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PAEDIATRIC PRE-OPERATIVE BEDSIDE GASTRIC ULTRASONOGRAPHY - ITS ASSESSMENT AND RELIABILITY – A STITCH IN TIME

Anesthesiology

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ABSTRACT

Background: Ultrasonographic measurement of gastric antral cross-sectional area(CSA) is an established method to assess gastric emptying with the potential to be a noninvasive bedside test for preoperative pulmonary aspiration risk assessment in children. Although direct calculation of gastric volume is imprecise in comparison to MRI, it's still simple and valid, useful as a perioperative bedside diagnostic risk assessing tool.

Aims: Gastric ultrasonography in fasting children to assess the reliability of measured gastric antral area in determining preoperative gastric volume with respect to age specific variations if any.

Methodology: Gastric USG was done preoperatively on 100 healthy volunteer children of 2-10 years, classified into 4 age-specific groups scheduled for elective surgeries with 4-hour NPO after receiving 50 ml plain milk, subsequently measuring antral CSA, GCV, GCV_w and gastric content characteristics. Data was analyzed as mean,SD,variation co-efficients and significance between age groups.

Results: Analyzing 100 children in 4 age-specific groups with Antral CSA, GCV and GCV_w calculations as chosen parameters for assessment, we noted that though CSA showed no variation in between age groups, GCV and GCVw showed statistical significance. (p value <0.001) Nature and characteristics of gastric contents on USG also correlated with measured parameters.

Conclusion: As per our observation, gastric sonography is a valid and feasible method to assess paediatric gastric contents and volume preoperatively with age specific variations in GCV_w. Furthur studies are needed to validate gastric sonography routinely prior to surgery in all children to define target population at risk even in electively scheduled prepared patients.

KEYWORDS

USG – Ultrasonography, RLD-Right Lateral Decubitus, CSA-Cross Sectional Area, GCV- gastric contents volume, GCVw - body weight corrected GCV.

INTRODUCTION

Pulmonary aspiration of gastric contents is one of the most feared complications in paediatric anesthesia.[1] Overall incidence of anesthesia-related pulmonary aspiration in pediatric population has been estimated to be 0.02–0.1%.[2]Risk factors includes both volume as well as content of gastric aspirate. Though rare, this can result in aspiration pneumonia, chemical pneumonitis, sometimes requiring mechanical ventilation.[3]

Recent updates in preoperative fasting guidelines aims shorter fasting duration in children upto 1-2 hrs for clear liquids orally, appropriate to improve hydration, child comfort and cooperation at time of induction of anaesthesia. [4,5] Various studies over time have concluded that children have a higher metabolic rate and reduced glycogen stores compared with adults, hence prolonged fasting is associated with irritable, less co-operative child and anxious parents.[6,7] Furthermore, prolonged fasting is associated with ketoacidosis.[7] In the era of concerns over avoiding prolonged starvation, importance of gastric volume and its contents assessment to avoid risk of aspiration in elective surgeries may be overlooked at times. Often assessment of perioperative aspiration risk relies almost exclusively on clinical history which is unreliable in paediatrics. Precise techniques like real time USG and MRI (magnetic resonance imaging) are available for gastric assessment with numerous studies,[8-13] yet a need for a feasible, easy and valid way of using bedside tools like ultrasonography in the operation theatre can aid tremendously helping in perioperative safe anaesthetic practice.

