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COMPARISON OF FASTING GASTRIC VOLUME USING ULTRASOUND IN DIABETIC AND NON-DIABETIC PATIENTS UNDERGOING ELECTIVE SURGERY: AN OBSERVATIONAL STUDY

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Abstract

Background: Delayed gastric emptying is a common complication in diabetic patients due to autonomic neuropathy, increasing the risk of pulmonary aspiration during anesthesia. This study evaluates fasting gastric volume (GV) in diabetic versus non-diabetic patients using point-of-care ultrasound (POCUS).

Objectives: To compare gastric antrum cross-sectional area (CSA) and fasting gastric volume in diabetic and non-diabetic individuals scheduled for elective surgery. Secondary objectives included analyzing the relationship between gastric volume and clinical parameters such as age, BMI, and duration of diabetes.

Methods: A comparative observational study was conducted involving 120 participants equally divided into two groups—60 diabetics (Group D) and 60 non-diabetics (Group C). Gastric antrum CSA and GV were measured using a curvilinear ultrasound probe in both supine and right lateral decubitus (RLD) positions. Grading of the antrum was performed using the Perlas 3-point grading system.

Results: Diabetic patients exhibited significantly larger antral CSA and gastric volumes. Group D had a mean GV of 62.51 ± 40.74 ml, whereas Group C recorded 48.50 ± 31.15 ml ($p = 0.036$). Ultrasound grading revealed higher proportions of Grade 2 content in diabetics than in non-diabetics. Antral diameters and CSA differences were statistically significant in both positions.

Conclusion: The observed increase in fasting gastric volume among diabetic individuals highlights the value of preoperative gastric ultrasound in identifying patients at greater aspiration risk. Routine use of POCUS in pre-anesthetic assessment could personalize perioperative care in diabetics.

Keywords: Gastric Emptying, Diabetes Mellitus, Ultrasound, Gastric Volume, Anesthesia, Gastroparesis, Aspiration Risk, Perlas Grading, Preoperative Assessment, Fasting Guidelines, Point-of-Care Ultrasound.

INTRODUCTION

Ensuring an empty stomach before administering anesthesia is vital to avoid the risk of aspiration, especially in patients with comorbid conditions like diabetes mellitus. Aspiration, often resulting from regurgitation of gastric contents during anesthesia, can lead to serious complications such as aspiration pneumonia or ARDS.

Diabetics are particularly susceptible to delayed gastric emptying due to gastroparesis. Current fasting protocols recommended by organizations such as the ASA and ESA might not fully address the gastric physiology of diabetic patients. While ESA supports standardized fasting across all patients, ASA guidance allows flexibility considering coexisting conditions.

Given this variability and the widespread prevalence of diabetes, accurate, individualized preoperative gastric assessment becomes essential. Ultrasound offers a non-invasive, bedside method for visualizing gastric contents and estimating volume, enabling risk stratification in real-time.

This study aimed to quantify and compare fasting gastric volumes in diabetic and non-diabetic patients using bedside ultrasound.

AIM AND OBJECTIVES

Aim:

To compare fasting gastric volume between diabetic and non-diabetic patients scheduled for elective surgery using ultrasound imaging.

Primary Objective:

- Measure and compare the fasting gastric volume by ultrasound between diabetic and non-diabetic patients.

Secondary Objectives:

- Assess the influence of diabetes duration and glycemic control (HbA1c) on gastric volume.
- Correlate CSA and GV with demographic characteristics like age, sex, and BMI.

Hypothesis:

Diabetic individuals have an increased antral CSA and fasting gastric volume when compared to non-diabetic individuals.

MATERIALS AND METHODS

Study Design:

Comparative observational study.

Study Site and Duration:

Conducted at Saveetha Medical College Hospital over a period of 12 months (September 2023 – August 2024).

Population and Sampling:

- **Total Population:** 120 patients (60 diabetics, 60 non-diabetics).
- **Inclusion Criteria:** Adults over 18 years, ASA physical status I–III, fasting as per standard guidelines.
- **Exclusion Criteria:** ASA IV, pregnant patients, patients on drugs affecting gastric motility, CKD, hypothyroid, altered gastrointestinal anatomy, and unwilling participants.

Tools:

- Curvilinear abdominal ultrasound probe (2–5 MHz).
- Gastric ultrasound performed in both supine and RLD positions.

Methodology:

Upon consent, eligible patients were grouped into:

- **Group D (Diabetic)**
- **Group C (Control, Non-Diabetic)**

Key data collected:

- Demographics: Age, BMI, ASA grade, duration of diabetes, and HbA1c levels.
- Ultrasound Assessment:
  - Qualitative: 3-point Perlas grading system.
  - Quantitative:
    - Antral diameters (AP and CC).
    - CSA calculated using CSA=AP×CC×π4$CSA = 4AP \times CC \times \pi$.
    - Gastric Volume estimated using:
      GV(ml)=27.0+(14.6×CSA)−(1.28×Age)$GV(ml) = 27.0 + (14.6 \times CSA) - (1.28 \times Age)$

Statistical Analysis:

Data analyzed using unpaired t-test and Chi-square test. A p-value < 0.05 was considered statistically significant.

RESULTS

Demographics:

- Average age: Diabetics (52.8 ± 12.3), Non-diabetics (37.8 ± 15.1), $p < 0.001$.
- No significant differences in BMI, height, or weight.

ASA Classification:

- Group D: Majority ASA II–III
- Group C: Primarily ASA I

Ultrasound Grading:

- Grade 2 (high-volume stomach): Seen in 30% of diabetics vs only 8.4% of non-diabetics.

