

## The Outcome of Pre-operative Gastric Ultrasound Examination on the Choice of General Anaesthetic Induction Technique in Paediatric Patients Posted for Surgery - An Observational Study

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### KEYWORDS

Gastric volume,  
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### ABSTRACT

**BACKGROUND & AIM:** Ultrasonographic assessment of the gastric antrum, is a non-invasive reliable tool for gastric content estimation in both adults and children. This study aimed to determine the most appropriate induction technique and assessment of gastric content by aspiration of nasogastric tube. **METHODOLOGY:** 80, ASA I and II paediatric patients aged 6 months to 16 years were considered. Ultrasound was performed preoperatively in semi-recumbent and right lateral decubitus position to assess the gastric content. Perlas grading 0-2 was used to determine the gastric volume. A final induction plan (Routine or Rapid Sequence Induction-RSI) was made based on this assessment. Immediately after tracheal intubation, gastric contents were suctioned through a nasogastric tube; these were defined as above risk threshold for regurgitation and aspiration if there was clear fluid > 0.8 ml/kg, and/or the presence of thick fluid and/or solid particles. **RESULTS:** Out of 80 patients examined, RSI was performed in 23 after assessing by ultrasonography. p value was highly significant (<0.0001) for appropriate technique of induction based on Perlas grade. Confirmation of gastric volume by nasogastric tube aspiration was also highly significant (p<0.0001). **CONCLUSION:** Ultrasonography is a useful guide to assess the gastric volume to aid for the choice of general anaesthetic technique that can reduce risk of pulmonary aspiration.

## INTRODUCTION

Pulmonary aspiration of gastric contents remains a significant concern in pediatric anesthesia, particularly during emergency surgeries.<sup>1</sup> Although advances in anesthesia practices have reduced the incidence of aspiration to a range between 0.02% and 0.1%,<sup>2</sup> it continues to pose risks of neuronal injury and anesthesia-related complications that may lead to severe outcomes, including mortality, evaluating and managing the risk of aspiration is critical, especially in high-risk scenarios, to further enhance the safety of anesthesia protocols.<sup>3</sup>

Ultrasound examination of the gastric antrum offers a non-invasive and efficient method for assessing gastric contents, providing valuable information to guide the choice of anesthetic induction technique. By employing a three-point grading system for qualitative assessment in both supine and right lateral positions, clinicians can estimate gastric fluid volume, thereby identifying patients at higher risk for aspiration during induction.<sup>4</sup> Gagey et al.<sup>1</sup> conducted a prospective study showing that ultrasound-assisted assessments significantly improve the choice of induction technique compared to clinical assessment alone. Similarly, Bouvet L et al.<sup>2</sup> ultrasound reliably detected “at-risk stomach” profiles, allowing for tailored induction approaches in children undergoing elective and emergency procedures.

Given these advancements, this study aims to assess the influence of pre-operative gastric ultrasound on the choice of anesthetic induction technique in pediatric patients. By correlating ultrasound findings with gastric content obtained via nasogastric aspiration, this study evaluates the impact of ultrasound-guided assessments on induction choices, ultimately aiming to optimize anesthesia management and minimize aspiration risk in pediatric surgical patients.

## METHODOLOGY

**Study Design:** This study is a single-center observational study aimed at determining the impact of pre-operative gastric ultrasound examination on the selection of general anesthetic induction techniques in pediatric patients scheduled for surgery. The study was conducted over a six-month period from October 2021 to March 2022 at KLE’s Dr. Prabhakar Kore Charitable Hospital and Medical Research Centre, Nehru Nagar, Belagavi.

**Participants:** The study included pediatric patients aged 6 months to 16 years, classified as ASA physical status I or II, undergoing elective and emergency surgeries under general anesthesia. A sample size of 84 patients was calculated based on a prevalence of gastric fluid volume over 0.8 mL/kg at 67%, with a margin of error set at 15% (10.05%). Patients were recruited as per inclusion and exclusion criteria.

### Inclusion Criteria

- Patients or their guardians provided informed consent or assent.
- ASA physical status I and II.
- Patients aged between 6 months and 16 years.
- Patients scheduled for elective or emergency surgeries under general anesthesia.

