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Original Research Article

Ultrasound Assessment of Prevalence of 'At Risk Stomach' in Children Undergoing Elective Surgery- Prospective, Observational Study

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Abstract: Children may be at increased risk of pulmonary aspiration because of retention of gastric contents caused by pain or inadequate fasting. We performed this study to analyze the use of ultrasound for evaluation of gastric ultrasound in children less than 12 years. Two hundred children, 1-12 years of age belonging to ASA physical status I to II, scheduled to undergo elective surgery were included in the study. Patients were scanned in supine position followed by right lateral decubitus position (RLD). In qualitative assessment, the antrum was judged to contain fluid if it appeared to have an endocavitary lumen with hypoechoic content and distended walls. All measurements were taken with antrum at rest (between contraction) to avoid underestimating volume. It was observed that majority of the children were in Perlas grade 0, 116(58%) followed by 75 children in grade 1 and 9 children in grade 2. Using Karl Pearson's Correlation coefficient, low positive correlation was found between gastric volume and fasting status solid (in hours) and the variation (correlation) was found to be statistically non-significant (r=0.139; p>0.05). There is no proportionate decline in gastric volume with increased duration of preoperative fasting. Ultrasonographic measurement of antral area can be of interest to anesthesiologist for accurate qualitative and quantitative estimation of preoperative gastric contents and volume. However, gastric ultrasonography has to be validated in further trials involving a larger patient population before it can become a routine standard of care in perioperative period.

Keywords: gastric ultrasound, Pulmonary aspiration, Ultrasound, Elective Surgery.

INTRODUCTION

Pulmonary aspiration of gastric contents in perioperative period can lead to significant morbidity and even death [1]. General anaesthesia is a risk factor for aspiration of gastric contents due to abolition of protective airway reflexes. Children may be at increased risk of pulmonary aspiration due to pain, insufficient fasting or gastric/intestinal pathology resulting in reduced gastric emptying and gastro-esophageal reflux [2,3]. Diabetic, obese and bedridden children are more prone to aspiration pneumonitis [4-6].

Presence of gastric contents is an important related risk factor for pulmonary aspiration. The implementation of preoperative "fasting guidelines" limit the contents in stomach and has an important role in mitigating the risk [7]. Fasting guidelines cannot be applied to urgent or emergent surgeries and some medical conditions such as diabetes, liver or renal dysfunction and trauma can result in delayed gastric emptying with a substantial residual gastric volume, even in adequately fasted patients. In spite of adequate fasting these children are more prone for aspiration [8].

Presently perioperative aspiration risk assessment depends completely on clinical history which may not be reliable in all patients [9]. Various methods identifying volume of gastric antrum such as, electrical impedance tomography, radiolabeled diet, paracetamol absorption and aspiration of gastric content by ryles tube are invasive and not readily available [10-14]. A noninvasive bedside test to ascertain the gastric volume and content preoperatively and assess the pulmonary aspiration risk might help to mitigate aspiration risk specifically in emergent scenario [9].

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Recently, ultrasonography has been used in adults to provide near accurate qualitative and quantitative information about the volume and nature of gastric content (fluid or solid). Gastric ultrasound can differentiate a fasted stomach from one filled with solid or liquid in adults. Additionally, where the stomach contain liquid, the cross-sectional area (CSA) of the antrum determined in the right lateral decubitus position can assess gastric volume [9]. Hence, we performed this study to analyze the use of gastric ultrasound for evaluation of gastric contents in children less than 12 years.

