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The Correlation between Ultrasonographic Gastric Antral Area and Vomiting in Patients undergoing Procedural Sedation and Analgesia

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Abstract

Introduction: Aspiration of gastric contents is one of the most important complications during procedural sedation and analgesia (PSA). It seems that gastric ultrasonography could be a suitable tool for qualitative and quantitative measurement of gastric contents before PSA.

Objective: In the present study, efforts were made to assess the correlation between ultrasonographic gastric antral area and incidence of vomiting in patients underwent PSA.

Methods: In the present cross-sectional study, using a convex 4MHz probe in supine position, ultrasonographic evaluation of gastric antral area was done for 100 participants in need of PSA. The evaluations were done from the outer layer of the gastric wall and 3 images were recorded between peristaltic contractions. Finally, the rate of vomiting incidence in patients were recorded and compared with the results of patients' ultrasonography.

Results: The findings showed that anteroposterior diameter (AP), craniocaudal diameter (CC), and cross-sectional area (CSA) had a statistically significant correlation with incidence of vomiting in patients ($p \leq 0.0001$). The odds ratio of these variables show that increase in antral diameter leads to increase incidence of vomiting. Based on these findings, 1 unit rise in AP increases the odds of vomiting by 7.45 times, 1 unit increase in CC increases the odds by 7.20 times, and finally, 1 unit increase in CSA increases the odds of vomiting by 1.32 times.

Conclusion: Gastric antrum ultrasonography can be used as a proper diagnostic tool for assessing the risk of vomiting in patients undergoing PSA.

Key words: Conscious Sedation; Correlation of Data; Pyloric Antrum; Ultrasonography; Vomiting

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INTRODUCTION

Procedural sedation and analgesia (PSA) has become a routine practice in the emergency department (ED); and even various types of outpatient Diagnostic and therapeutic measures, as well as managing patients in the intensive care unit are among interventions requiring PSA (1). Aspiration of stomach contents is one of the most important possible complications during PSA. For this purpose, current instructions recommend fasting before sedation to decrease the side effects due to aspiration of gastric contents (2, 3). However, some studies believe that long-term fasting does not lead to a decrease in gastric volume or increase in immunity to PSA side effects and just leads to unnecessary discomfort for the patient, and in emergency cases it may not be possible to use such recommendations (4). Therefore, many studies have attempted to somehow predict the occurrence of this complication. It seems that gastric ultrasound is a valid, reliable and non-invasive method in this regard (5, 6). Some studies have reported a linear correlation between the cross-section of gastric antrum (CSA) and gastric volume, with a Pearson's correlation coefficient ranging from 0.6 to 0.91 (6-11). Most of such studies have conducted before surgery and have found it to be a very useful tool for assessing the risk of aspiration in patients undergoing PSA (12, 13). However, studies on emergency patients are still very limited. In this study, efforts were made to assess the correlation between ultrasonographic gastric antral area and vomiting in patients undergoing PSA in ED.

Methods

Study design

The present cross-sectional study was performed on patients presenting to the EDs of Alzahra and Kashani Hospitals, Isfahan, Iran, in 2017-2018. The ethics committee of Isfahan University of Medical

Sciences approved the study proposal (Code: 396982). Informed consent was obtained from all participants or their legal guardian.

Study population

Inclusion criteria consisted of all patients in need of PSA for treatment of extremity trauma. Patients aged less than 18 years, and those with upper gastrointestinal disorders, decreased level of consciousness, traumas other than extremity trauma, and a body mass index (BMI) over 40 were excluded. Sampling was done using census method.

