Archives of Anesthesiology and Critical Care (Spring 2024); 10(2): 143-147.

Available online at http://aacc.tums.ac.ir

Research Article

Cross-Sectional Study to Compare Preoperative Fasting Volume of Gastric Contents by Using Ultrasonography in Non-Diabetic and Diabetic Patients Posted for Elective Surgery

Kaushal Kenchey, Sarita Swami, Kalyani Patil*

Department of Anaesthesia, Bharati Vidyapeeth (Deemed to be) University Medical College, Pune, India.

ARTICLE INFO

Article history:
Received 21 May 2023
Revised 14 June 2023
Accepted 28 June 2023

Keywords:
Point-of-care gastric ultrasound;
Glycosylated haemoglobin;
Fasting gastric volume

ABSTRACT

Background: Diabetic patients are known to have gastroparesis and consequent delayed gastric emptying which predisposes them to an increased risk of aspiration as compared to the general population. This study compares the gastric volumes in diabetic and non-diabetic patients using point-of-care ultrasound and correlates it with the HbA1c levels in diabetic patients.

Methods: This cross-sectional study included 180 patients, 90 diabetic (>5 years) and 90 nondiabetic, aged >40 years, American Society of Anaesthesiologists' physical status I–II kept fasting for 8 hours. Before induction, gastric ultrasound was performed to measure craniocaudal (CC) and anteroposterior (AP) diameters followed by calculation of antral cross-sectional area (CSA) and gastric volume (GV) in right lateral decubitus (RLD) position using curved array probe. In diabetic patients, the gastric volumes were correlated with HbA1c values.

Results: In the RLD, the mean CC and AP diameters were higher in diabetic Group. The calculated CSA in RLD in diabetics (8.014 ± 2.412 cm^2) were significantly higher than non-diabetic (6.314± 2.894 cm^2) ($p < 0.0001$). The calculated GV of 71.501 ± 35.937 ml in the diabetic group was significantly higher than 48.0022± 41.587 ml in the non-diabetic group ($p < 0.0001$). In diabetics, the gastric volumes showed significant correlation with HbA1c.

Conclusion: Diabetic patients show higher residual gastric volume as compared to non-diabetic patients indicating gastroparesis. The gastric volumes are further increased in those with poorly controlled disease with high HbA1C levels. Ultrasound is an effective tool in assessing the risk of aspiration and altering anaesthetic management accordingly.

Introduction

Aspiration of the gastric contents is a grave perioperative complication, leading to significant morbidity as well as mortality [1-2]. Prevention of aspiration therefore remains pivotal in anaesthetic practice and is a standard of care.

Various guidelines developed so far suggest what should be the ideal fasting interval prior to any elective procedure that is planned under either deep sedation or general anaesthesia. The guidelines also recommend the time for resumption of oral feeds after the procedure. However there is no specific mention in the guidelines regarding their applicability to a subset of patients with medical conditions such as diabetes mellitus which predisposes them to aspiration, owing to the autonomic neuropathy and concomitant gastroparesis [3].

Assessment of gastric volume by Point-of-Care gastric ultrasonography (GUS) is a recent addition to preoperative assessment tools. It has proven to be a valid assessment technique which can be performed at the

The authors declare no conflicts of interest.
*Corresponding author.
E-mail address: kalyanish19@gmail.com

Copyright © 2024 Tehran University of Medical Sciences. Published by Tehran University of Medical Sciences.
This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license (https://creativecommons.org/licenses/by-nc/4.0/). Noncommercial uses of the work are permitted, provided the original work is properly cited.

bedside, for rapid assessment of gastrointestinal contents [4-6]. The present study compares the preoperative fasting volume of gastric contents as calculated based on ultrasound parameters, in nondiabetic patients and patients with longstanding diabetes and further correlates the gastric volumes in the diabetic patients with the levels of glycosylated haemoglobin.

