International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

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Gastric ultrasound as a bedside tool for assessment of fasting status in paediatric surgical patients

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Abstract

Peri-operative aspiration of gastric contents is a rare but serious complication of anaesthesia. Aspiration pneumonia is associated with significant morbidity, including prolonged mechanical ventilation. This is a study to analyse the usefulness of gastric ultrasound in paediatric patients in elective and emergency cases. 80 children were enrolled into the study. Children were allocated into 2 groups of 40 each - undergoing elective surgery (EL), and those undergoing emergency surgery (EM). Gastric ultrasonography was done preoperatively, gastric content checked and gastric antral volume was measured. In our study out of 40 elective cases, the stomach was empty in 87.5% of children in whom the same planned anaesthesia was performed. 10% had liquidcontent, 2.5% had solid content. Among them in 20% plan was changed to regional technique, in 40% changed to RSI and in 40% rescheduling of surgery was done. Outof 40 emergency cases in 80% children stomach was empty or had liquid content of volume less than 1.5ml/kg. The same planned anaesthesia was performed. In rest 20% of children gastric content was more than 1.5ml/kg. Among them in 12.5% of children, plan was changed to regional anaesthesia in 50% to RSI and in 37.5% surgery was rescheduled. No aspiration was seen in both the groups. Gastric ultrasound assessement of antral content and volume measurement is a simple and useful point of care tool for the choice of most appropriate anaesthesia technique in paediatric surgical patients to avoid risk of pulmonary aspiration of gastric contents.

Keywords: Gastric Ultrasound, Tool for Assessment, Fasting Status, Paediatric Surgical Patients

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1. Introduction

Pre-operative fasting which is defined as the restriction of food and fluid intake for few hours before general anaesthesia or sedation, is one of the cornerstones of peri operative patient safety [1]. The current guidelines for preoperative fasting recommend intervals of 6, 4, and 2 h (6–4–2) of fasting for solids, breast milk, and clear fluids, respectively. The objective is to minimize the risk of pulmonary aspiration of gastric contents, but also to prevent unnecessarily long fasting intervals. The incidence may have decreased during the last decades, judging from several audits published recently. However, several reports of very long fasting intervals have also been published, in spite of implementation of the 6–4–2 fasting regimens. Pre anaesthetic or pre-operative fasting is a universally applied principle in elective cases to minimize the risk of pulmonary aspiration of gastric content posedby the combination of regurgitation and loss of protective airway reflexes by anaesthetic agents. The aspiration of breast milk or infant formula in particular may result in severe damage to the lungs [2]. Subjects are fasted before surgery in order to allow gastric emptying, thus reducing the risk of pulmonary aspiration [3]. However, prolonged periods of fasting can cause distress, fatigue, irritability, dehydration and biochemical or metabolic imbalances. Recently it has been observed that a reduction in the duration of preoperative fasting is not only safe for the patient, but also improves patient compliance, cooperation and general wellbeing [1].

2. Materials and Methods

This Prospective randomized was conducted among Paediatric patients aged 2 to 10 years posted for elective /emergency surgeries in Bapuji Child Health Institute, Bapuji Hospital and Chigateri General Hospital attached to JJM Medical College Davangere. Duration of study was two years. Sample size was 80 patients.

2.1. Inclusion Criteria

1. Paediatric patients between 2-10 years of age.
2. ASA grade 1and 2.
3. Elective/emergency surgeries.

2.2. Exclusion criteria

1. Large hiatus hernia.
2. Recent upper GI bleed.
3. Previous lower esophageal or gastric surgeries.
4. On drugs known to cause delayed gastric emptying.
5. Syndromic babies.
6. Mentally retarded.

2.3. Plan of study

A detailed history and complete clinical examination will be done to rule out systemic diseases. Routine investigations for proposed surgery will be done accordingly. Written and informed consent will be taken from parents/guardian prior to scheduled surgery. All the children posted for elective and emergency surgerieswill be allocated to group EL (Elective) and group EM (Emergency) respectively.