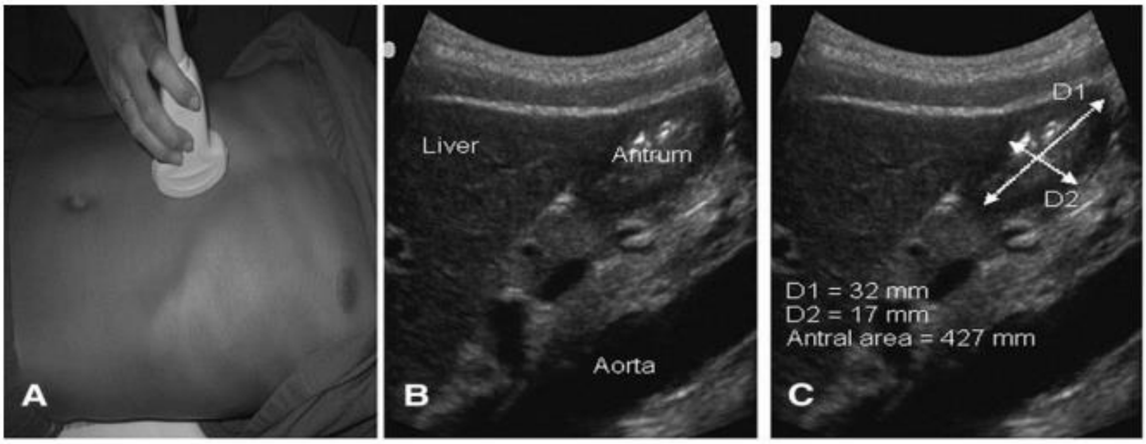
MATERIAL AND METHODS

This study was conducted in the department of Anaesthesia & Intensive care, Vardhman Mahavir Medical College &Safdarjung Hospital, New Delhi after obtaining approval from hospital ethics committee and written informed consent from guardian/ parent of all children from January 2019 to January 2021. Two hundred children in age group of 1 to 12 years having American Society of Anaesthesiologist (ASA) Physical Status I and II and undergoing elective surgical procedures under general anaesthesia were included. Children having history of gastrointestinal surgery or emergency surgery were excluded.

Pre-anaesthetic checkup included detailed clinical history and general physical examination. Children were investigated as per the institution protocol and specific investigation was left to the discretion of attending Anaesthesiologist. The guardian/ parents were educated regarding purpose and protocol of the study. Preoperative fasting guidelines were followed (i.e. fasting period for clear liquids 2 h, light meal 6 h and additional fasting time (8 h) for fried or fatty foods [15].

On the day of surgery, ultrasonographic assessment of antrum was done in the preoperative area before induction of anaesthesia. A curvilinear low frequency transducer 2-5 MHz (M-Turbo, Sonosite, USA) was used. Gastric ultrasonography was performed in both supine and right lateral decubitus position (RLD). The epigastric region was scanned in sagittal plane.

By tilting the transducer from right to left, we scanned gastric antrum to assess the gastric cavity and its contents. We visualized antrum in a parasagittal plane just right to the midline, surrounded anteriorly by the left lobe and caudate lobe of the liver and posteriorly by head or neck of the pancreas. Ultrasonographic appearance of antrum was visualized as multilayered hyperechoic wall. (Figure A & B).



A: Ultrasound Placement B: Ultrasound View C: Gastric Antrum Area

Qualitative assessment of the residual gastric fluid volume was then graded according to the three-point grading scale by Perlas *et al*., [16] (Table – 1).

Table 1: Qualitative assessment of gastric volume (Perlas *et al*.,)

Absence of visualization of any content into a flat antrum in both the supine and the RLD positions
Appearance of fluid content in the RLD position.
Visualization of fluid content in both the supine and the RLD position.

The antrum was labeled to contain fluid if it had hypoechoic contents and there were distended walls and solids if it was distended with hyperechoic content or had “frosted glass appearance” or it contained small “specular images” of intermediate echogenicity. Antral cross-sectional area (CSA) was used as a parameter for quantitative assessment of gastric volume. Antral CSA was then calculated using two perpendicular diameters: {CSA=(AP x CC x p)/4}. AP corresponded to anteroposterior diameter, CC corresponded to cranio-caudal diameter and value for p is 3.14. (Figure C) [16].

All measurements were recorded with the antrum at rest (in between contractions). Three images of antrum were obtained in both positions (RLD and supine) and average of 3 was used for calculation purposes. Antrum CSA was measured taking into account full thickness gastric wall (i.e. from serosa to serosa). A mathematical model previously validated in children aged 1 to 12 yrs was then used for calculating gastric content volume [17].

$$\text{Gastric Volume (mL/kg)} = [-7.8 + 0.035 \times \text{RLD CSA (mm}^2) + 0.127 \times \text{age (months)}] / \text{body weight (kg)}.$$

The ultrasound finding was informed to the treating anaesthesiologist. Appropriate induction technique was used for all children. Anaesthesia was maintained as per standard institutional protocols. Muscle relaxation was reversed with inj Neostigmine 0.05mg/kg and inj Glycopyrrolate 0.01 mg/kg at the end of surgery and trachea was extubated as per standard protocol. Any postoperative nausea, vomiting or episode of regurgitation/aspiration was noted and managed accordingly.

Sample Size Calculation

Taking prevalence as 1%, with alpha (α) error of 0.05 and power of 80 %, minimum sample size was calculated as 176. Taking attrition rate of 10%, we conducted this study in 200 children.

Statistical Analysis

MS Excel spreadsheet was used for entering data and analysis was done using latest licensed version of Statistical Package for Social Sciences 22.0 (SPSS). The relationship between quantitative variables (gastric volume and duration of fasting) was calculated by Pearson Correlation Coefficient along with its statistical significance by '**t**' test. The association between qualitative variable was calculated by Chi-square test/ Fisher's exact test. The comparisons of different quantitative variables in different age group were tested by Anova Test / Non parametric Kruskal-Wallis test and Bonferroni multiple comparison test. For each test, $P < 0.05$ was considered as statistically significant.

RESULTS

This study was conducted in 200 children, majority in age group 7- 8 y. The mean age of participants was 6.14 ± 3.1 y with age range of 1-12 y (Table 2). Majority of children were in Perlas grade 0, 116(58%) followed by 75 (37.5%) in grade 1 and 9 (4.5%) in grade 2. (Table 2).

