ORIGINAL RESEARCH

Analytical Role of Ultrasound in Assessment of Fasting Gastric Volume in Diabetic and Non-Diabetic Patients in Elective Surgery: An Observational Study

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Received: 16 February, 2023 Accepted: 22 March, 2023

Abstract
Introduction: Gastroparesis despite standard fasting in diabetic patients may increase the aspiration risk. This study aimed to compare fasting gastric volume (GV) of diabetic with non-diabetic patients scheduled for elective surgery using USG.
Material & methods: This prospective observational study was conducted at Department of Anesthesiology and Critical Care Medicine, Sher-i-Kashmir Institute of Medical Sciences, (SKIMS) for a period of 2 year among 60 diabetic and 60 non-diabetic patients fulfilling the inclusion and exclusion criteria. USG grade, cross-sectional area (CSA) of the antrum and GV were calculated. The gastric antrum was classified as Grade 0, 1 or 2, signifying empty antrum, fluid in RLD position only and antral fluid in both supine and RLD positions, respectively.
Results: The mean glycosylated haemoglobin (HbA1c) was 7.54% with a range of 5.9 to 10.4%. The average fasting intervals were 8.62 ± 0.35 h in diabetic group ($P = 0.125$) and 8.73 ± 0.44 h in control/non-diabetic group. The gastric volume was higher in diabetic patient ($p < 0.001$). The mean diameters (both AP and CC) and CSA calculated in both supine and RLD positions had a statistically significant difference with a higher value observed in the diabetic group as compared to the controls (P values<0.05).
Conclusion: Bedside ultrasound can provide reliable information about the volume and nature of gastric contents. Diabetic patients have higher gastric antral cross-sectional area and gastric volumes than the non-diabetic patients.
Keywords: Diabetes, Fasting, Gastric Volume, Surgery, Ultrasound.

Introduction

Gastric aspiration during the perioperative phase is a serious complication that carries a high risk of morbidity and mortality.[1] Patients with diabetes are more likely to experience the gastropathy brought on by autonomic dysfunction. They are known to have gastroparesis, which causes their gastric emptying to be delayed, making them more susceptible to aspiration than the general population.[2] It is more common in patients with type 1 diabetes than in those with type 2 diabetes. Delayed gastric emptying is found in 27– 65% of patients with type 1 diabetes and in up to 30% of patients with type 2 diabetes.[3]
Currently, there is no consensus on what constitutes an adequate fasting interval in diabetic patients. American Society of Anesthesiologists (ASA) in 2017 fasting guidelines mentioned that the standard eight hours 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.[4]
In anesthesiology and acute care medicine, there is a growing interest in bedside evaluation of gastric ‘fullness’ to assess pulmonary aspiration risk and several methods are used. Barium contrast examinations, scintigraphy, manometric techniques, and intubation methods have the disadvantages of being invasive and potentially harmful. An alternative safe, reproducible, and reliable non-invasive technique would be preferable.[5] MRI is the latest modality for imaging of the acute abdomen. Although it affords superior soft tissue visualization compared to CT and ultrasound but its use in an urgent setting is not cost-effective as compared to abdominal CT and ultrasound imaging. [6,7]

ISSN:0975-3583,0976-2833 VOL14,ISSUE03,2023

As diabetic patients are prone to have an inadequately empty stomach even after an adequate fasting, USG can be used prior to induction for screening the fasting gastric volume (GV) of diabetic patients.[8] There is no published literature evidence documenting a significant difference in real-time fasting gastric volume between the healthy and diabetic patients after following the same fasting guidelines. In the present study, ultrasonography (USG) was used to compare the fasting GV in diabetic and non-diabetic patients scheduled for elective surgery.

Material & methods

This hospital based prospective, observational study was conducted in the Department of Anesthesiology and Critical Care Medicine, Sher-I Kashmir Institute of Medical Sciences, (SKIMS) from December 2020 to November 2022.

Adult patients diagnosed with type II diabetes, ASA physical status I-III, fasting duration of 8 hours, undergoing elective surgery requiring general anesthesia, with age >18 years and<75 years, BMI <40 and belong to any gender were included in the study. Patients with previous oesophageal or abdominal surgery, morbidly obese and pregnant with nasogastric tube in situ and on medication for upper gastrointestinal tract (GIT) symptoms, chronic kidney disease, hypothyroidism, connective tissue disease affecting GIT motility, current smoking history, on antidepressant medication were excluded from the study. After receiving written informed consent, 120 patients satisfying inclusion criteria were enrolled for the study.