2.3.1. Technique

Upon arrival in the preoperative holding area, all the children will be enquired about the NPO status, connected to pulse oximeter. They will be premedicated with injection midazolam 0.03mg/kg and/or fentanyl 1mcg/kg IV. Gastric USG will be done using a linear high frequency transducer probe in the epigastric saggital plane. With the child placed in RLD position and 45degree head end elevation or in supine position. The gastric antrum will be visualized inferior to left lobe of liver and anteriorto pancreas at the level of aorta or inferior venacava. In an empty stomach, antrum has no appreciable content in both supine and RLD position and hence appears flat and collapsed. In case of clear fluid, antrum is round and distended with thin walls, content is anechoic or hypoechoic. In case of solid content, antrum appears distended with thin walls and content is hyperechoic. The CSA has a linear correlation with gastric volume. On obtaining a still image of the antrum (between peristaltic contractions), a free tracing tool is used to measure the CSA including the full thickness of the gastric wall (from serosa to serosa) and gastric volume. When the ultrasound suggests an empty-stomach the children are taken for surgery under planned anaesthesia technique. When the ultrasound indicates clear fluid in antrum, the volume is estimated using a predictive model. If the estimated volume is less than or equal to 1.5ml/kg it is suggestive of low aspiration risk and proceeded for surgery under planned anaesthesia technique. If the estimated volume ismore than 1.5ml/kg it is suggestive of high aspiration risk. In case of emergency surgery, it will be performed under RSI with all the measures to prevent aspiration. In case of elective surgery, it will be postponed. When the ultrasound indicates solid content in the antrum, surgery will be postponed until and unless it is a life-threatening emergency.

2.3.2. Sample Size Calculation

Based on the Cochran formula,

$$\text{Sample size} = Z^2\, p\,(1\text{-}p)\,/d^2$$

Where p = prevalence; taken as 26% based on previous studies, d = desired level of precision i.e. margins of error - taken as 10%, and Z = standard normal variant; taken as 1.96 for 95% confidence level. Therefore;

$$\text{Sample size} = (1.96)^2 \times 0.79 \times (1 - 0.79) / (0.10)^2 = 74$$

rounded off to 80

2.3.3. Statistical Analysis

Data were entered into Microsoft Excel and statistical analysis was carried out in SPSS software version 17.0. Categorical variables like contents of antrum, antral volume (categorized as zero, less than 1.5 ml/kg and more than 1.5 ml/kg), anaesthesia technique and 'on table' aspiration was presented as frequency and percentages. Bar diagrams charts were used for graphical representation of data.

3. Results

80 children of age group 2-10 years were divided into 2 groups EL (elective surgeries), EM (emergency surgeries) with 40 children in each group. A preoperative bedside gastric ultrasound was performed in both groups. Out of 40 emergency cases, 45% were male and 55% were female. Out of total 40 elective cases, the antrum of 4 children (10%) had liquid content and antrum of 1 child (2.5%) had solid content. The antrum of remaining 35 children (87.5%) was empty. Out of total 40 emergency cases, the antrum of 9 children (22.5%) had liquid contents and the antrum of 2 children (5%) had solid contents. The antrum of remaining 29 children (72.5%) were empty (table 1). The antral volume in elective cases of 4 children (10%) was more than 1.5ml/kg where as in 1 child (2.5%) it was less than 1.5ml/kg. The antral volume in emergency cases of 8 children (20%) was more than 1.5ml/kg, where as in 3children (7.5%) it was less than 1.5ml/kg. The anaesthesia technique was as per plan in 35 children (87.5%), in 5children (12.5%) there was change of plan. The anaesthesia technique was as per plan in 32 children (80%), in 8 children(20%) there was change of plan. In 1 child (20%) the technique was changed from GA to regional anaesthesia, in 2 children (40%) RSI was done. In remaining 2 children (40%) surgery was postponed. In 1 child (12.5%) the technique was changed from GA to regional anaesthesia, in 4 children (50%) RSI was done. In remaining 3 children (37.5%), surgery was postponed. None of the children with antral content had on table aspiration in electivecase group. None of the children with antral content had on table aspiration in emergencycase group.

