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Journal of
Clinical Anesthesia and Research

Research Article

Preoperative Ultrasound Evaluation of Gastric Emptying in Patients with Type 2 Diabetes Mellitus Posted for Elective Surgery

Somita Christopher*, Syed Abdullah and TVS Gopal

Department of Anesthesiology, Care Hospitals, Hyderabad, India.

Corresponding Author: Somita Christopher, Department of Anesthesiology, Care Hospitals, Hyderabad, India.

Received: 2024 Apr 21 **Accepted:** 2024 May 10 **Published:** 2024 May 20

Abstract

Introduction: Aspiration of gastric contents during the perioperative period is a grave complication with significant morbidity and mortality. Patients with Diabetes Mellitus have a higher incidence of autonomic dysfunction causing gastropathy. Currently, there is no consensus on what constitutes an adequate fasting interval in diabetic patients. Ultrasound is widely available and has been proven to be a reliable, bedside assessment tool for real-time evaluation of gastric contents. Material and Methods: This prospective and comparative study was conducted over a period of one year. 100 patients scheduled for elective surgery under general anesthesia were allocated to Group D (diabetic) and Group C (Non-diabetic) based on their diabetic status. Preoperative ultrasonography was done to assess the gastric volume and content of diabetic patients in comparison with non-diabetic patients. Results: There was no difference as far as the demographic data is concerned between the two groups. The cross-sectional area (CSA) of the stomach in the supine position was 2 ± 0.42cm in group D and 1.36 ± 0.4 cm in group C which was statistically significant (p =0.001). The mean CSA in the lateral position was 2.2cm in Group C and 3.9 cm in Group D which was also statistically significant.

Conclusion: Our study suggests that diabetic patients have significant qualitative and quantitative changes in the stomach content and volume compared to non-diabetic patients. Therefore, doing a gastric ultrasound assessment preoperatively helps in assessing and preventing the pulmonary aspiration of gastric content and its complications, which are rare but life-threatening.

Keywords: Antrum, Hiatal Hernia, Ultrasonography, Diabetes, Pulmonary Aspiration

1. Introduction

Aspiration of gastric contents during the perioperative period is a grave complication with significant morbidity and mortality [1]. Patients with diabetes mellitus have a higher incidence of autonomic dysfunction causing gastropathy [2- 4]. They are known to have gastro paresis and the consequent delayed gastric emptying which predisposes them to an increased risk of aspiration. Furthermore, general anesthesia and sedation decrease the tone of the lower oesophageal sphincter and depresses the upper airway protective reflexes, thus increasing the chances of aspiration [5].

Currently, there is no consensus on what constitutes an adequate fasting interval in diabetic patients. European Society of Anesthesiology (ESA) 2011 fasting guidelines state that diabetic patients can follow the same guidelines as healthy adults. The American Society of Anesthesiologists (ASA) in 2017 fasting guidelines mentioned that the standard eight hours of fasting may not apply or may need to be modified for patients with coexisting diseases or conditions that can affect gastric emptying or fluid volume. Ultrasound is widely available and has been proven to be a reliable, bedside assessment tool for real- time evaluation of gastric contents [6-10].

Ultrasonography (USG) can be used prior to induction for screening the fasting gastric volume and content in diabetic patients to evaluate if it is more than the recommended safe limit. There is no published literature or evidence documenting a significant difference in real-time fasting gastric volume between healthy and diabetic patients after following the same fasting guidelines.

In the present study, USG was used to compare the fasting gastric volume in diabetic patients and non-diabetic patients scheduled for elective surgery. It is a non-invasive procedure and can be performed in the preoperative area without any harm or pain to the patient.

2. Materials and Methods

The study was conducted in the preoperative area of the operation theatre at Care Hospital, Hyderabad. Point-of-care gastric ultrasound was performed on the selected patients who fulfilled the inclusion and exclusion criteria.

2.1. Study Duration
The study was conducted over a period of one year, from May 2019 to May 2020

2.2. Study design
A prospective and comparative study

2.3. Study Population
The study population included those patients who fulfilled the inclusion and exclusion criteria and were scheduled for elective surgery.

2.4. Inclusion Criteria
- (ASA) status 1-2
- Age 18 years to 60 years
- Diabetic Patients
- Patients with valid informed consent

2.5. Exclusion Criteria
- Patient refusal
- Age < 18 years
- Patients with Chronic Kidney Disease
- BMI>30
- History of Oesophageal surgery
- Presence of Hiatus Hernia
- Pregnant patients

2.6. Sample Size Estimation
The sample size was calculated based on the observation of a 25% prevalence of gastroparesis in diabetics in the previous studies {2-4}.

