 ± 2.28	0.079[b]
Peripheral neuropathy			
Yes	7 (17.1)	34 (82.9)	**0.005**[a]
No	18 (46.2)	21 (53.8)	
GFR	92.51 ± 19.23	84.29 ± 18.26	0.070[b]
Duration of diabetes(year)			
< 8 year	23 (71.9)	9 (28.1)	**0.005**[c]
≥ 8 year	2 (4.2)	46 (95.8)	
Fasting time (solid) (hour)	9.5 ± 1.8	10.6 ± 2.2	**0.027**[b]
Fasting time (liquid)(hour)	2.4 ± 0.7	2.6 ± 0.7	0.293[b]
CSA Supine (cm^2)	4.72 ± 2.32	7.16 ± 2.24	**< 0.001**[b]
CSA RLD (cm^2)	5.54 ± 2.34	8.49 ± 2.42	**< 0.001**[b]

Data are shown as mean±standard deviation or number (percent). BMI = Body mass index, HbA1c = Hemoglobin A1c, GFR = Glomerular filtration rate, CSA = Cross-sectional area, RLD = Right lateral decubitus

[a]Chi-square test, [b]Independent samples T-test, [c]Fisher test

DISCUSSION

This prospective observational study ascertained that approximately 15% of patients with type 2 DM exhibited a full stomach post-adherence to the conventional preoperative fasting guidelines set by the ASA. Notably, parameters such as age, BMI, duration of solid fasting, and CSA values in both supine and RLD stances were significantly elevated in these individuals. Our data also highlighted an increased likelihood of a full stomach among patients with diabetes exhibiting peripheral neuropathy and those diagnosed with type 2 DM for eight years or more.

Currently, diabetes affects approximately 25% of patients undergoing surgical intervention worldwide [19]. This metabolic disorder is a substantial risk factor that complicates anesthesiologic management. A primary concern is the threat of pulmonary aspiration, given the predisposition of diabetic patients towards full stomachs as a consequence of autonomic gastropathy [20]. Camilleri *et al*. [21] identified that nearly half of the patients with long-standing diabetes experience delayed gastric emptying, a salient concern. Although clinicians typically obtain the NPO status from patients, its accuracy is debatable, especially in high-risk individuals, potentially leading to an ele-

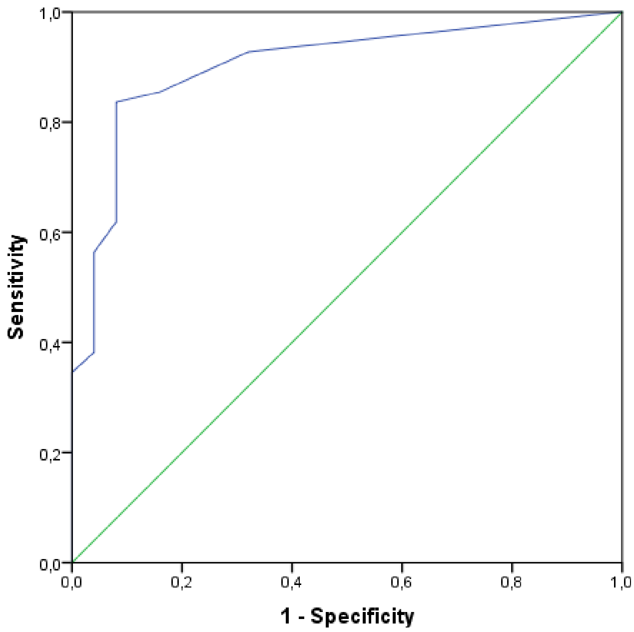

Fig 1. Determination of a threshold value for prediction of diabetes duration (ROC curve).

vated aspiration risk.