Gastric ultrasonography has recently been proposed as a noninvasive bedside technique estimating preoperative gastric contents volume (GCV) by measuring antral CSA (Cross sectional area), an indicator for the risk of paediatric perioperative pulmonary aspiration.[19-26] USG as a noninvasive, portable equipment is generally available bedside and free of adverse effects when performed with caution. With adequate training and expertise, indirect assessment of GCV by measuring the cross-sectional area of the best visible part, the gastric antrum, as a surrogate parameter has proved to be useful.[9] A study by Schmitz et al [10] concluded that, antral CSA correlated with GCVw (body weight corrected GCV) in healthy children over a wide range of gastric filling, with the RLD (Right Lateral Decubitus) position is clearly superior to SUBE (Supine Upper Body Elevation) position, confirming a previously derived formula. Although direct calculation of GCVw is imprecise, this technique has the potential to become a diagnostic risk assessment test. Hence, we conducted this prospective cohort gastric ultrasonography study on fasting children posted for elective surgeries to assess the preoperative residual gastric volume in RLD position, comparing different age groups to assess any clinical benefits and age specific variation so as to guide us on which age group of children actually need 4 hours fasting before surgery.

We used portable USG for assessing gastric content and volume as bedside perioperative tool, along with description of the sonographic appearance of the gastric contents, determining CSA, GCV and GCV_w. Thus, trying to determine if there is a numerical correlation between various age groups. In view of safety of ultrasonography, we also monitored both mechanical and thermal indices for all children keeping the values < 1.0 and restricting duration of examination within this safe range.

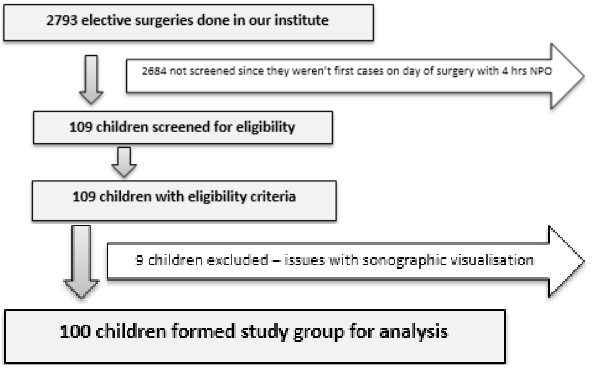
Methodology:

This prospective cohort observational study was undertaken from June 2017 to June 2018 for one year with approval from our institutional ethical committee. Sample size was chosen with confidence level of 95% and 10 % precision. A written informed parental consent was obtained. 100 children of American Society of Anaesthesiologists (ASA) physical status I-II, aged 2-10 yrs, coming for elective surgeries, scheduled as first case of the day formed the inclusion group. Parents not consenting, children with gastrointestinal disorders, malnutrition, syndromes were excluded from the study. Children were randomly allocated to 4 groups based on their age.

Table 1: Study group distribution

Group	Age Group	Sample size
Group A	Children between 2 to <4 years	25
Group B	Children between 4 to <6 years	25
Group C	Children between 6 to <8 years	25
Group D	Children between 8 to 10 years	25

A routine pre-anaesthetic check-up was done a day prior to surgery. After explaining the examination procedure, informed consent was taken. On consenting NPO instructions were given to parents. Volume of milk to be given was informed to parents clearly providing a measuring cup previous day, to feed plain milk 50ml at 5 am on the day of surgery. On the day of surgery at 9.00 am, premedication with 0.05 mg/kg of midazolam IV as per institutional protocol was given and USG was performed.



Flow chart of study methodology

USG technique:
Ultrasonography assessment was performed with realtime 2D portable diagnostic abdominal ultrasonography machine using the paediatric linear transducer with a frequency of 5–12 MHz (Samsung ultrasound device, PT60A). The smallest cross-sectional gastric antral area (CSA) in RLD position was determined. All children were cooperative for the procedure with parental presence, counselling and premedication. From each scan, two orthogonal diameters (D1 and D2) of the antral cross-section, including the gastric wall were measured. Then cross-sectional area was calculated according to formula used by Bolandi [11] (CSA = π * D1 * D2/4). This was repeated 3 times and CSA was then averaged. In RLD, sagittal or approximate to sagittal plane was chosen, the aorta and superior mesenteric vessels were used to define the CSA plane. CSA was identified by gastric anatomy, using vascular landmarks only to facilitate intraabdominal orientation. The stomach was continuously scanned from the corpus to the duodenum, using sagittal, horizontal, and oblique US planes. The best plane for scanning the smallest cross-sectional area, perpendicular to the long axis of the antrum. [12,13]

Figure 1: Gastric ultrasonographic image with measurement of the antral area.