- Significant difference in ultrasound grades ($p < 0.001$).

Antral Measurements:

- Larger antral diameters and CSA noted in diabetics:
  - **Supine CSA:** 6.37 ± 2.65 cm² (D) vs 3.94 ± 1.84 cm² (C)
  - **Lateral CSA:** 6.93 ± 2.85 cm² (D) vs 4.79 ± 2.25 cm² (C)
  - All values statistically significant.

Gastric Volumes:

- **Group D:** 62.51 ± 40.74 ml
- **Group C:** 48.50 ± 31.15 ml
- $P = 0.0364$, indicating statistical significance.

DISCUSSION

This study demonstrates a clear difference in fasting gastric volumes and antral cross-sectional areas (CSA) between diabetic and non-diabetic patients scheduled for elective surgery, with diabetics consistently showing higher values. These findings hold important clinical relevance, as increased gastric volume is a recognized risk factor for pulmonary aspiration during anesthesia induction. The use of point-of-care gastric ultrasound (POCUS) allowed for a direct, non-invasive, and reproducible assessment of gastric contents, enabling quantification beyond clinical judgment alone.

Comparison with Existing Literature

Our results are consistent with prior studies that have documented delayed gastric emptying in diabetic patients, particularly those with long-standing disease and poor glycemic control. Diabetic gastroparesis, primarily due to autonomic neuropathy affecting the vagus nerve, leads to impaired gastric motility and prolonged retention of gastric contents. This mechanism has been supported by scintigraphy studies as well as ultrasound-based assessments (De Block et al., 2008; Perlas et al., 2014). The mean gastric volume in our diabetic group (62.51 ± 40.74 ml) closely aligns with values reported by Nair et al. (2018) and Paidimuddala et al. (2023), both of which concluded that diabetic patients are more likely to have residual gastric contents despite adherence to standard fasting protocols.

Our ultrasound grading analysis revealed a significantly higher incidence of Grade 2 stomachs in diabetics (30%) compared to non-diabetics (8.4%), indicating a higher proportion of high-volume stomachs in the diabetic population. Similar trends were reported by Garg et al. (2020) and Panjabi et al. (2017), reinforcing that fasting times recommended by the American Society of Anesthesiologists (ASA) may not be adequate for patients with altered gastric physiology.

Physiological and Clinical Implications

Thepathophysiology underlying these observations is multifactorial. Chronic hyperglycemia can lead to oxidative stress and microvascular changes in the enteric nervous system, impairing gastric pacemaker activity and motility patterns. Acute hyperglycemia, even in non-gastroparetic diabetics, has been shown to slow gastric emptying (Kong & Choi, 2015). In the perioperative setting, these physiological alterations can significantly increase the risk of regurgitation and aspiration pneumonia, especially during rapid sequence induction or in emergencies.

Our findings also highlight that age was an influencing factor, as the diabetic group was significantly older on average. Age-related decline in gastric motility could act synergistically with diabetic autonomic neuropathy, further delaying emptying. However, BMI was not significantly different between groups, suggesting that obesity was not a major confounding factor in this cohort.

Role of Gastric Ultrasound in Perioperative Practice

POCUS provides a rapid, bedside tool to stratify aspiration risk and tailor anesthetic management. In high-risk patients, identification of a high-volume stomach could influence decision-making—options include delaying induction, using rapid sequence induction, or employing regional anesthesia techniques when appropriate. Our study supports the growing body of evidence advocating for the integration of gastric ultrasound into routine preoperative assessment for at-risk populations, especially diabetics.

The Perlas 3-point grading system used in this study remains a validated and practical approach to qualitative gastric content assessment, while the CSA-based quantitative method allows objective estimation of gastric volume. Both methods demonstrated consistent findings in our diabetic cohort.

Limitations and Future Directions

While our study is strengthened by its prospective design and equal group distribution, several limitations should be acknowledged.

1. Single-center design may limit generalizability to other populations with different dietary habits or comorbidity profiles.
2. Operator dependency is an inherent limitation of ultrasound-based studies; although all scans were performed by trained anesthesiologists, variability cannot be entirely eliminated.
3. We did not stratify results based on duration of diabetes or HbA1c into multiple categories, which could help in identifying threshold levels associated with significant gastric retention.
4. The impact of perioperative medications such as prokinetics or opioids was not studied.

Future research could focus on developing individualized fasting protocols for diabetics based on gastric ultrasound findings, glycemic control status, and disease duration. Large multicentric trials could help validate gastric ultrasound as a standard preoperative assessment tool in high-risk populations.

Clinical Recommendations

Given the higher incidence of increased gastric volumes in diabetic patients despite standard fasting, we recommend:
Considering preoperative gastric ultrasound in all diabetic patients undergoing elective surgery, particularly those with long-standing disease or poor glycemic control.
Reevaluating fasting guidelines for diabetics, potentially extending fasting times or tailoring dietary instructions.
Training anesthesiologists in POCUS to improve perioperative safety.

CONCLUSION

Bedside gastric ultrasound serves as a practical, non-invasive tool for assessing fasting gastric content in surgical patients. This study demonstrates that diabetic individuals routinely present with greater gastric volumes, underscoring the need for individualized fasting guidelines in anesthesia planning.

Incorporating preoperative ultrasound assessment in diabetic patients can enhance perioperative safety, reduce aspiration events, and refine fasting protocols in elective surgical care.

KEYWORDS:
Gastric Emptying, Diabetes Mellitus, Ultrasound, Gastric Volume, Anesthesia, Gastroparesis, Aspiration Risk

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