4. Discussions

Out of 40 elective cases, the antrum of four children (10%) had liquid content and antrum of one child (2.5%) had solid content, the antrum of remaining thirty-five children (87.5%) was empty.

In a study conducted by P. van de putte et al., suggested that antral content assesement by gastric ultrasonography is highly reproducible, indicating a better specificity and sensitivity in differentiating the type of content [4]. When we

studied the antral volume among these 5 children 4 had an antral volume of greater than 1.5ml/kg and 1 child had volume of less than 1.5ml/kg. Even though several descriptions of type of content is published, determining the exact volume of content remains challenging. Song I. K. et al., in their study noted that there is linear co-relation between antral cross section area (CSA) and gastric volume [5]. Adam o spencer et al., in their study noted significant differences between absolute gastric volume (ml) and gastric volume measured by ultrasound [6]. But majority of the studies conclude that in presence of clear fluid, a sonographic volume assessement of less than 1.5ml/kg is consistent with gastric secretion and carries negligible risk of aspiration. In our study 35 children (87.5%) were found to have no antral content. They were anaesthetised according to the initial plan of management. 5 children (12.5%) who had antral content were subjected to a change in anaesthetic management or postponement of surgery. Among them one child aged six years had antral content of less than 1.5ml/kg was posted for an incision and drainage of leg abscess. We went ahead by administering regional anaesthesia (subarachnoid block) without sedating the child.

Two children who had liquid content of greater than 1.5ml/kg were posted for laparotomy with diagnosis of intestinal perforation and intestinal obstruction respectively. Even though these children were kept NPO according to set protocols mentioned in first part of our study. Intestinal pathology attributed to the presence of gastric contents. The plan was changed to RSI in these children. One child aged 5 years was posted for a hydrocoele repair had solid gastric content, in whom the surgery was postponed. one child aged four years posted for right inguinal hernia repair had liquid content of volume greater than 1.5ml/kg was also postponed. Miscommunication and inability of parents to follow NPO guidelines were found to be the major reasons for presence of gastric content in elective cases. Noneof the children grouped under elective category had on table aspiration. Frykholm P et al., in their study found that children given a preoperative advice of keeping NPO for 6 hours for solids and 4 hours for liquids ended up fasting for 10-12 hours [7]. Long elective lists and inability of parents to follow preoperative NPO advice in midnight were found to be the reasons. This resulted in complications like hypoglycaemia, metabolic acidosis, dehydration, cardiovascular instability etc. Song I.K et al., in their study assessed gastric volume in paediatric patients using gastric USG in 2 phases [5]:

1. After fasting for 8 hours.
2. Two hours after first USG.

They found that consumption of a carbohydrate drink 2 hours before administering general anaesthesia reduced gastric volume. Many similar studies were done showing same results. Making child drink apple juice at 6-6.30 am on the morning of surgery prevented dehydration and favored positive behavior in children, also reduced incidence of post operative nausea and vomiting in these children. Hence one may conclude that there is a need for preoperative gastric USG in elective paediatric population and tailoring the anaesthesia requirement accordingly rather than following conventional NPO guidelines which may exceed in time and associated with its own complications. In our study, out of 40 children in the emergency group, 29 (72.5%) had no antral content. 9 children (22.5%) were found to have liquid in their antrum, out of which 3 had antral volume of less than 1.5ml/kg and 6 had antral volume greater than 1.5ml/kg. In 2 of the children (5%) the antrum was found to contain solid on gastric ultrasonography. Children with empty antrum along with children with antral volume less than 1.5ml/kg (80%) were anaesthetized according to initial plan of management. Amongthe remaining 8 cases (20%) 1 child aged 6years was posted for left foot burns dressing which was carried out under regional anaesthesia (Sub Arachnoid Block). 4 children with liquid content of more than 1.5ml/kg with diagnosis of Acute appendicitis (aged 8 years), Intestinal obstruction (aged 6years), Torsion testis (aged 5years), Intestinal perforation (aged 3 years), respectively were assessed for the necessity of emergency surgery and the plan of management was changed to RSI instead of postponing the surgery.