Taking a prediction of 90% power and an alpha error of 0.05, the sample size was calculated using the formula n = 1.64 × 1.64 pq ÷ I2

Where p = prevalence of gastroparesis = 25%
q = (100 − p) = 100 − 25) = 75%

I = allowable error = at 90% power, the allowable error will be 10% Substituting the same in the formula,
n = 1.64 × 1.64 × 25 × 75 ÷ 102 n = 50.43 = 50 (rounded to 50)

Therefore, a sample of 50 diabetics and 50 non-diabetics was taken for this study.

2.7. Ethical Consideration
Hospital ethics committee clearance was taken for this study. Informed and Written consent was taken from all the patients who were included in this study.

2.8. Study Population
A total of 100 patients were selected who fulfilled the inclusion and exclusion criteria and a proper signed informed consent.

2.9. Randomization and Sampling
The selected patients were divided into two groups based on diabetic history namely Group D (diabetic) and Group C (control). This was a convenient sampling based on the status of DM.

2.10. Material
A Sonosite ultrasound machine with a low-frequency probe (2-5 MHz) was used for bedside gastric ultrasonography.

2.11. Methodology
After institutional, ethical and scientific committee approval, we enrolled and selected 100 patients scheduled for their elective surgery under general anaesthesia. Based on the diabetic status, we made two groups namely Group D and Group C. Diabetic history, medication and gastropathy status of the Group D patients was confirmed. Group C are those patients who are non-diabetic with or without hypertension. This is a prospective and comparative designed to assess the gastric volume and content of diabetic patients with controls. So the fasting status of all the patients was assessed and the duration of fasting was noted. Before starting the procedure was clearly explained to the patients in their own understandable language.

Ultrasonography (USG) was done in all the patients in the preoperative area before the induction of anaesthesia by a person who was unaware of the patient's diabetic status. A curved array, low frequency (2- 5MHz) transducer (fig .2) and the Sonosite machine were used for ultrasonography. (Fig-1).

Figure 1: The Sonosite Ultrasound Machine

Figure 2: A low frequency (2-5MHz) curvilinear probe

Patients were scanned in the supine position (fig-3) followed by the right lateral decubitus position (fig-4) with the probe facing cranially

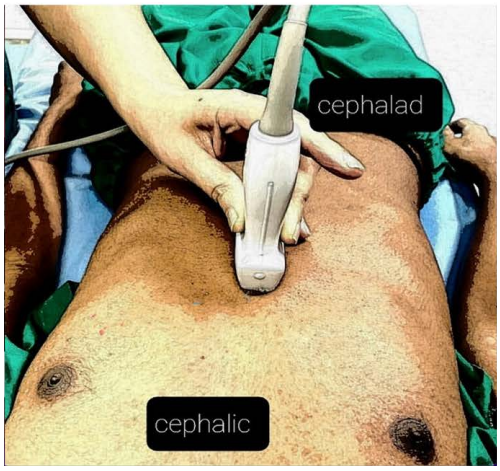

Figure 3: Gastric ultrasonography in Supine

Figure 4: Gastric ultrasonography Right Latera Decubitus position

The sonographic appearance of the gastric antrum was classified as described by Anahi Perla's [11].

- Grade 0 - signifying empty antrum (fig-5)
- Grade 1 - fluid detected in right lateral decubitus position only (fig-6)
- Grade 2 - fluid detected in both supine and right lateral decubitus positions

Figure 5: Empty antrum on gastric ultrasonography (L-Liver, A- Antrum, P-Pancreas and SMA -Superior Mesenteric Artery)