Ultrasonographic assessment

Ultrasonographic assessment of gastric antral area was performed by an experienced emergency medicine resident via a convex 4MHz probe using Logiq® e US (GE Healthcare, Wauwatosa, WI, USA) device in supine position. Gastric antrum was assessed in sagittal or parasagittal cross-sections between the left lobe of the liver and pancreas, at the level of aorta and inferior vena cava (IVC). Then the probe was tilted and with a rotation perpendicular to the longitudinal axis of the antrum for seeing a real cross-section of the antrum, the cross-sectional area of the antrum was measured using the classic 2 dimensional methods. This included measurement of 2 perpendicular diameters of the antrum and calculating the antral area, assuming that the antrum has a complete oval shape. The following standard formula was used for calculating the area of the ellipse: $CSA=(AP\times CC\times\pi)/4$ where AP and CC are stand for anteroposterior and craniocaudal diameters, respectively. The measurements were always done from the outer layer of the gastric wall and all images were obtained between peristaltic contractions. Since using all 3 images in each point is a standard practice in gastric ultrasonography (14, 15), we obtained all 3 images for measurement and used the mean values.

Intervention

After performing ultrasonography, patients underwent PSA using proper drugs based on the opinion of the emergency medicine specialist. Ramsay sedation score (RSS) was used for measuring the level of sedation. The aim was to reach the score of 3 or 4 on RSS for scan, which is classified as adequate sedation (AS). Score of 1-2 was considered as under-sedation (US), and score of 5-6 was defined as over-sedation (OS). Failed sedation was defined as a situation in which the procedure could not be completed even after administrating the maximum dose of the drug or adding any other agents. Another important parameter is the induction time, which is the time needed from the administration of the drug to the patient reaching AS and becoming ready for undergoing the procedure (Ramsay scores 2-3). At the end of the procedure, supplement oxygen administration was continued for the patient until the patient met the criterion required to be discharged. Throughout the sedation of the patients, they were monitored based on guidelines for monitoring outpatients including continuous monitoring of heart rate and respiratory rate, oxygen saturation, and intermittent and non-invasive measurement of blood pressure.

Data gathering

For each patient, overall duration of sedation as well as duration of procedure performance and time to improvement of patient, recovery (the time interval between the last dose of drug being administered to the time the patient was ready to be discharged), possible side effects on the patient during the procedure and during recovery time, and also patient's need for auxiliary ventilation during the procedure were registered on the patient's medical profile and finally, the rate of vomiting was recorded for the patients and compared with the results of their ultrasonography findings.

Statistical analysis

Data were analyzed using SPSS version 21. In the descriptive section, mean, standard deviation, and frequency (%) were reported and all demographic and clinical characteristics of the patients were also described based on descriptive criteria. Then the demographic variables were compared between the individuals based on presence or absence of nausea and vomiting and the correlation of ultrasonographic area with nausea and vomiting was assessed via univariate analysis and correlation coefficient, odds ratio, significance and confidence intervals of the correlation between gastric antrum area and vomiting were studied. In addition, multivariate regression analysis (entering all variables into the model) was also performed for assessment of variables that affected nausea and vomiting. Finally, Spearman's correlation coefficient was used to assess the correlation between CSA and duration of fasting. To analyze qualitative findings, chi-square test and for comparing quantitative findings Student's t test were used. All tests were evaluated considering 5% probability of error.

RESULTS

Totally, 120 participants were included in the study, of which 20 were excluded due to inability to see the gastric antrum due to long-term fasting, the patient not cooperating during ultrasonography

performance, presence of intense peristaltic contractions in the stomach and vomiting at the time of performing ultrasonography. Finally, the data obtained from 100 participants were analyzed, of whom 76% were male, and 53% had normal BMI and 4% had class II obesity. Demographic characteristics of the study participants and comparing the variables based on presence or absence of vomiting are presented in table 1. Mean age of the participants was 37.11 ± 15.43 years and their mean weight and BMI were 74.14 ± 11.77 kg and 25.54 ± 4.38, respectively. Mean fasting time was 4.06 ± 2.37 hours. The mean AP, CC, and CSA sizes were 2.21, 2.16, and 4.43, respectively. Utterly, 21% had nausea and 14% reported vomiting. There was no statistically significant difference ($p \geq 0.05$) regarding mean age, height, weight, BMI, BMI Rank, and sex

Table 1: Demographic characteristics of the study participants and comparing the variables based on presence or absence of vomiting