Patients were divided into two groups based on their history of diabetes mellitus (DM). 60 patients were classified under group D (diabetics) and 60 patients in group C (control). Patients with Diabetes were assessed for the duration of diabetes, medication history, glycemic control and gastropathy symptoms. The fasting status were assessed and the duration of fasting interval noted.

A thorough medical history regarding any co-morbid condition, previous anesthetic exposure, medications, allergy to any drugs and personal habits was noted. Predictive factors for difficult airway including Mallampatti (MP) grade was recorded. USG was done 1 hour prior to induction of anesthesia after fasting interval of 8 hours by an expert radiologist blinded to the patient's diabetic status after obtaining their written informed consent during pre-operative visit. A curved array, low frequency (2-5 MHz, 60 mm) transducer providing a scan depth up to 30 cm was used. Patients were scanned in the supine position followed by right lateral decubitus (RLD) position.

A B

Image 1: *Depicting scanning positions A) in supine and B) right lateral decubitus position*

The sonographic appearance of the gastric antrum was classified based on the appearance in both the positions as defined by Perlas et al.[8]

Grading appearance

0. Empty antrum
1. Fluid detected in RLD position only

ISSN:0975-3583,0976-2833 VOL14,ISSUE03,2023

2. Fluid detected in both supine and RL

The patients with Grades 0 & 1 were taken for surgery while Grade 2 were reassessed after an interval of 1 hour till volumes < 100ml were found on subsequent scans (if required).

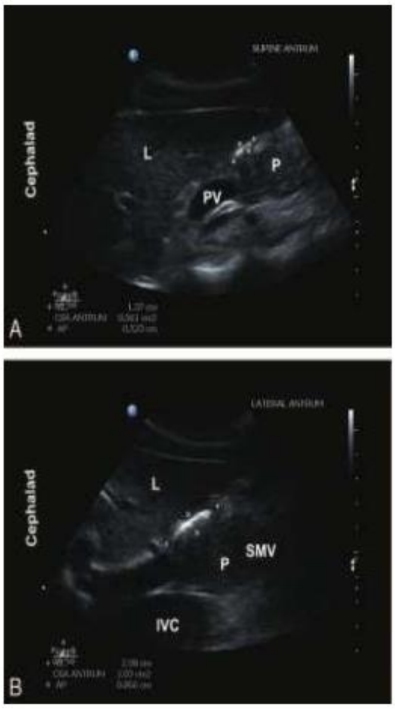


Image 2. *The empty antrum (grade 0) in the supine (A) and lateral decubitus (B) positions. The empty antrum appears small and "flat" in both patient positions. It is pointed out by4 x's corresponding to its 2 perpendicular diameters. L liver; P pancreas; PV portal vein; IVC inferior vena cava; SMV superior mesenteric vein.*

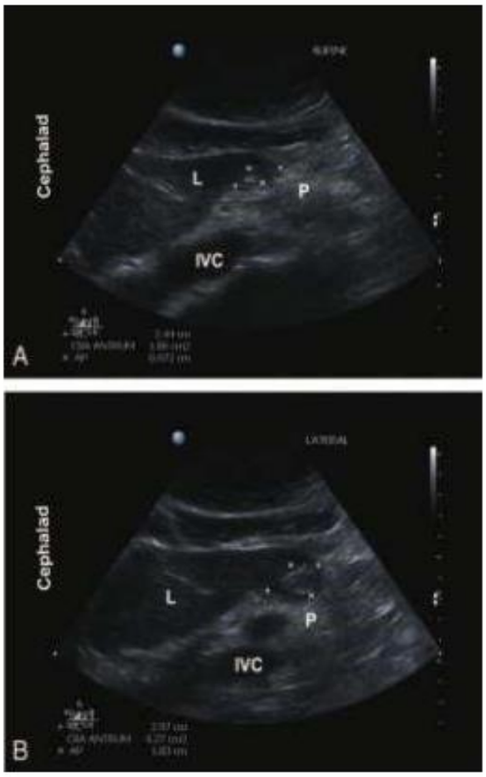


Image 3. *The antrum with minimal, insignificant amount of fluid (grade 1) in the supine (A) and lateral decubitus (B) positions. Note that a small amount of fluid is detectable only in the right lateral decubitus position. L liver; P pancreas; IVC inferior vena cava.*