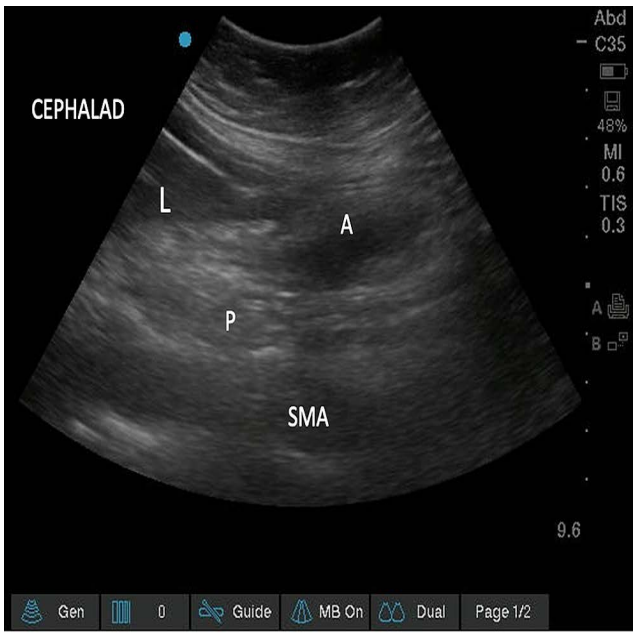

Figure 6: Antrum with clear fluid on Gastric sonography (L-Liver, A- Antrum, P-Pancreas and SMA -Superior Mesenteric Artery)

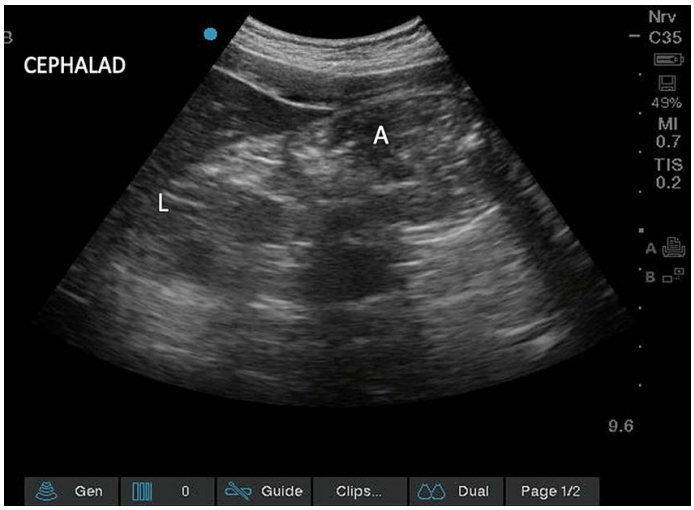

Figure 7: Solids in antrum on Gastric sonography, (L -Liver, A - Antrum)

The cross-sectional area of the antrum was calculated by using two perpendicular diameters namely craniocaudal (CC) and antero-posterior (AP) diameters and the formula for calculating is

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

The gastric volume (GV) was calculated using the previously validated formula

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

3. Results

A total of 100 patients were assessed which included 50 diabetic and 50 non-diabetic and all the 100 patients were included in the study. After randomization, all the patients underwent gastric ultrasonography in the pre-operative area before taking them into the operating room.

Table 1: Comparing Patient demographics between Two Groups

VARIABLE		GROUP D	GROUP C
AGE (in yrs)		46.4 6.6	43.1 4.38
GENDER	MALE	33 (66%)	32 (64%)
	FEMALE	17 (34%)	18 (36%)
ASA	1	0	38 (76%)
	2	50 (100%)	12 (24%)