Methods

After being approved by the institutional ethics committee (BVDUMC/IEC/77), we conducted this cross-sectional analytical study. All the enrolled participants were explained the nature of the study and a valid, written, informed consent was obtained. The study included male as well as female patients, with age >40 years, those with ASA physical status I to III and undergoing elective surgery. Patients with chronic renal disease, gastro-intestinal malignancy, connective tissue disease affecting the motility of the gastro-intestinal tract, those with hypothyroidism, active smokers, those on anti-depressant drugs or on treatment for upper gastrointestinal symptoms, patients with prior oesophageal or abdominal surgery, obese patients and pregnant females were excluded.

Patients were split into two groups and were designated as group D (diabetic) and group ND (nondiabetic). The patients were allocated to the respective groups according to their history of diabetes or otherwise. Only those patients who had diabetes for more than past 5 years were included in the diabetic group.

Diabetic patients were assessed in detail with respect to the anti-diabetic treatment they were receiving, their blood sugar levels and signs and symptoms of autonomic neuropathy, specifically so for gastropathy.

The fasting status of all patients was confirmed.

Preoperative gastric ultrasound was performed for all patients, in the right lateral decubitus (RLD) position (Figure1).

Ultrasound machine (FUJIFILM Sonosite, Inc. Bothell, WA 98021 USA) was used in B mode. Ultrasonographic curvilinear low-frequency probe with frequency of 2-5 MHZ was used. The abdomen area was cleaned. sterile jelly was applied to the USG probe and placed vertically visualizing the liver, pancreas, IVC and gastric antrum (Figure 2). Then cranio-caudal (CC) diameter and antero-posterior (AP) diameter were measured.

The cross-sectional area was calculated using the following formula [7].

$CSA = (AP \times CC \times \pi)/4$. (1)

The gastric volume was calculated using Perlas and colleagues' equation for the right lateral position [8]:

Gastric residual volume (mL) = 27.0 + 14.6 × right-lateral CSA − 1.28 × age. (2)

To calculate the sample size we assumed that 25% of patients with longstanding diabetes develop gastroparesis. In order to limit the alpha error to 0.05 and to achieve 90% power, we enrolled 90 diabetic (Group D) and 90 non-diabetic (Group ND) patients.

Figure 1- Gastric ultrasound in Right Lateral Decubitus position

Figure 2- Craniocaudal and anteroposterior diameter measurement on ultrasound

Statistical Analysis

SPSS software (version 25.0) was used to perform the statistical analysis. ASA physical status amongst diabetic and non-diabetic patients were analysed by applying the Chi square test. Age, weight and BMI amongst both groups were compared by Independent t-test. HbA1C was correlated with gastric volume using Pearson correlation test.

Results

Our study included total 180 patients, 90 diabetic and 90 non-diabetic.

The mean age was found to be 56.64±9.642 years in Group D and 55.61±12.245 in Group ND. 31 patients (32.2%) in Group D and 28 (31.1%) in Group ND study population were females. 59 patients (67.8%) in group D and 62(68.9%) in group ND were males. The groups were comparable with respect to gender distribution. All patients of Group D were ASA II (owing to their diabetic status) while in Group ND, 43 patients were ASA I and 47 were ASA II. The mean weight of patients was found to be 66.63±11.137 kgs and 61.49±10.524 kgs in group D and group ND respectively. Mean body mass index (BMI) of patients included in group D was 25.64±3.003 kg/m^2 and in Group ND was 23.47±2.908 kg/m^2. The diabetic patients had a significantly higher mean weight and BMI as compared to their non-diabetic counterparts (Table 1).

AP diameter, CC diameter as measured on ultrasound and CSA and GV as calculated from the previously mentioned formulas, all were significantly higher in diabetics as compared to non-diabetics ($p<0.01$) (Table 2, Figure 3). The calculated mean gastric volume in diabetics was 147.9% of non-diabetics.

Mean HbA1C was 8.93011 ± 2.16424 in the diabetic group. Gastric volume (GV) calculated from the ultrasound parameters was correlated with the level of HbA1C in the diabetic group (Figure 4).

Pearson correlation test was applied to quantify the degree of correlation between the gastric volume and glycosylated haemoglobin levels. A significant moderately positive correlation was observed between HbA1C and GV (p – 0.000) (Table 3).