Gastric contents were differentiated as empty, liquid or solid, based on the appearance as follows: Bull's eye/collapsed, hypoechoic, hyperechoic, frosted glass, starry sky [12,13]

Gastric content volume (GCV) was calculated using the derived parameters and the formula:

GCV (ml) = -7.8 + (3.5 * RLD CSA) + 0.127 * age in months [12]

The gastric volume is then converted into ml/kg body weight to obtain GCVw (Weight corrected GCV)

Data analysis: Data were presented as mean ± Standard deviation and coefficient of variation (CV). Independent T test was used to calculate the significance between 2 groups. ANOVA test was used to calculate the significance of study parameters between the four groups. P < 0.05 was considered significant. The statistical software version 20.0 was used to analyze the data. Microsoft office word 2013 and excel 2013 were used to generate graphs and charts.

RESULTS
Demographic characteristics are summarized as in Table 2.

Table 2: Demographics

Group	Parameter	Mean ±SD	Minimum	Maximum
Group A	Age	35.68 ±9.69	24	48
	Weight	10.53 ±2.30	8	17
	Height	86.44 ± 8.55	74	110
Group B	Age	59.76 ± 7.36	48	72
	Weight	14.36 ± 2.79	10	20
	Height	100.92 ± 9.61	78	112
Group C	Age	86.92 ± 7.35	72	96
	Weight	18 ± 3.43	11	26
	Height	104.28 ±6.89	93	120
Group D	Age	114.16 ±6.60	96	120
	Weight	22.76 ±3.46	17	32
	Height	129.32 ±7.79	119	148

*Age in months, Weight in Kgs, Height in cms.

In Group A, empty gastric antrum or bull's eye appearance was seen in 14 children, 3 hypoechoic, 5 hyperechoic and 3 had frosted glass appearance. Mean CSA in this group was 1.78 cm2 (SD – 1.32). Mean gastric volume was 3.32ml (SD 4.74), whereas mean gastric volume/kg body weight was 0.261ml/kg (SD 0.356).

In Group B, number of children with empty gastric antrum or bull's eye appearance was 4, 11 were hypoechoic, 8 hyperechoic and 2 starry sky appearance. Mean CSA was 2.11 (SD 1.39). Mean gastric volume was 7.19ml (SD 5.06), whereas gastric volume/kg bodyweight was 0.481ml/kg (SD 0.329).

In Group C, empty gastric antrum was seen in 3, 11 hypoechoic, 6 hyperechoic, 4 frosted glass appearance and 1 starry sky appearance. Mean CSA in this group was 2.2cm2 (SD 1.03). Mean gastric volume was 11.02ml (SD 3.83) and gastric volume per kg body weight was 0.597ml/kg (SD 0.213).

In Group D, number of children with empty gastric antrum were nil, 9 hypoechoic, 2 hyperechoic contents, 13 frosted glass and 1 starry sky appearance. Mean CSA was 2.75 cm2 (SD 0.89). Mean gastric volume was 16.32 ml (SD 3.39) with gastric volume/kg body weight of 0.753 ml/kg (SD 0.168).

Table 3: Inter group variability in CSA, GCV and GCVw

	Group A		Group B		Group C		Group D		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
CSA *	1.78	1.32	2.11	1.39	2.20	1.03	2.75	0.89	0.03
GCV **	3.32	4.74	7.19	5.06	11.02	3.83	16.32	3.39	< 0.001†
GCV_W ⁋	0.261	0.356	0.481	0.329	0.597	0.213	0.753	0.168	< 0.001†

* antral cross-sectional area,** Gastric content volume, ⁋ Body weight corrected GCV.
† statistically significant