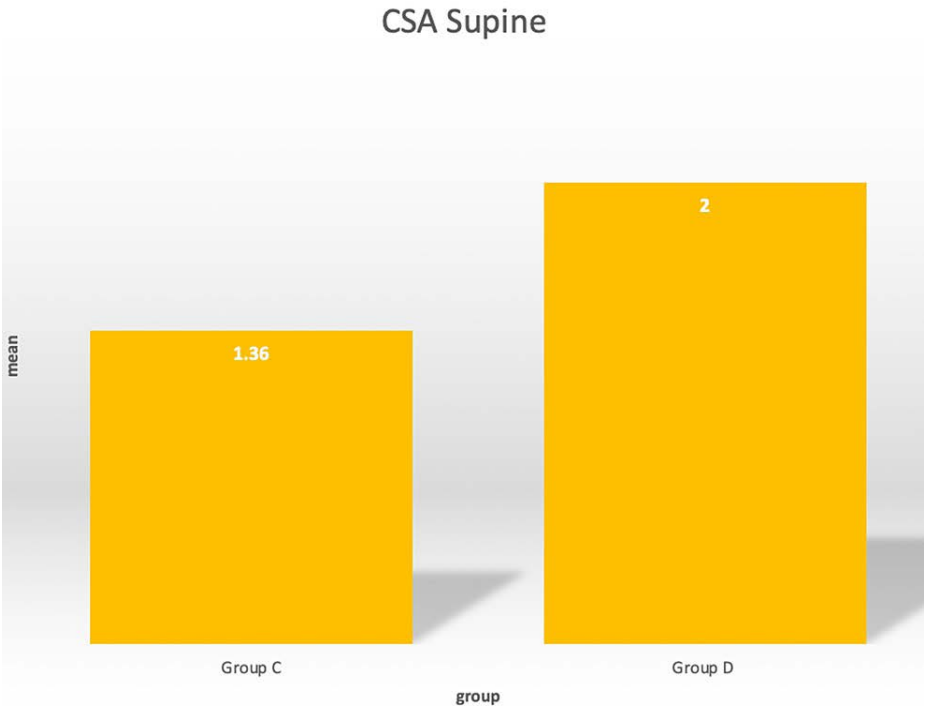

Figure 8: CSA Distribution between two groups

Table 2: Comparison of CSA (in supine) between Two Groups

Diameter (cm)	GROUP D	GROUP C	P VALUE
AP Diameter	1.14 0.12	0.9 0.25	0.001
CC Diameter	2.2 0.25	1.8 0.16	0.001
CSA	2 0.42	1.36 0.4	0.001

The mean CSA in Group C was 1.36 and in Group D it was 2. The CSA in Supine of both the groups were calculated after obtaining the AP and CC diameters in the supine position. Samples of CSA between the groups were matched and found that it was a statistically significant with a p value of 0.001 CSA distribution in Right Lateral Decubitus (RLD) between two groups

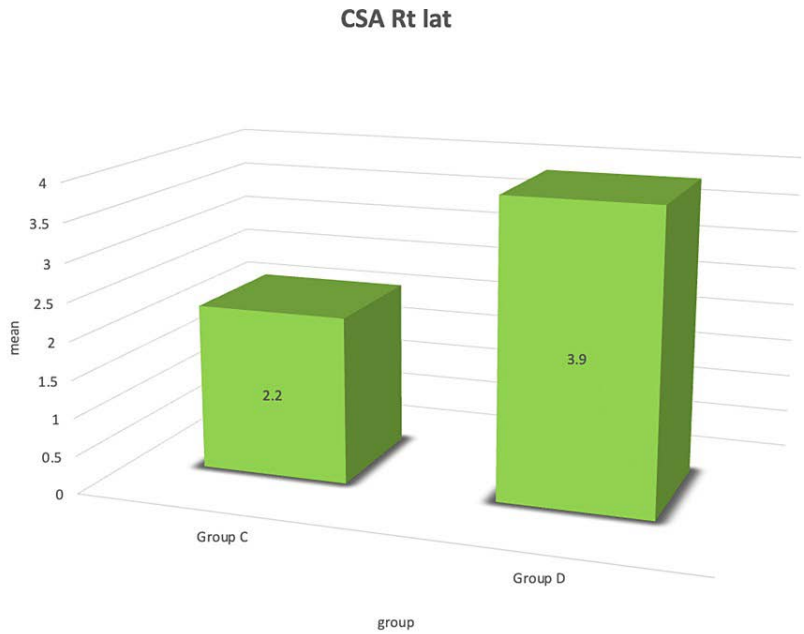

Figure 9: CSA Distribution in RLD between Two Groups

Table 3: CSA distribution in Right Lateral Decubitus (RLD) between Two Groups

Diameter (cm)	GROUP D	GROUP C	P VALUE
AP Diameter	1.88 0.34	1.2 0.21	0.001
CC Diameter	2.59 0.30	2.3 0.2	0.001
CSA	3.9 1.1	2.2 0.5	0.001

The mean CSA was 2.2 in Group C and 3.9 in Group D. The CSA of both groups was calculated after obtaining AP and CC diameters in the RLD position. Samples of CSA between the two groups were matched and found out to be statistically significant with a p -value of 0.001.

Table 4: Gastric Volume in RLD Distribution between Two Groups

PARAMETER	GROUP D	GROUP C	P- VALUE
GASTRIC VOLUME(in ml)	24.9 12.1	4.5 8.1	0.001

The mean gastric volume was 4.5 in Group C and 24.9 in Group D. Samples of Gastric Volume between the two groups were matched. There was a statistically significant P value of 0.001.