Table 2: Age (y) based distribution of children (Perlas grade)

Age (y)	**Perlas Grading**			**Total**
	Grade 0	**Grade 1**	**Grade 2**	
1-2	27	3	2	32
3-4	23	13	0	36
5-6	29	11	0	40
7-8	34	6	1	41
9-10	2	26	4	32
11-12	1	16	2	19
Number of children	116	75	9	200

Three children had RLP volume ≥ 1.25 ml/kg and 197 children had RLP volume < 1.25 ml/kg. Among 3 children with RLP volume ≥ 1.25 ml/kg, 1(33.3%), 0 (0%) and 2 (66.7%) had Perlas grading 0, 1 and 2 respectively (Table 3). In children with RLP volume < 1.25 ml/kg, 115(78.8%), 75(38.1%), 7(3.6%) had Perlas gradings 0, 1 and 2 respectively (Table 3).

Table 3: Comparison in different Perlas Grades volume based on area of antrum

RLP volume(ml/kg)	**Perlas Grading**			Total	P value
	Grade 0	**Grade 1**	**Grade 2**		
≥ 1.25 ml/kg	1	0	2	3	< 0.001
< 1.25 ml/kg	115	75	7	197	
Total	116	75	9	200	

* RLP: Right lateral position

The relative risk of gastric content volume > 1.25ml/kg was higher in grade 2 than grade 0. (RR: 24.7, CI (8.8-69.2) (Table 4). None of the children had evidence of solid content. Nine (4.5%) children had Grade 2 antrum.

Table 4: Relative risk of gastric volume > 1.25 ml/kg in different Perlas grades in children

RLP Volume	Relative Risk (95% confidence Interval)
Gastric fluid volume >1.25 mL/Kg	
Grade 1 vs Grade 0	0
Grade 2 vs Grade 0	24.7(8.8-69.2)
Grade 2 vs Grade 1	0

* RLP: Right lateral position

Discussion

Aspiration pneumonia during general anaesthesia and deep sedation is a potentially preventable anaesthesia-related complication that accounts for up to 9% of all anaesthesia-related deaths [12]. Adequately fasted patients frequently have residual gastric volume (RGV) up to 1.5ml/ kg[2] without significant aspiration risk; although, the critical volume threshold of gastric fluid that increases aspiration risk is controversial [18,19].

Currently, ASA committee recommends a minimum of 2 h of fasting for clear fluids, 6 h after a light meal (toast and clear fluids), and 8 h for a full meal with high calorie or fat content before anaesthetic intervention [15]. Though these guidelines are appropriate for healthy children for elective surgery, but may not be completely reliable in children with coexisting diseases that affect gastric emptying.

Antrum is the gastric region most acquiescent to sonographic examination [8,16]. It is the most consistently identified gastric region, bounded superficially between left lobe of liver anteriorly and pancreas posteriorly in sagittal plane. (Figure B).

In our study, all measurements were taken with the antrum at rest, between peristaltic contractions because measuring the antrum during a peristaltic contraction would then yield a lower right lateral CSA value and thus underestimate gastric volume [22].

In a clinical audit conducted by Sharma *et al.*, on effectiveness of standard fasting guidelines as assessed by gastric ultrasound examination, they are unable to find any correlation between duration of fasting and residual gastric volume (p=0.47) [24]. Kaydu *et al.*, also conducted ultrasonographic measurement of antral area for gastric content preoperatively. They made a linear correlation curve depicting an inverse relationship between duration of fasting and antral CSA. The correlation coefficient was determined as r=0.499 (p<0.01) [25]. In our study using Karl Pearson's Correlation coefficient, low positive correlation was found between gastric volume, duration of fasting (h) and was statistically non-significant (r=0.139; p>0.05). One promising technique for assessing gastric volume is 3D ultrasound [26]. However, there is a learning curve and this technique requires standardization.

Hence, performing gastric ultrasound in children to delineate the gastric content volume seems a practical solution. The present study observed that ultrasound assessment of gastric content, a noninvasive and easy to perform point of care tool was feasible in 100% of children. It showed that 3% children scheduled for elective surgery presented with "at risk stomach" and had potentially increased risk of regurgitation and pulmonary aspiration of gastric contents inspite of following fasting guidelines. However, gastric ultrasound has to be validated in further trials involving a larger patient population before it can become a routine standard of care in perioperative period.

STRENGTHS

A consultant anaesthesiologist trained in gastric ultrasound conducted all ultrasound examinations, which prevented the inter subject variability in the study. The formula principle we used for the calculation of gastric volume is mathematically robust and simple to relate clinically with age. It is applicable to 1 to18 y child. All the measurements were taken in between the peristaltic contractions as recommended.

Limitations

There are few limitations of this study. The number of children in our study were less in this study. Gastric content volume was not directly measured but calculated using gastric ultrasound.

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