One child aged 5 years posted for ring finger laceration wound suturing had liquid content of greater than 1.5ml/kg in whom the surgery was postponed. Two children aged 4 and 5 years with diagnosis of hand abscess and tongue laceration respectively had solid content on ultrasonography in whom the surgery waspostponed. No child had on table aspiration in emergency group. Brunet-wood K et al., in their study showed that 39%of children posted for emergency appendicectomy had empty stomach [8]. Although conventional teaching would suggest that all patients with appendicitis should be considered to have full stomach. They concluded that gastric ultrasonography gives anaesthesiologists a unique opportunity to individualize assessment of aspiration risk and tailoranaesthesia rather than continuing with standard approach based on general assumptions. S. D. Cook-Sather et al., reported that 83% of infants undergoing pyloromyotomy had gastric volume greater than 1.25ml/kg, independant of preoperative fasting duration. After evacuation of gastric content by NG aspiration, 95.5% had empty stomach [9]. A. C. Gagly et al., in their study couldn't conclude the choice of anaesthesia even after blind aspiration in children posted for pyloromyotomy [10]. In the same study RSI with cricoid pressure was inconvenient and was found challenging to most anaesthesiologists. Hence majority anaesthesiologists avoid RSI with cricoid pressure and go on with gentle mask ventilation before tracheal intubation. Hence, they were of a conclusion that USG examination of gastric contentprior to surgery will be useful in deciding the need for NG aspiration, once stomach was found to be empty, anaesthesiologists can go about with desired plan avoiding. R. S. I. Parekh et al., in their study concluded that supplementing NPO guidelines with a sonographic assessment of gastric contents in children posted for emergency surgeries may improve decision making in administering anaesthesia. As preoperative fasting status is unknown in them, we can reduce the risk of pulmonary aspiration and may also limit the need for unnecessary delay or postponement of cases [11-12].

Table 1: Antral contents in elective cases and emergency cases.

Antral contents	Elective cases	Emergency cases
Empty	35 (87.5%)	29 (72.5%)
Liquid	4 (10%)	9 (22.5%)
Solid	1 (2.5%)	2 (5%)
Total	**40**	**100**

Table 2: Antral Volume in in elective cases and emergency cases.

Antral volume	Elective cases	Emergency cases
0	35 (87.5%)	29 (72.5%)
Less than 1.5ml/kg	1 (2.5%)	3 (7.5%)
More than 1.5ml/kg	4 (10%)	8 (20%)
Total	**40**	**100**

Table 3: Anaesthesia Technique in elective cases and emergency cases.

Anaesthesia Technique	Elective cases	Emergency cases
As per plan	35 (87.5%)	32 (80%)
Change of plan	5 (12.5%)	8 (22.5%)
Total	**40 (100)**	**40 (100)**

Table 4: Change of Plan in anaesthesia technique in elective cases and emergency cases.

Change of plan	Elective cases (n=5)	Emergency cases (n=8)
Changed to regional	1 (20%)	1 (12.5%)
Changed to RSI	2 (40%)	4 (50%)
Postponement	2 (40%)	3 (37.5%)
Total	**5 (100)**	**8 (100)**

Table 5: On Table aspiration in elective cases and emergency cases with antral content.

On Table aspiration	Elective cases (n=5)	Emergency cases (n=8)
No	5 (100)	8 (100)
Yes	0	0
Total	**5**	**100**

5. Conclusion

Our results suggested that gastric ultrasound assessement of antral content andvolume measurement is a simple and useful point of care tool for the choice of most appropriate anaesthesia technique in paediatric surgical patients to avoid risk of pulmonary aspiration of gastric contents.

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