### Exclusion Criteria

- Patients or guardians who did not provide consent.

- ASA physical status III and IV.
- Patients with known or anticipated difficult airways.
- Patients with contraindications to nasogastric tube insertion.
- Patients for whom ultrasound assessment was inconclusive.

**Ethical Approval:** Approval for the study was obtained from the hospital's institutional ethics committee. Written consent was obtained from the guardians of all participating patients or the patients themselves, depending on their age and level of understanding.

**Data Collection:** Upon arrival in the anesthetic preparation room, each patient underwent a routine pre-operative evaluation, followed by gastric ultrasound examination. The ultrasound examination was performed using a SonoSite M-Turbo (Fujifilm-USA, 100-240 VAC, 50/60 Hz input) fitted with a curvilinear probe (2-5 Hz). The gastric antrum was examined in both supine and right lateral positions to evaluate gastric contents.

**Ultrasound Technique and Grading:** A sagittal cross-section of the antrum was obtained to assess the contents. The Perlas grading system was used to evaluate gastric content volume:

- **Grade 0:** No gastric contents in either position.
- **Grade 1:** Fluid content visible only in the right lateral position.
- **Grade 2:** Fluid content visible in both the supine and right lateral positions.
- **Solid or thick fluid contents:** Defined as the presence of any solid contents or thick fluid in any position.

**Intervention Based on Ultrasound Findings:** Following the ultrasound, the induction technique was selected based on the risk categorization from the ultrasound findings:

- **Routine Induction:** Chosen for patients with minimal gastric content (Perlas Grade 0 or Grade 1).
- **Rapid Sequence Induction:** Used for patients identified as having a full stomach (Perlas Grade 2 or visible solid/thick fluid contents) to mitigate aspiration risk.

**Gastric Content Aspiration:** After the induction of anesthesia and endotracheal intubation, a nasogastric (NG) or feeding tube (size 6–10 FG based on patient size) was inserted. Correct placement of the NG tube was confirmed by auscultation of the stomach while injecting air. Gastric contents were then aspirated and categorized based on the volume and consistency.

**Risk Assessment of Gastric Contents:** The aspirated gastric contents were classified as “above risk threshold” if they contained more than 0.8 mL/kg of clear fluid, thick fluid, or visible solid contents. Contents below this threshold were considered to carry a low risk for aspiration.

**Outcome Measures:** Primary outcomes included the selection of induction technique (routine or rapid sequence induction) based on ultrasound findings. Secondary outcomes involved an evaluation of the volume and nature of aspirated gastric contents, correlating these findings with ultrasound results.

**Statistical Analysis:** Quantitative data were presented as mean  $\pm$  standard deviation, and qualitative data as median values. To test associations between categorical variables, Chi-square or Fisher's exact test was used. Continuous variables were analyzed using Student's t-test for

independent samples. The ANOVA test was employed where needed to evaluate differences across groups. A p-value of <0.05 was considered statistically significant.

## RESULTS

### Demographics and Baseline Characteristics

- **Age of Participants:** Participants ranged from 6 months to 16 years with a mean age of 7.03 years (SD = 3.78).
- **Weight:** Participants weighed between 6 kg and 54 kg.
- **Gender Distribution:** Out of the 80 participants, 33 were female (41.25%) and 47 were male (58.75%).

| Gender       | Number    | Percentage (%) |
|--------------|-----------|----------------|
| Female       | 33        | 41.25          |
| Male         | 47        | 58.75          |
| <b>Total</b> | <b>80</b> | <b>100</b>     |

- **Age Group Distribution:**

| Age (Years)  | Number    | Percentage (%) |
|--------------|-----------|----------------|
| 1 - 3        | 14        | 17.5           |
| 3 - 5        | 9         | 11.25          |
| 5 - 7        | 11        | 13.75          |
| 7 - 9        | 12        | 15.0           |
| 9 - 11       | 18        | 22.5           |
| >11          | 16        | 20.0           |
| <b>Total</b> | <b>80</b> | <b>100</b>     |