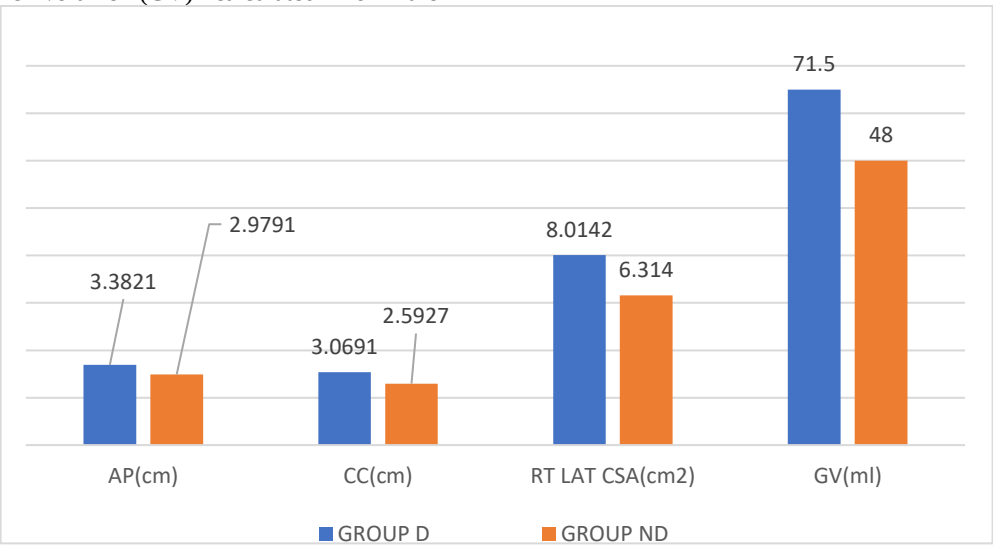

Figure 3- Comparison of AP, CC diameter, CSA and GV in diabetics and non-diabetics

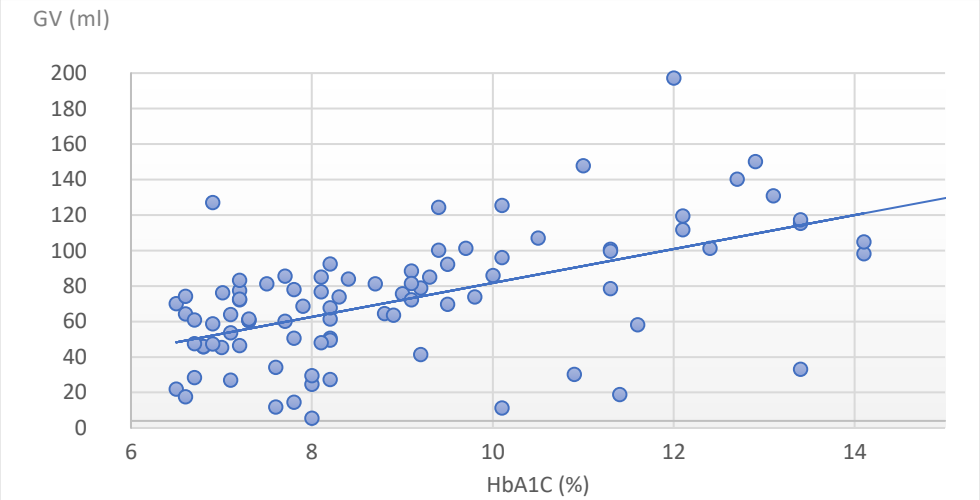

Figure 4- Scattered plot diagram showing correlation between HbA1c (%) and GV (ml).

Table 1- Socio-demographic characteristics

Socio-demographic characteristics		Group D (n=90)	Group ND (n=90)	P value
Age (years) Mean±SD		56.64±9.642	55.61±12.245	0.53
Gender	Female	31	28	0.87
	Male	59	62	
ASA grade	I	0	43	0.000 HS
	II	90	47	
Weight (kg) Mean±SD		66.63±11.137	61.49±10.524	0.002 HS
Body mass index (BMI)(kg/m²) Mean±SD		25.64±3.003	23.47±2.908	0.000 HS

(SD: Standard deviation, HS: Highly Significant)

The measurement of AP and CC diameter, CSA and GV obtained from the study is as depicted in the table below.