ISSN:0975-3583,0976-2833 VOL14,ISSUE03,2023

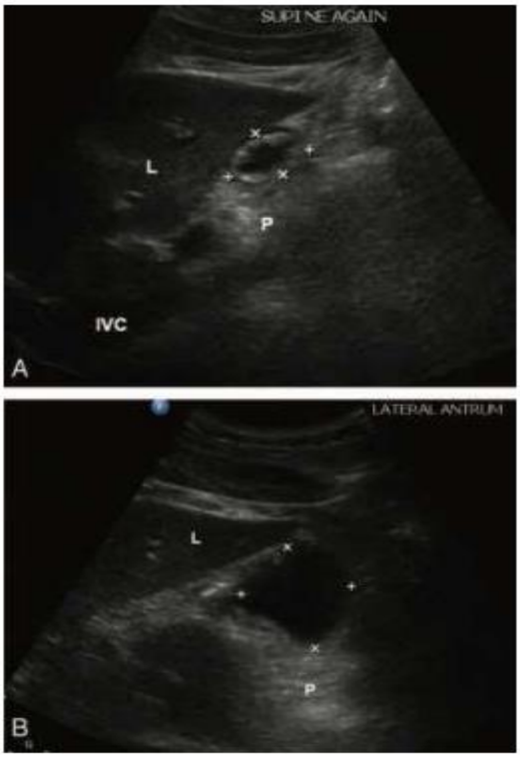


***Image 4.** The antrum with significant fluid content (grade 2) in the supine (A) and right lateral (B) positions. Note that fluid is evident in both positions, but more marked in the right lateral decubitus position. These images correspond to the patient who regurgitated on emergence from anesthesia. L liver; P pancreas; IVC inferior vena cava.*

Cross-sectional area (CSA) was calculated by using two perpendicular diameters— anteroposterior (AP) and craniocaudal (CC) and the formula for area of an ellipse [9]

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

The gastric volume was calculated using the previously validated formula [8]

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

Statistical analysis

The recorded data was compiled and analyzed using SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as Mean ± SD and categorical variables were summarized as frequencies and percentages. Student's independent t-test or Mann-Whitney U-test, whichever feasible, was employed for comparing continuous variables. Chi square test or Fisher's exact test, whichever appropriate, was applied for comparing categorical variables. A P-value of less than 0.05 was considered statistically significant.

Results

The demographic data of the two groups – Age, gender distribution, weight, BMI and ASA status are depicted Table 1. The mean Age in Group C and Group D were 41.7 ± 6.12 and 52.9 ± 6.68 respectively which was statically significant (p- value <0.001). Out of total subjects 50 (41.6 %) were males and 70 (58.3%) were females. The mean weight (kg) in Group C and Group D were 62.9 ± 6.49 and 65.1 ± 8.06. The mean BMI (Kg/m2) in Group C and Group D were 23.2 ± 3.45 and 24.1 ± 2.94 respectively. ASA grade I patients – 50 (83.3%) were controls. 10 (16.7%) patients of control group and 58 (96.7%) diabetic patients were having ASA grade II and only 2 (1.6 %) patients- both diabetics were having ASA grade III and the value was statistically significant (p-value <0.001).

Table 1 showing demographic data of two groups

Variable	Group C	Group D	P value
Age (mean ±SD)	41.7 ± 6.12	52.9 ± 6.68	<0.001
Gender			
Male (%)	43.3	40	0.211
Female (%)	56.7	60	
Weight (Kg)	62.9 ± 6.49	65.1 ± 8.06	0.104
BMI (Kg/m^2)	23.2 ± 3.45	24.1 ± 2.94	0.126
ASA			

ISSN:0975-3583,0976-2833 VOL14,ISSUE03,2023

ASA I (%)	83.3	0	<0.001
ASA II (%)	16.7	96.7	
ASA III (%)	0	3.3	

The variable related to diabetes like duration of disease, HbA1C and duration of fasting are depicted in table 2. The mean duration of DM was 6.7 years. The maximum duration of DM was 18 years and the mean glycosylated haemoglobin (HbA1c) was 7.54% with a range of 5.9 to 10.4% in study group D. The average fasting intervals were 8.73 ± 0.44 h in group C and 8.62 ± 0.35 h in group D (P = 0.125).