Variable	Total (n=100)	Vomited (n=14)	Did not vomit (n=86)	P-value
	Frequency (%)			
Sex				
Male	76 (76)	12 (15.8)	64 (84.2)	0.35
Female	24 (24)	2 (8.3)	22 (91.7)	
BMI rank				
Normal	53 (53)	8 (57.1)	45 (52.3)	0.14
Overweight	32 (32)	4 (28.6)	28 (32.6)	
Class I obesity	11 (11)	0 (0.0)	11 (12.8)	
Class II obesity	4 (4)	2 (14.13)	2 (2.3)	
Variable	**Mean ± standard deviation**			**P-value**
Age (year)	31.11 ± 15.43	36.78 ± 3.26	37.16 ± 1.72	0.93
Height (cm)	170.76 ± 9.40	173.28 ± 2.10	170.34 ± 1.03	0.28
Weight (kg)	74.14 ± 11.77	77.57 ± 3.48	73.58 ± 1.24	0.24
BMI	25.54 ± 4.38	26 ± 1.37	25.46 ± 0.46	0.67
Duration of fasting (hour)	4.06 ± 2.37	2.17 ± 0.36	4.36 ± 0.25	0.001
AP	2.21 ± 1.06	3.55 ± 0.16	1.99 ± 0.10	≤ 0.0001
CC	2.16 ± 1.09	3.65 ± 0.20	1.91 ± 0.10	≤ 0.0001
CSA	4.43 ± 3.7	10.33 ± 0.84	3.47 ± 0.31	≤ 0.0001

SD: standard deviation; BMI: Body Mass Index; AP: Anteroposterior; CC: Craniocaudal; CSA: Cross-Sectional Area

Table 2: Coefficient, odds ratio (OR), significance, and confidence interval for the correlation between ultrasonographic gastric antral area and incidence of vomiting with demographic variables in a univariate manner

BMI: Body Mass Index; AP: Anteroposterior; CC: Craniocaudal; CSA: Cross-Sectional Area

Variable	B	OR	OR confidence interval	P- value
Age	0.002	1	0.94 – 1.06	0.94
Sex	0.20	1,23	0.16 – 9.30	0.84
BMI	0.042	1.04	0.86 – 1.26	0.66
BMI rank	0.032	1.03	0.38 – 2.78	0.94
Duration of fasting	- 0.47	0.62	0.32 – 1.20	0.15
AP	2	7.45	2.81 –19.74	≤ 0.0001
CC	1.97	7.20	2.76 – 18.75	≤ 0.0001
CSA	0.500	1.64	1.32 – 2.05	≤ 0.0001

BMI: Body Mass Index; AP: Anteroposterior; CC: Craniocaudal; CSA: Cross-Sectional Area.

Table 3: Coefficient, odds ratio (OR), significance, and confidence interval for the correlation between ultrasonographic gastric antral area and incidence of vomiting in a multivariate manner

Variable	B	OR	OR confidence interval	P-value
Age	- 0.02	0.98	0.91 – 1.04	0.55
Sex	0.33	1.39	0.13 – 14.91	0.78
BMI	0.04	1.04	0.84 – 1.29	0.68
Duration of fasting	- 0.56	0.56	0.27 – 1.19	0.13
CSA	0.46	1.58	1.24 – 2.02	≤ 0.0001

BMI: Body Mass Index; CSA: Cross-Sectional Area.

Table 4: Correlation coefficient of CSA with duration of fasting, age, and BMI

Variable	Duration of fasting	Age	BMI
CSA	- 0.68	0.047	0.009
P-value	≤ 0.0001	0.63	0.92

BMI: Body Mass Index; CSA: Cross-Sectional Area.

between those who vomited and those who didn't. However, there was a statistically significant difference between the 2 groups regarding CSA, CC, AP, and duration of fasting. It was found that CSA size, CC, and AP were higher in those who vomited compared to those who did not. On the other hand, fasting time was shorter in those who vomited compared to those who did not. CSA, CC, and AP sizes had a significant correlation with vomiting in patients. Such that the odds ratio of these variables shows that increase in all areas in ultrasonography leads to an increased rate of vomiting. Based on these findings, 1 unit rise in AP increases the odds of vomiting by 7.45 times, 1 unit increase in CC increases the odds by 7.20 times, and finally, 1 unit increase in CSA increases the odds of vomiting by 1.32 times.