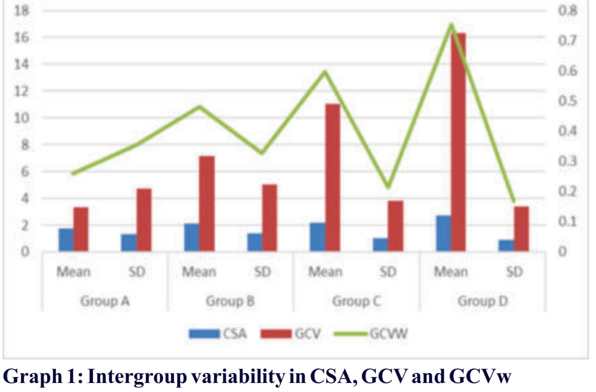
There was no statistically significant difference in the gastric antrum cross sectional area with a P value of 0.03 as shown in table 3. But GCV and GCV_w showed statistical significance with p value of <0.001 as in graph 2. Group A had GCV 3.32 ml in comparison to Group D which had 16.32ml. GCV_w was 0.261 ml/kg in Group A compared to 0.753ml/kg in Group D. The GCV significantly increased with increasing age with the same fasting duration of 4 hours after plain milk of 50ml. Even GCV_w also significantly increased with increasing age. During the study, we also observed few children with associated global developmental delay, cerebral palsy, neuromuscular disorders had significantly increased gastric volume after 4 hours of fasting, but due to negligible number of cases required for statistical results we excluded them from our study. Large scale studies are needed in this group exclusively in future.

DISCUSSION:
Paediatric preoperative fasting time, its perioperative impact and methods to assess is an ongoing debate with newer insights and updates. In the era of highly accurate methods like real time MRI and USG, bedside use of easily available equipment's like USG to the best possible level with possible accurate parameters for better perioperative care is most challenging among paediatric population.

Gastric sonography parameters like antral CSA, GCV, GCV_w and nature of contents have been a reliable markers in paediatrics.[9-16] More validation of these parameters in large population with keen look into the age specific variations was aimed in our study. Bedside gastric USG was a reliable noninvasive tool easily available for estimating preoperative gastric contents volume.

Our study was done to assess the residual gastric volume by bedside gastric ultrasonography after a 4-hour fasting period with plain non-human milk in children aged from 2 to 10 years, trying to localize till which age group non-human milk can be given 4 hours prior to surgery without the increased risk of aspiration. When we compared the results, we found that Group A had highest number of children with collapsed gastric antrum, whereas group D had no children with collapsed gastric antrum suggesting that as the age group increased, time to gastric emptying was more, but the difference in parameters were within the safe range of aspiration risk.

Mean gastric volume per kg body weight was 0.261ml/kg in Group A, 0.481ml/kg body weight in Group B, 0.597ml/kg body weight in Group C, and 0.753ml/kg body weight in Group D. Even though the gastric volume is more in Group B and C, it is not significant to cause aspiration (The gastric volume of 0.8 to 1.5ml/kg is significant and increases the risk of aspiration). Group D children had mean gastric volume of 0.753ml/kg body weight which might appear to increase the risk of aspiration theoretically. Perioperative anaesthetic management of this group was uneventful with no events of aspiration in group D. Similar results were obtained by Bouvet et al,[17] when they observed 1% elective children had potentially increased risk of pulmonary aspiration on assessing prevalence at-risk stomach by USG in 200 children.



Graph 1: Intergroup variability in CSA, GCV and GCVw

Though the antral CSA is not significantly different between the groups, GCV_w significantly increased with age because gastric volume is calculated using a mathematical model which has age as a parameter. This suggests that GCV_w is a more specific parameter, valuable when compared in between age groups. Also, fasting guidelines with parameters like GCV_w might prove to be more useful and precise. In group D, 2 children had hyperechoic appearance, and 13 children had frosted glass appearance which means total 15 children had residual milk in the gastric antrum. Spencer et al [14] had reported that nine out of 100 children scheduled for elective gastrointestinal endoscopy had a Grade 2 antrum (Grade 2 antrum may correspond to gastric fluid volume <1.5 mL/kg in 25% of the cases).[18] Unlike this study which had included only children with gastrointestinal complaints that hinders generalizability of their result to the overall elective pediatric population, our study had excluded children with GI disorders.