Table 2- Intergroup comparison of parameters on gastric ultrasound

Parameters (Right lateral decubitus)	Mean±SD Group D (n=90)	Group ND (n=90)	P value
AP diameter (cm)	3.3821±0.90438	2.9791±0.69098	<0.01
CC diameter (cm)	3.0691±0.75120	2.5927±0.81917	<0.01
CSA (cm2)	8.0142 ±2.41202	6.3140±2.89480	<0.01
GV (ml)	71.5018±35.93770	48.0022±41.58704	<0.01

(AP: Antero-posterior, CC: Cranio-caudal, CSA: Cross sectional area, GV: Gastric volume, SD: Standard deviation)

Table 3- Pearson correlation

		GV_D
HbA1C	Pearson Correlation	0.5519**
	N	90

**moderate positive correlation

Discussion

Various scintigraphic studies in the past, have clearly demonstrated that almost 30-50% patients suffering from diabetes mellitus for a prolonged period, have delayed emptying of the gastric contents. However, in patients recently diagnosed with Type 2 diabetes mellitus, prevalence of disordered gastric emptying is controversial. In our study, we have therefore included patients with a history of diabetes for at least 5 years [9].

Furthermore, the severity or absence of symptoms does not necessarily correlate with the delay in gastric emptying [10]. This fact further emphasizes the need for and objective assessment tool like gastric ultrasound that would be decisive in planning anaesthesia for these patients. Gastric ultrasound has several pertinent advantages. It is a bedside, focused, goal-directed, diagnostic tool, the learning curve is not very steep, and most important is its role in cases with delayed gastric emptying where the fasting status remains a clinical uncertainty.

As poor glycaemic control in diabetics is positively associated with neuropathic gastrointestinal complications, we have included the HbA1c values in our study and correlated them with the gastric volumes as calculated by ultrasound [11].

The age of patients with diabetes is significantly higher than the non-diabetics in our study, which is due to the fact that we have only included patients with longstanding diabetes in the diabetic group. Also the BMI of patients with diabetes is higher than those without diabetes as the association between diabetes and obesity is a well-known fact. Also previous studies conducted have significant differences in age and weight of patients in diabetic and non-diabetic groups [12].

Previous studies have assessed the gastric contents by ultrasonographic measurement of the cranio-caudal (CC) and antero-posterior (AP) diameters of the gastric antrum in two positions, namely supine and RLD. However, Anahi Perlas et al and Schmitz et al have proven in their studies that for any given volume of gastric fluid, the value of antral CSA is higher in the RLD position as compared to that in supine, owing to the fact that the fluid shifts towards the antrum due to gravitational effect. Measurements in RLD position are therefore more sensitive to determine changes in volume, particularly in low volume states. Hence in our study we have done the measurements only in the RLD position [13-14].

In spite of adequate fasting, the diabetic patients had significantly higher values of mean CC and AP diameters as measured on ultrasound. Logically, the calculated value of CSA in diabetics was significantly higher than non-diabetics ($p < 0.0001$) and so was the calculated GV as well ($p < 0.0001$). Our findings correlate well with the observational studies performed by Heena Garg et al and Avinash Haramgatti et al [12,15].

A significant gastric volume (i.e. >1.5 ml/kg of body weight) was observed in 16 diabetics and 10 non-diabetics which were considered as being at high risk of aspiration, as per the risk stratification by Van de Putte et al. Hence a modified rapid sequence induction was done in these patients to avoid aspiration [7].

The strength of our study is that we have correlated the level of HbA1c with the gastric volumes as calculated from the ultrasound parameters, considering the fact that the gastroparesis owing to diabetic autonomic neuropathy is associated with long-standing uncontrolled diabetes mellitus. Our literature search did not yield any published study till date, that has studied the correlation of HbA1c levels with gastric volumes [16].