Associations between delayed gastric emptying in patients with diabetes and complications such as retinopathy, nephropathy, and autonomic neuropathy have been established in the literature [22, 23]. Earlier studies have also underscored the centrality of autonomic and enteric neuropathies in the onset of diabetic gastroparesis [21]. Our findings echo these observations, with an elevated prevalence of full stomach in patients with peripheral neuropathy. Such insights suggest a potential need for extended preoperative fasting durations in this patient subset, underscoring the need for rigorous studies to corroborate our postulates.

Although diverse techniques for stomach content evaluation exist, from paracetamol absorption to radiolabeled diet evaluations [17, 24], their utility during the preoperative phase remains questionable, often due to reliability and convenience concerns. Modern ultrasound technologies enable clinicians to detect hazardous stomach contents with noninvasive precision. Such tools enable the personalization of aspiration risk assessments at point-of-care and streamline anesthetic approaches [24]. Moreover, the adoption of POCUS enhances real-time decision-making before anesthesia administration, reduces perioperative complications [25], and assists in monitoring the gastric antrum and volume thresholds [26]. The learning curve for anesthesiologists in GU evaluations is also notably brief [27].

In our investigation, the differentiation between empty and full stomachs was based on Perlas's qualitative grading system, coupled with antral CSA measurements in the RLD position [14]. Qualitative ultrasound analyses of diabetic patients revealed 31.3% with grade 0 in 53.8%, grade 1, and grade 2 in 15 %. Aligning with Chaitra *et al*.'s [28] findings, we found that 15% of patients with type 2 DM, following current preoperative fasting recommendations, remained at high regurgitation risk, amplifying pulmonary aspiration concerns under general anesthesia (GA). It is noteworthy to juxtapose these findings with

Table 5. Results of ROC curve analysis

	Threshold value	SEN	SPE	PPV	NPV	AUC	%95 CI	*p value*
Duration of diabetes	8 year	83.6	92.0	95.8	71.9	0.904	(0.832-0.976)	**< 0.001**

SEN = Sensitivity, SPE = Specificity, PPV = Positive predictive value, NPV = Negative predictive value, AUC = Area under the curve, %95 CI = %95 Confidence Interval those of Sabry *et al*. [29] and Chaitra *et al*. [28], who reported a 60% and 28.4% prevalence of full stomachs, respectively. When GA is essential for a patient with full stomach, rapid sequence induction and tracheal intubation are recommended [22].

Patients with diabetes had larger residual GV and antral CSA [12, 30]. Similarly with the study by Sharma *et al*. [31], the mean GV was found to be 58.63 ± 37.62 ml and the mean calculated supine CSA was 6,40 ± 2,52 cm2, the calculated RLD CSA was 7.57 ± 2.75 cm2. In line with the literature, when we compared the CSA and gastric volumes regarding the fasting times, patients who had fasted between 11-15 hours had greater gastric volumes than patients who had fasted between 6 and 10 hours. Therefore, there is no relationship between secure gastric enviroment and prolonged fasting. Other studies stated that with prolonged fasting, due to increased secretion of gastric acid, there is a decrease in the pH of gastric content (pH < 2.5) [32, 33]. Two of our patients who fasted more than 6 hours and three who fasted for more than 10 hours had significant liquid on their stomach (> 1.5 mL/kg). Of the seven patients who had solid gastric contents five have fasted for more than 11 hours and two for 6-10 hours. This would implicit slow gastric emptying.

The mean age of our study cohort was 61 ± 9 years, spanning between 35 and 75 years, which aligns with existing literature [1, 22, 29, 31]. This skew towards older ages is unsurprising given the propensity for type 2 DM to manifest later in life, coupled with our inclusion criterion necessitating a minimum diabetes duration of six years.

Our data also revealed a statistically significant elevation in BMI for those with a full stomach (27.70 ± 1.90) compared to their counterparts (26.09 ± 2.13). However, no correlation was discerned between CSA values in either the supine or RLD position and gastric volumes, potentially because the study excluded obese patients. Since we did not include patients with BMI>30 kg/m2 in our study, this may have been the case. Sharma *et al* found that as the BMI increased from 25-35 there were significantly rise in the gastric CSA in both supine and RLD positions [31].