Furthermore, our results correlated well with the other calculated volume parameters suggesting better reliability. We also observed that nature and appearance of gastric contents along with measured values aa a very useful consideration in gastric sonography. We suggest that gastric sonography as a complete entity with measured parameters and contents appearance yields better tool for perioperative aspiration risk assessment.

During course of our study, we also observed that children with obstructive sleep apnea, cleft lip and palate, and global developmental delay had increased gastric volume which was significant enough to cause aspiration and after calculating the gastric volume we took precautions to prevent aspiration in such children and they were excluded from the study. Since the number of such cases were less, we could not arrive at a statistically significant value. Future studies targeting this group exclusively might provide new arenas on separate special fasting guidelines for these children.

From our study, we conclude that duration of fasting can be reduced to 4 hours with non-human plain milk in children upto the age group of 8 years with no risk of aspiration. Between 8 to 10 years the volume was nearly significant to cause aspiration theoretically. By giving plain milk 4 hours before surgery, children were more cooperative, relaxed, reduced thirst and hunger, less prone for dehydration, hypoglycemia as well.

Limitations of our study include smaller sample size, gastric volume assessment only by ultrasonography with no MRI correlation or gastric volume pH. We suggest that future studies coordinating MRI, USG and endoscopy with laboratory methods might yield newer perspectives on age specific variations. An age specific NPO guideline in children may open new arenas. We also suggest further studies on specially abled children may be needed for a separate fasting guideline.

In conclusion, preoperative bedside gastric USG can provide reliable information as a clinically useful noninvasive tool. Routine preoperative Gastric USG should be encouraged, benefitting not just elective but even during emergency surgeries for better perioperative aspiration risk assessment.

REFERENCES:

1) Lienhart A, Auroy Y, Pe´quignot F, Benhamou D, Warszawski J, Bovet M et al. Survey of anesthesia-related mortality in France. Anaesthesiology 2006;105:1087–97.
2) Borland LM, Sereika SM, Woelfel SK et al. Pulmonary aspiration in pediatric patients during general anesthesia: incidence and outcome. J Clin Anesth 1998;10:95–102.
3) Tan Z, Lee SY. Pulmonary aspiration under GA: a 13– year audit in a tertiary pediatric unit. Pediatr Anesth 2016;26:547-52.
4) American Society of Anesthesiologists Committee. Practice guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures: an updated report by the American Society of Anesthesiologists Task force Committee on Standards and Practice Parameters. Anesthesiology 2017;126:376-93.
5) Lerman J. Clear fluid fasting in children: Is 1 hour the answer? Paediatric anaesthesia 2019;29(4):385.
6) Thomas DKM. Hypoglycaemia in children before operation: its incidence and prevention. Br J Anaesth 1974;46:66-8.
7) Dennhardt N, Beck C, Huber D, et al. Impact of preoperative fasting times on blood glucose concentration, ketone bodies and acid-base balance in children younger than 36 months: a prospective observational study. Eur J Anaesthesiol 2015;32:857-61.
8) Bouvet L, Mazoit JX, Chassard D et al. Clinical assessment of the ultrasonographic measurement of antral area for estimating preoperative gastric content and volume. Anaesthesiology 2011;114:1086–92.
9. Bouvet L, Miquel A, Chassard D, et al. Could a single standardized ultrasonographic measurement of antral area be of interest for assessing gastric contents? A Preliminary Report. Eur J Anaesthesiol 2009;26:1015-9.
10. Schmitz A, Thomas S, Melanie F, et al. Ultrasonographic gastric antral area and gastric contents volume in children. Pediatr Anesth 2012;22:144– 9.
11. Bolondi L, Bortolotti M, Santi V, Calletti T, Gaiani S, Labo` G. Measurement of gastric emptying by real time ultrasonography. Gastroenterology 1985;89:752–9.
12. El-Boghdadly K, Kruisselbrink R, Chan VWS, Perlas A; Images in Anesthesiology: Gastric Ultrasound. Anesthesiology 2016;125(3):595.
13. Van de Putte P, Perlas A. Ultrasound assessment of gastric content and volume. British J Anaesth 2014;113(1):12–22.
14. Spencer AO, Walker AM, Yeung AK, et al. Ultrasound assessment of gastric volume in the fasted pediatric patient undergoing upper gastrointestinal endoscopy: development of a predictive model using endoscopically suctioned volumes. Pediatr Anesth 2015;25:301-8.
15. Schmitz A, Schmidt AR, Buehler PK, et al. Gastric ultrasound as a preoperative bedside test for residual gastric contents volume in children. Pediatr Anesth 2016;26:1157-64.
16. Perlas A, Van de Putte P, Van Houwe P, et al. I-AIM framework for point– of– care gastric ultrasound. Br J Anaesth 2015;116:7– 11.
17. Bouvet L, Bellier N, Riegel ACG, Desgrangers FP, Chassard D, Siqueira MDQ. Ultrasound assessment of the prevalence of increased gastric contents and volume in elective paediatric patients:A prospective cohort study. Paediatric anaesthesia 2018;28(10);906-13.
18. Perlas A, Mitsakakis N, Liu L, Cino M, Haldipur N, Davis L, Cubillos J, Chan V. Validation of a Mathematical Model for Ultrasound Assessment of Gastric Volume by Gastroscopic Examination. Anesth Analg 2013;116:357–63.
19. Perlas A, Chan VW, Lupu CM, Mitsakakis N, Hanbidge A. Ultrasound assessment of gastric content and volume. Anesthesiology 2009;111:82–9.
20. Schmitz A, Schmidt AR, Buehler PK, Schraner T, Frühauf M, Weiss M et al. Gastric ultrasound as a preoperative bedside test for residual gastric contents volume in children. Paediatr Anaesth 2016;26:1157–64.
21. Engelhardt T, Wilson G, Horne L, Weiss M, Schmitz A. Are you hungry? Are you thirsty? – fasting times in elective outpatient pediatric patients. Paediatr Anaesth 2011;21:964–8.
22. Castillo-Zamora C, Castillo-Peralta LA, Nava-Ocampo AA. Randomized trial comparing overnight preoperative fasting period Vs oral administration of apple juice at 06:00–06:30 am in pediatric orthopedic surgical patients. Paediatr Anaesth 2005;15:638–42.
23. Charlesworth M, Wiles MD. Preoperative gastric ultrasound-should we look inside Schrodinger's gut?.Anaesthesia 2018;74(1):109-12.
24. Habre W, Disma N, Virag K, et al. Incidence of severe critical events in paediatric anaesthesia (APRICOT): a prospective multicentre observational study in 261 hospitals in Europe. Lancet Respir Med 2017;5:412-25.
25. Walker RW. Pulmonary aspiration in pediatric anesthetic practice in the UK: a

prospective survey of specialist pediatric centers over a one year period. Pediatr Anesth 2013;23:702-11.
26. Hanna A, Acchim S, Peter F. Preoperative fasting guidelines in paediatric anaesthesia: are we ready for a change? Current opinion in anaesthesiology 2018;31(3):342-8.
27. Fawcett WJ, Thomas M. Preoperative fasting in adults and children: Clinical practice and guidelines. Anaesthesia 2019;74(1):83-8.
28. Warner MA, Warner ME, Warner DO et al. Perioperative pulmonary aspiration in infants and children. Anesthesiology 1999;90:66–71.
29. Perlas A, Davis L, Khan M et al. Gastric sonography in the fasted surgical patient: aprospective descriptive study. Anesth Analg 2011;113:93–7.