Table 2 shows history of diabetes in study groups

Study group	**Variable**
	Duration of diabetes (mean ± SD, yr)
Group D	6.7±4.17
	HbA1C (%) level (mean ± SD, %)
Group D	7.54±0.98
	Duration of fasting hours (mean ± SD, h)
Group D	8.73 ± 0.44
Group C	8.62 ± 0.35

Table 3 depicts differences in ultrasound grading between the groups. 23 (38.3%) patients of Group C had USG Grade 0 as compared to 17 (28.3%) patients of Group D . 27 (45%) patients of Group C had USG Grade 1 as compared to 25 (41%) patients of Group D while 10 (16.7%) patients of Group C had USG Grade 2 as compared to 18 (30%) patients of Group D.

Table 3 showing Comparison based on USG Grade in two groups

USG grade	**Group C (%)**	**Group D (%)**	**P value**
0	38.3	28.3	0.196
1	45	41.7	
2	16.7	30	

Table 4 depicts comparison of two groups C and D on the basis of different supine and RLD positions and it was found the results were statistically significant with p value less than 0.05 in each comparison.

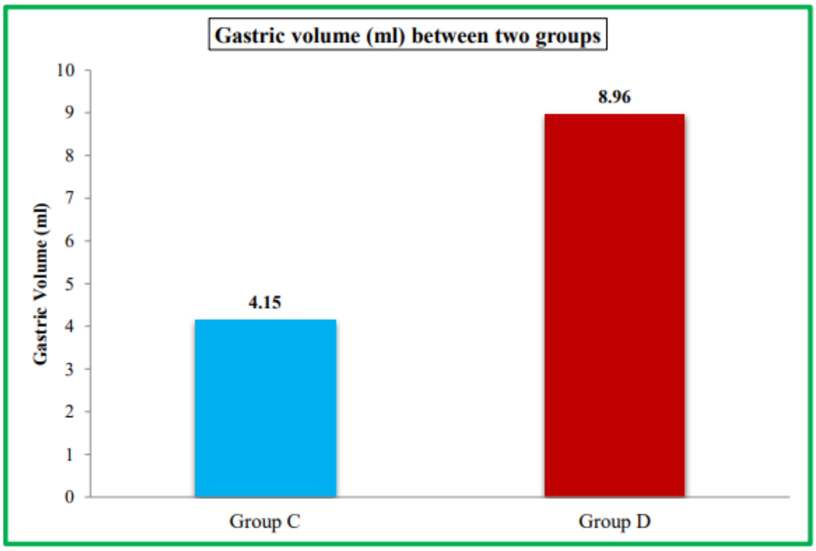
Table 4 showing comparison of groups according to positions

Position	**Group C (mean ± SD)**	**Group D (mean ± SD)**	**P value**
craniocaudal (CC) diameter (cm) in supine position	1.92 ± 0.2	2.25 ± 0.1	0.003
anteroposterior (AP) diameter (cm) in supine position	0.85 ± 0.2	1.31 ± 0.1	<0.001
craniocaudal (CC) diameter (cm) in RLD position	2.24 ± 0.2	2.48 ± 0.1	0.007
anteroposterior (AP) diameter (cm) in RLD position	1.18 ± 0.2	1.73 ± 0.2	<0.001
cross-sectional area /CSA (cm2) in supine position	1.31 ± 0.4	2.34 ± 0.4	<0.001
cross-sectional area /CSA (cm2) in RLD position	2.11 ± 0.5	3.40 ± 0.5	<0.001

Graph 1 depicts the comparison of mean gastric volumes between the two groups and it was found to be 4.15 ± 0.601 ml in Group C as compared to 8.96 ± 1.033 ml in diabetic patients which was a statistically significant difference (p-value <0.001).