### Perlas Grading and Induction Technique

Perlas grading, which categorizes gastric fluid volume, was used to determine the induction technique (Routine or Rapid Sequence Induction, RSI).

| Perlas Grade | Induction Technique | Routine | RSI | Total | p-value | Inference |
|--------------|---------------------|---------|-----|-------|---------|-----------|
| 0            | Routine             | 42      | 1   | 43    | <0.0001 |           |

|              |         |           |           |           |                         |
|--------------|---------|-----------|-----------|-----------|-------------------------|
| 1            | Routine | 15        | 7         | 22        | Highly Significant (HS) |
| 2            | RSI     | 0         | 15        | 15        |                         |
| <b>Total</b> |         | <b>57</b> | <b>23</b> | <b>80</b> |                         |

The majority of patients with Perlas Grade 0 underwent routine induction, while those with Perlas Grade 2 underwent RSI.

The study demonstrated a significant association between Perlas grade and the choice of induction technique. Patients classified under Perlas Grade 0 were primarily managed with routine induction, reflecting their lower risk of gastric aspiration. Conversely, patients under Perlas Grade 2, who had larger or more solid gastric contents, required RSI to reduce the risk of aspiration, underscoring the utility of ultrasound in pre-operative evaluation.

### NG Tube Aspiration Content

Gastric content obtained through NG tube aspiration was classified as clear fluid, thick fluid, or nil. A significant association was observed between Perlas grade and NG tube content.

| Perlas Grade | NG Tube Content |             |           | Total     | p-value | Inference |
|--------------|-----------------|-------------|-----------|-----------|---------|-----------|
|              | Clear           | Thick Fluid | Nil       |           |         |           |
| 0            | 2               | 0           | 41        | 43        | <0.0001 | HS        |
| 1            | 15              | 5           | 2         | 22        |         |           |
| 2            | 7               | 0           | 8         | 15        |         |           |
| <b>Total</b> | <b>24</b>       | <b>46</b>   | <b>10</b> | <b>80</b> |         |           |

Patients with Perlas Grade 0 predominantly had nil gastric content, while Grades 1 and 2 showed higher proportions of clear fluid.

Clear fluid was most common in Perlas Grades 1 and 2, supporting the Perlas classification's effectiveness in predicting the nature and volume of gastric content. The significantly higher mean volume in Perlas Grade 2 patients further validated ultrasound's role in identifying high-risk patients who may benefit from RSI.

### NG Tube Aspiration Volume

The volume of aspirated gastric content was analyzed across different Perlas grades. ANOVA showed a highly significant difference in NG tube volume by Perlas grade.

| Perlas Grade | NG Tube Volume |        | Standard Deviation (SD) | p-value | Inference |
|--------------|----------------|--------|-------------------------|---------|-----------|
|              | Mean (mL)      | Volume |                         |         |           |
| 0            | 0.16           |        | 0.47                    | <0.0001 | HS        |
| 1            | 6.50           |        | 5.17                    |         |           |

|   |       |      |  |  |
|---|-------|------|--|--|
| 2 | 10.00 | 6.51 |  |  |
|---|-------|------|--|--|

The mean gastric content volume was significantly higher for Perlas Grade 2 compared to Grades 0 and 1.

The majority of patients were classified as below risk for aspiration, with only a subset requiring RSI based on the ultrasound findings. This stratification could enhance patient safety by tailoring anesthesia protocols to individual gastric content levels, thus preventing complications related to aspiration.

### Risk Assessment

Based on gastric content volume thresholds, participants were categorized into "High Risk" and "Below Risk" groups for aspiration.

| Risk Level   | Number of Participants | Percentage (%) |
|--------------|------------------------|----------------|
| Below Risk   | 63                     | 78.75          |
| High Risk    | 17                     | 21.25          |
| <b>Total</b> | <b>80</b>              | <b>100</b>     |

This methodology emphasizes the relevance of ultrasound in pre-operative assessment, which may contribute to improved patient outcomes through more informed selection of anesthetic techniques. Future studies could expand the sample size and evaluate long-term outcomes associated with ultrasound-guided anesthetic decision-making in pediatric patients.