Table 5: Ultrasound grading Distribution between Two Groups

ULTRASOUND GRADE	GROUP D	GROUP C	P- VALUE
0	12	22	
1	19	19	0.03
2	19	09	
TOTAL	50	50	100

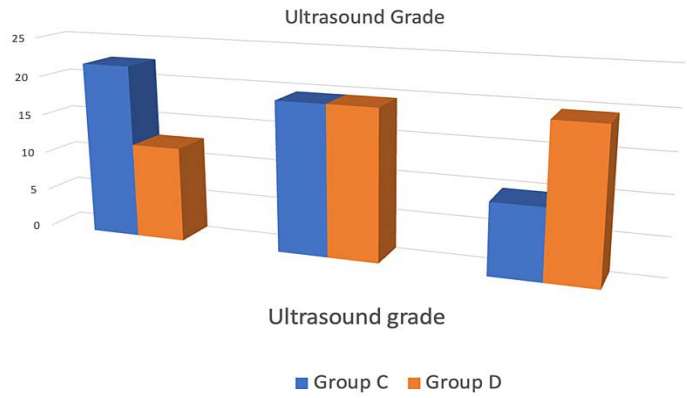

Figure 10: Ultrasound Grade Distribution between Two Groups

Samples of ultrasound grading between the two groups were matched. Grade 2 was statistically significant between the two groups with a p-value of 0.03.

4. Discussion

Diabetic patients have often been considered a high-risk group posing a serious challenge to anaesthesiologists in many aspects. One of the dreadful and feared complications is pulmonary aspiration in diabetic patients. In adults, pulmonary aspiration causes significant morbidity including respiratory failure, acute lung injury and multiorgan failure. Many measures can be taken in order to decrease the risk and severity of pulmonary aspiration. However, fasting before the anaesthesia is the major contributor in the prevention of pulmonary aspiration before ultrasound, there was no proper and accurate diagnostic tool to know the gastric content and volume, except inserting a nasogastric tube preoperatively or preoperatively. Now point- of- care gastric ultrasound has emerged as one of the most useful diagnostic tools to prevent the pulmonary aspiration and its complications.

Camilleri et al observed that delayed gastric emptying was the major highlight of DM. Our study included 100 patients with 50 in each group namely Group C and Group D. Group D included type 2 diabetes mellitus patients whereas Group C had non-diabetic patients. The average fasting interval for patients both groups was around 10 hours [12].

In our study, there are 12 ASA II patients with controlled Hypertension and the rest of them are ASA I. Age of the patients in group D is slightly higher than the control group. However , there is no statistically significant difference in the age in both groups (p=0.001).In Group C, 22 patients had grade 0 and 19 had grade 1 antrum, whereas in Group D, 12 patients had grade 0 and 19 had grade 1 antrum in ultrasonography representing safe gastric volumes. However 9 patients in Group C and 19 patients in Group D had grade 2 with a statistically significant difference p-value of 0.03.

Darwiche et alconducted a study on the measurement of gastric antrum by real-time ultrasonography and found out that it is a valid method in determining gastric emptying in our study also gastric ultrasonography was very useful and convenient in measuring the gastric antrum.

Perlas et al classified the sonographic appearance of the gastric antrum into gradings based on its appearance in both the supine and right lateral positions. We also applied the same grading method in our study and graded the patients accordingly [13, 14].

The CSA in supine had a statistically significant difference in both the groups with a p- value of 0.001 whereas diabetic patients had higher CSA values. Similarly, in the Right Lateral decubitus position, there is a statistically significant difference is found in both groups with a p- value of 0.001.

The GV also showed higher values in Group D with a significant statistical difference of p-value 0.001. The gastric volume shown in Group D was 37 ml whereas it was 12 ml in Group C.

Perlas et al have assigned the formula in calculating the gastric volume in their study. We applied the formula in calculating the gastric volume of our patients and graded it accordingly [15].

Similar studies on the diabetic gastroparesis have found that there is a significant delay in gastric emptying in diabetic mellitus patients [16].

4.1. Limitations of the Study

The patients in Group C were younger and healthier than Group D Surgery itself was a stress factor which may have impacted gastric secretion and emptying. Some parameters were in negative values

5. Conclusions

Our study suggests that diabetic patients had higher gastric antral cross-sectional area and gastric volumes than in non-diabetic as seen by ultrasound preoperatively signifying delayed gastric emptying. They have significant qualitative as and quantitative changes in the stomach content and volume compared to the non-diabetic .There are no specific fasting guidelines for the diabetic patients before the surgery in order to prevent the aspiration of gastric content. So our results suggest that doing gastric ultrasound assessment preoperatively helps in assessing and preventing the pulmonary aspiration of gastric content and its complications, which are rare but life- threatening.

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