Graph 1 – Showing comparison of Gastric volume (ml) between two groups

ISSN:0975-3583,0976-2833 VOL14,ISSUE03,2023



Discussion: Diabetes has often been considered a high-risk state posing a serious challenge to the anesthesiologist in many aspects. One of the feared complications is pulmonary aspiration as diabetic patients are considered as possible full stomach due to autonomic gastropathy.[10] Until recently, there were no readily available tools to assess gastric content in the acute setting. Many techniques have been described to assess the contents of the stomach like paracetamol absorption, electrical impedance tomography, radio-labelled diet, polyethylene glycol dilution and gastric content aspiration [11]. These methods are not suitable in the perioperative period and none of these methods are easy to use. Recently bedside ultrasound has been used to evaluate gastric content to assess perioperative aspiration risk and guide anesthetic management. Present study was done to find out the analytical role of ultrasound in assessment of fasting gastric volume in diabetic and nondiabetic patients in elective surgery.

Among the demographic characteristics like age, gender, weight, BMI , only gastric volumes showed statistically significant relationship with age (P<0.001). This is in line with Evans, M.A et al [12] in which gastric emptying rates were assessed in the elderly by a modified sequential scintiscanning technique after administration of the nonabsorbable chelated radiopharmaceutical 99mTcDTPA. The average fasting intervals were 8.73 ± 0.44 h in group C and 8.62 ± 0.35 h in group D (P = 0.125) which is in line with the current guidelines regarding preoperative fasting. In a study by Van de Putte et al. [9] they found that a standard fasting interval does not ensure adequate emptying even in healthy individuals.

Finding of USG grading were in line with study done by Perlas et al [8] who described the findings for 200 patients, with majority of them (193 of 200; 96.5%) classified as grade 0 or 1 in comparison to our study (92 of 120 ; 76.6 %). However, there was a higher number of patients with USG Grade 2 (28 of 120; 23.3%).

The mean diameters (both AP and CC) and CSA calculated in both supine and RLD positions had a statistically significant difference with a higher value observed in the diabetic group as compared to the controls (P values<0.05) . This is consistent with the Darwiche et al [13] who compared the gastric emptying rate in 33 diabetic and non-diabetic volunteers using ultrasound after ingestion of a semi-solid meal. In a similar study by Chiu et al [14] they compared the gastric antral area in 11 Type 2 diabetic patients and healthy controls after ingestion of a meal each. All underwent transabdominal ultrasound for gastric motility and visual analogue scales. They found that the gastric emptying was significantly slower in diabetic patients, who also had lesser antral contractions than controls.

In our study, quantitative analysis of gastric volumes showed a statistically significant value in diabetic group (p-value<0.001) with mean volumes as 4.15 ± 0.601 ml in Group C as compared to 8.96 ± 1.033 ml in diabetics. The maximum volume obtained was 13.74 ml in diabetic patients as compared to 5.27 ml in the control group. The findings of our study– larger diameters (both antero-posterior and craniocaudal), larger cross-sectional area and therefore, larger gastric volumes in diabetic patients highlighted the importance of gastric emptying studies. In the presence of clear fluid, a sonographic volume assessment was determined and the volume present was consistent with baseline gastric secretions and negligible risk (safe limit up to 1.5ml/kg) and did not need any interventions. The high incidence of patients with delayed gastric emptying indicates that testing should be considered to enable a tailored management of diabetic patients.

Our study was not without limitations. Some limitations in our study were small sample size, short duration, dissimilar diet taken by patients, variation in age of patients which might have altered the results. Future research is required to determine the training requirements to achieve competence in gastric ultrasound examination, with both qualitative and quantitative assessment.

ISSN:0975-3583,0976-2833 VOL14,ISSUE03,2023

Conclusion

Regurgitation and aspiration is a serious threat to the safety of patients especially with disorders of gastric emptying like diabetes. Current studies have shown that bedside ultrasound can provide reliable information about the volume and nature of gastric contents. With this technology, anesthesiologists can make individual decision to minimize the risk of perioperative aspiration–in patients who have not followed fasting guidelines - either because of a communication gap or due to the urgent nature of the clinical situation, patients with unreliable or unclear history or in patients with delayed gastric emptying due to significant comorbidities - whom recommended fasting intervals may not reliably ensure an empty stomach. While qualitative grading may be useful for screening purposes, quantitative analysis provides a more reliable estimate of gastric volume and reduce the chances of aspiration thereby leading to a decrease in intra- as well as postoperative morbidity and mortality.

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