## DISCUSSION

This study's results highlight the significance of gastric ultrasound as a pre-operative tool for assessing gastric content and volume in pediatric patients. By stratifying patients into risk categories, gastric ultrasound allows for more informed anesthetic induction choices, reducing the risk of aspiration. The findings align with existing literature on the benefits of using ultrasound to evaluate gastric status in pediatric anesthesia.

### Gastric Ultrasound and Induction Technique:

The significant association between Perlas grading and the choice of induction technique in this study suggests that ultrasound plays a critical role in guiding anesthetic decision-making. Specifically, patients with Perlas Grade 2 underwent rapid sequence induction (RSI), underscoring the method's utility for patients with higher gastric content volumes, potentially decreasing aspiration risk. Gagey et al. (1) also demonstrated that pre-operative ultrasound significantly improved the rate of appropriate induction techniques, verified by analysis of actual stomach contents. This suggests that ultrasound can offer a more reliable assessment than clinical evaluation alone, particularly in situations where a full stomach poses a high risk.

### Prevalence of 'At-Risk' Gastric Content:

The study identified a subset of patients as high risk due to significant gastric volumes, further validating ultrasound's ability to identify patients needing modified anesthesia protocols. Bouvet et al. (2) examined elective pediatric patients and found that while solid contents were absent, about 1% of patients had a high gastric fluid volume ( $>1.25$  mL/kg), classifying them as "at-risk." Although our study involved a smaller sample, the findings align with Bouvet et al.'s (5) observation that a considerable portion of emergency patients had full stomachs, emphasizing the predictive value of ultrasound, especially in emergent cases.

#### **Gastric Content Volume and Aspiration Risk:**

The significant differences in gastric volume among Perlas grades in our study ( $p < 0.0001$ ) further emphasize the importance of ultrasound in detecting varying gastric content volumes. High-risk patients displayed increased mean gastric fluid volumes, reflecting findings by Bouvet et al. (2), who showed that even in elective settings, certain patients exhibit "at-risk" stomach volumes. The ability to accurately assess this risk can facilitate timely interventions, supporting safer anesthesia practices. Notably, Desgranges et al. (6) observed that while intra-operative changes in gastric content were minimal, pre-operative ultrasound consistently identified patients with minimal gastric content, reducing aspiration risk during extubation.

#### **Practical Implications of Gastric Ultrasound in Pediatric Anesthesia:**

The practical application of gastric ultrasound as a non-invasive, reliable, and reproducible assessment tool is further supported by the fact that ultrasound examination was conclusive in nearly all cases in this study, mirroring findings by Gagey et al. (1). Given the broad range of ages and body weights in our sample, ultrasound provided an adaptable approach that could assess various gastric volumes effectively, suggesting its utility across pediatric age groups and case complexities.

#### **Comparison with Fasting Guidelines:**

Our study observed gastric content even after fasting, indicating that compliance with fasting guidelines does not always correspond to an empty stomach. This aligns with Bouvet et al. (2), who reported fluid contents in 3% of their fasting pediatric sample. Ultrasound can therefore provide a real-time assessment of fasting status, potentially reducing the reliance on standard fasting times and individualizing care for pediatric patients.

### **CONCLUSION**

This study demonstrates that gastric ultrasound is a valuable tool for pre-operative assessment of gastric content and volume in pediatric patients, aiding in the stratification of aspiration risk and guiding anesthetic induction technique. The significant association between higher Perlas grades and the use of rapid sequence induction (RSI) highlights ultrasound's role in enhancing patient safety by facilitating individualized care. Our findings reinforce existing literature, suggesting that despite adherence to fasting guidelines, pediatric patients may still present with "at-risk" stomach contents, which can be accurately identified through ultrasound.

By allowing for real-time, non-invasive evaluation of gastric status, gastric ultrasound provides a reliable approach to minimizing aspiration risk, particularly in diverse age and weight groups.

Implementing gastric ultrasound in routine pediatric anesthesia practice may thus reduce reliance on clinical assessments alone, support adherence to evidence-based anesthetic protocols, and potentially improve outcomes in both elective and emergency pediatric surgeries. Further research is warranted to explore its application across various surgical settings, including urgent cases where timely risk assessment is paramount.

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