When age, sex, height, weight, BMI, BMI rank, and duration of fasting were entered to a model one by one along with CSA (evaluating the correlation of ultrasonographic gastric antral area with incidence of vomiting), they did not show any statistically significant effect on incidence of vomiting (Table 2).

In addition, entering all of these variables to the model simultaneously did not show a statistically significant relationship with incidence of vomiting either ($p \geq 0.05$). However, for every unit increase in CSA, the odds of vomiting increased by 1.58 times, which was statistically significant with $p \leq 0.0001$ (Table 3).

The results of the present study showed a reverse statistical correlation between CSA and duration of fasting, such that with increase in duration of fasting, CSA decreased. On the other hand, no significant correlation was found between CSA and age or BMI (Table 4).

Discussion

By comparing CSA in those who vomited with those who did not, the results of the present study showed that CSA size is higher in those who have vomited compared to those who have not, and this increase is statistically significant. Such that 1 unit raise in CSA, increased the risk of vomiting by 1.64 times. Since previous studies have shown that the risk of aspiration rises with increase in the gastric content and there is a positive linear correlation between CSA and the volume of gastric content (3), it is safe to say that increase in CSA is a predictive variable for incidence of vomiting in those undergoing PSA.

Our findings showed that when other variables (age, sex, BMI, duration of fasting) were entered to the model one by one, no statistically significant correlation was found with incidence of nausea or vomiting. However, age sex and BMI showed a weak positive correlation with incidence of vomiting, which was not statistically significant. On the other hand, duration of fasting had a non-significant reverse correlation with incidence of vomiting, which can be justified considering that increase in duration of fasting leads to decrease in the volume of gastric contents and therefore, reduces the risk of aspiration. When all variables were entered to the model along with CSA, the results showed that none of them had a significant correlation with incidence of nausea except for CSA, which had a significant reverse correlation with incidence of nausea. However, in incidence of vomiting only CSA showed a positive significant correlation. Such that rise in CSA led to increase in vomiting, which is in line with the findings of other studies (16).

The results of the present study did not show a significant correlation between age and CSA. In contrast, other studies have shown that CSA size is bigger in the elderly compared to young individuals (14).

The findings of the present study showed that there was a strong reverse correlation between CSA and duration of fasting and CSA decreases with increase in duration of fasting. A similar study showed that 4 hours of fasting significantly decreases CSA size compared to 1 hour. Yet, after 4 hours, CSA size does not decrease much, such that after 8 hours of fasting there is a weak correlation between CSA and volume of gastric content (10). Another study performed in 100 children also confirms these findings (16). Considering the results of the study it can be concluded that duration of fasting is a relatively appropriate predictive factor for CSA size.

Studies have shown that obesity increases the risk of aspiration and performing ultrasonography in very obese individuals is challenging. In obese people, antrum is thicker than normal people (about 7 cm); additionally, the accuracy of ultrasonography in assessing the volume of gastric contents is lower in those with a BMI over 40. Overall, obese people have a higher CSA and more volume of gastric contents from the start (16). However, in the present study a weak positive correlation was found between CSA and BMI and it was not statistically significant. The reason could be that all the patients in this study had a BMI over 18 and less than 40. Overall, it can be concluded that CSA is high in obese people and those who have recently eaten and as time passes from the meal (fasting duration increases), CSA decreases.

Limitations

There are some limitations regarding such studies used ultrasonography for a specific aim, named as point of care ultrasound (POCUS), that usually related to the operator and her/his skill in this regard. Also the accuracy of the ultrasonography may have varied in relation to the amount of gas present in the patients' hollow viscus and stomach.

Conclusions

Considering the results of the present study, it can be concluded that gastric antrum ultrasonography can be used as a proper diagnostic tool for assessing the risk of vomiting in patients undergoing PSA; The lower the volume of gastric contents, the lower the risk of vomiting.

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Authors' contribution

All the authors met the standards of authorship based on the recommendations of the International Committee of Medical Journal Editors.

Conflict of interest

None declared.

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