While several studies have posited varied conclusions regarding the impact of hemoglobin A1c and blood glucose levels in patients with type 2 DM [22, 34-36], our study found no discernible relationship between postprandial glucose and hemoglobin A1c concentrations.

In alignment with the extant literature, our participants exhibited a mean fasting duration of 10.2 ± 2.1 hours. As stated by other studies, predicting the timing of the surgery is often accurate and surgical schedule is habitually subject to change [1, 28, 31]. Current trends in the medical community are leaning towards more liberal preoperative fasting protocols [37, 38]. Consequently, our findings urge anesthesiologists to exercise increased vigilance in patients with longstanding diabetes. The existing guidelines lack targeted preoperative recommendations for this demographic, signifying an urgent research gap that future prospective studies must address.

Limitations

As this was an observational and single-center study, the generalizability of our findings is limited. Different centers may have varied patient demographics, practices, and equipment, which can influence outcomes. Our study exclusively involved patients with type 2 DM, which did not provide insights into patients with type 1 DM. Given that individuals with type 1 DM often have a longer exposure to complications associated with the disease, the prevalence of gastroparesis might be more pronounced than in those with type 2 DM. The study did not consider or control for the influence of different diets on gastric emptying or residual volumes. Dietary habits can significantly influence the gastric motility and emptying time. The mean fasting interval observed in this study was approximately 10 h. Owing to the hectic conditions of our operating room schedules, it was challenging to have strict control over fasting duration in the preoperative phase. Our study exclusively utilized US to assess gastric residual volume, without comparing its efficacy or accuracy with other existing methods. This limits our ability to validate the accuracy or superiority of US as an evaluation tool. None of our patients with type 2 DM had diabetic nephropathy or was categorized as obese. Both uremic patients and those with obesity are known to exhibit elevated gastric residual volumes. This exclusion may have provided a skewed perspective regarding the prevalence of delayed gastric emptying in the broader diabetic population. Given these limitations, future research endeavors should aim to be multi-centered, involve a diverse patient cohort, including those with type 1 DM, obesity, and diabetic nephropathy, and perhaps incorporate various methods for gastric volume assessment. Such studies would offer a more comprehensive understanding of the factors that delay gastric emptying in patients with diabetes.

CONCLUSION

The findings of our study underscore the crucial fact that fasting for more than 6 to 10 h does not automatically equate to an empty stomach in patients with type 2 DM. There was a noticeable increase in antral CSA and, consequently, fasting gastric volume, as measured by POCUS in the RLD position, particularly in individuals afflicted with type 2 DM. This could potentially necessitate alterations in the anesthesia plans.

As a significant consideration for clinical practice, anesthesiologists should be aware of the importance of evaluating the gastric antrum with POCUS prior to induction, especially in diabetic patients who have had the disease for eight years or more, or those with peripheral neuropathy. Such an assessment is not merely a procedural formality but an eminent necessity in ensuring patient safety and optimal management.

There is a compelling need for comprehensive studies with larger and more diverse sample sizes, including patients with multiple comorbidities such as obesity, chronic renal disease, and advanced liver disease. Such research endeavors could elucidate a stronger correlation between gastroparesis and the diverse factors that contribute to delayed gastric emptying in patients with DM scheduled for elective surgeries under general anesthesia. By doing so, the medical community can hope to refine preoperative guidelines and anesthesia protocols, further enhancing the safety and effectiveness of surgical interventions for this particular patient population.

Authors' Contribution

Study Conception: AD, MD; Study Design: MD, AD; Supervision: AD, MD; Funding: FG, AO; Materials: ANB, AO; Data Collection and/or Processing: FG, AD, AO; Statistical Analysis and/or Data Interpretation: AO, ANB; Literature Review: FG, ANB; Manuscript Preparation: AD; AO and Critical Review: AD, MD.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

Financing

The authors disclosed that they did not receive any grant during conduction or writing of this study.

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