There are few limitations of our study. We, in our study have only included type II diabetic patients. Similar studies need to be conducted on patients with type I diabetes mellitus as well. Furthermore though we found a moderate level of correlation between HbA1c levels and gastric volumes in the diabetic group, the sample size was too small and hence it needs to be substantiated with larger, multi-centric studies.

Conclusion

From our study we conclude that patients suffering from long-standing diabetes are at risk of aspiration even after adequate fasting intervals, owing to delayed gastric emptying. Furthermore, the severity of gastroparesis correlates with the HbA1c levels in diabetics. The gastroparesis can be assessed objectively and accurately with point of care gastric ultrasound and we recommend that it should be an integral part of preoperative assessment of gastric volume status, especially in patients who are at perceived risk of aspiration.

References

[1] Ng A, Smith G. Gastroesophageal reflux and aspiration of gastric contents in anesthetic practice. Anesth Analg. 2001; 93(2):494-513.

[2] Hveem K, Hausken T, Berstad A. Ultrasonographic assessment of fasting liquid content in the human stomach. Scand J Gastroenterol. 1994; 29(9):786-9.

[3] Darwiche G, Almér LO, Björgell O, Cederholm C, Nilsson P. Measurement of gastric emptying by standardized real-time ultrasonography in healthy subjects and diabetic patients. J Ultrasound Med. 1999; 18(10):673-82.

[4] 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.

[5] Perlas A, Davis L, Khan M, Mitsakakis N, Chan VW. Gastric sonography in the fasted surgical patient: a prospective descriptive study. Anesth Analg. 2011; 113(1):93-7.

[6] Cubillos J, Tse C, Chan VW, Perlas A. Bedside ultrasound assessment of gastric content: an observational study. Can J Anaesth. 2012; 59(4):416-23.

[7] Van de Putte P, Perlas A. Ultrasound assessment of gastric content and volume. Br J Anaesth. 2014; 113:12-22.

[8] Perlas A, Mitsakakis N, Liu L, Cino M, Haldipur N, Davis L, et al. Validation of a mathematical model for ultrasound assessment of gastric volume by gastroscopic examination. Anesth Analg. 2013; 116:357-63.

[9] Horowitz M, O'Donovan D, Jones KL, Feinle C, Rayner CK, Samsom M. Gastric emptying in diabetes: clinical significance and treatment. Diabet Med. 2002; 19(3):177-94.

[10] Horowitz M, Wishart JM, Jones KL, Hebbard GS. Gastric emptying in diabetes: an overview. Diabet Med. 1996; 13(9 Suppl 5):S16-22.

[11] Kong MF, Macdonald IA, Tattersall RB. Gastric emptying in diabetes. Diabet Med. 1996; 13(2):112-9.

[12] Garg H, Podder S, Bala I, Gulati A. Comparison of fasting gastric volume using ultrasound in diabetic and non diabetic patients in elective surgery: An observational study. Indian J Anaesth. 2020; 64:391-6.

[13] Perlas A, Chan VW, Lupu CM, Mitsakakis N, Hanbidge A. Ultrasound assessment of gastric content and volume. Anesthesiology. 2009; 111(1):82-9.

[14] Schmitz A, Schmitz A, Schmitz A, Schmitz A, Thomas S, Melanie F, et al. Ultrasonographic gastric antral area and gastric contents volume in children. Paediatr Anaesth. 2012; 22(2):144-9.

[15] Haramgatti A, Sharma S, Kumar A, Jilowa S. Comparison of ultrasound-guided residual gastric volume measurement between diabetic and non-diabetic patients scheduled for elective surgery under general anesthesia. Saudi J Anaesth. 2022; 16(3):355-60.

[16] Ewing DJ, Clarke BF: Diabetic autonomic neuropathy: a clinical viewpoint. In Diabetic Neuropathy Dyck PJ, Thomas PK, Asbury AK, Weingrad AI, Porte D, Eds. Philadelphia, WB Saunders,1987;66–88.