

PAEDIATRICS

Ultrasound assessment of the gastric contents for the guidance of the anaesthetic strategy in infants with hypertrophic pyloric stenosis: a prospective cohort study

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Abstract

Background: Evacuation of gastric content through a nasogastric tube, followed by rapid sequence induction, is usually recommended in infants undergoing pyloromyotomy. However, rapid sequence induction may be challenging, and is therefore controversial. Some anaesthetists regularly perform classical non-rapid induction technique, after blind aspiration of the gastric contents, although this aspiration may have been incomplete. This prospective observational study aimed to assess whether the ultrasound monitoring of the aspiration of the stomach contents, may be useful to appropriately guide the choice of the anaesthetic induction technique, in infants undergoing pyloromyotomy.

Methods: Infants undergoing pyloromyotomy were consecutively included. Ultrasound assessment of the antrum was performed before and after the aspiration of the gastric contents through a 10 French gastric tube. The stomach was defined as empty when no content was seen in both supine and right lateral positions. The correlation between antral area and the aspirated gastric volume was also tested.

Results: We analysed 34 infants. Ultrasound examination of the antrum failed in three infants. The stomach was empty in 30/34 infants (nine before aspiration, 21 after aspiration), allowing to perform a non-rapid induction technique in 88.2% of the infants. There was a significant correlation between antral area measured in right lateral decubitus and the aspirated gastric volume.

Conclusions: Our results suggest that the qualitative ultrasound assessment of the antral content may be a simple and useful point-of-care tool, for the choice of the most appropriate anaesthetic technique for pyloromyotomy according to the estimated risk of pulmonary aspiration of gastric contents.

Key words: infant; anesthesia, general; stomach; pyloric antrum; ultrasound

Editor's key points

- Pulmonary aspiration is a potential risk in induction of anaesthesia for pyloromyotomy.
- Ultrasound measurement of gastric contents was used in pyloromyotomy to guide anaesthetic technique.
- Antral cross sectional area and gastric volume, in lateral decubitus position, were strongly correlated.
- Further studies are needed of ultrasound assessment of gastric volume in guiding anaesthetic technique.

Hypertrophic pyloric stenosis is one of the most frequent gastrointestinal diseases requiring surgery in infancy.¹ Because of potentially large gastric volume resulting from gastric outlet obstruction, infants with pyloric stenosis are considered as being at increased risk of pulmonary aspiration of the gastric contents when performing general anaesthesia for pyloromyotomy. Consequently, blind aspiration of the gastric contents through a gastric tube before induction of anaesthesia, followed by rapid anaesthesia sequence induction, are usually recommended in infants with pyloric stenosis.²⁻³

However, the systematic achievement of rapid sequence induction after the prior evacuation of the gastric contents remains controversial.²⁻³ In fact, rapid sequence induction is challenging in infants because of possible increased difficulty for tracheal intubation induced by cricoid pressure,⁴⁻⁵ and an increased risk of hypoxaemia after the 60 s period of apnoea.⁶⁻⁷ Thus, in clinical practice, various induction techniques are performed by paediatric anaesthetists, after pre-induction evacuation of the gastric contents has been done.²⁻⁸⁻¹⁰ However, in some infants, the residual gastric fluid volume may remain $>1.5 \text{ ml kg}^{-1}$ after blind gastric evacuation, leading to potential increased risk for pulmonary aspiration of the gastric contents if inappropriate induction technique is performed.¹¹

Ultrasound examination of the antrum is a non-invasive and easy-to-perform tool that may allow reliable assessment of the gastric contents in both adults and children.¹²⁻¹⁷ Particularly, the gastric fluid volume may be estimated by using a three-point grading system, based on the qualitative assessment of the antrum performed in supine and right lateral position.¹⁴⁻¹⁸ Furthermore, linear mathematical models were constructed in adults and in children, for the prediction of the gastric volume, according to the antral cross-sectional area measured in right lateral decubitus, and the patients' age, with R^2 ranging from 0.6 to 0.73.¹⁵⁻¹⁸ Thus, one can assume that the ultrasound examination of the antrum could be useful for ascertaining that the gastric contents was totally emptied from the stomach, during the preoperative gastric suction in infants undergoing pyloromyotomy, allowing then to undergo safe non-rapid sequence induction when appropriate.

The aim of this prospective observational study was to assess whether the ultrasound monitoring of the aspiration of the stomach contents may be useful to guide the choice of the anaesthetic induction technique in infants undergoing pyloromyotomy. The second aim of this study was to test the correlation between the measurement of antral area and the aspirated gastric volume in those infants.

Methods**Study design**

This prospective observational cohort study received approval (n°2012-043B) from the local ethics committee (Comité pour la

Protection des Personnes Sud Est III, Groupement Hospitalier Est, Lyon, Chairperson Prof. F Chapuis, on December 4th, 2012). This single site study was performed in our university hospital (Hôpital Femme Mère Enfant, Bron, France) from January to October 2013. Patients were recruited according to operators' availability (three physicians, MDQS, SC and CN, with a practice of at least 50 gastric ultrasounds). Parents received information about the study during the preoperative visit. They gave their written consent to the anaesthetist on arrival of their infant in the operating theatre.

Patients

All infants undergoing pyloromyotomy during the study period were consecutively included. Exclusion criteria were parental refusal and any contraindication to insert an oro-gastric tube. Once hypertrophic pyloric stenosis was diagnosed, the infant remained fasting, and an eight French enteral feeding tube (Enteral™, Maxter Catheters, Marseille, France) was inserted in order to provide passive draining of the gastric contents. Dehydration and electrolyte imbalance were corrected appropriately before surgical repair, which was performed the day after the diagnosis.

Ultrasound examination of the antrum

An ultrasound device (SonoSite S-Nerve™, Inc., Bothell, WA) fitted with a linear high-frequency transducer (probe HFL38, 10–13 MHz) was used to obtain a sagittal cross-section of the antrum, in a plane including the left lobe of the liver and either the aorta or the inferior vena cava, as previously described.¹⁵⁻¹⁶⁻¹⁹ All examinations were performed with the infant placed first in supine and then in right lateral decubitus position.

During each examination, qualitative assessment of the gastric antrum contents was performed. An 'empty' stomach was defined by the absence of any hypoechoic fluid contents seen in the antrum, in both supine and right lateral positions, corresponding to a grade 0 according to the Perlas's three-point grading scale.¹⁴ A 'full' stomach was defined by the visualization of hypoechoic fluid contents into the antrum, either in right lateral decubitus only, or in both supine and right lateral positions, corresponding to a Perlas grade 1 or 2, respectively.¹⁴

The calculation of the antral cross-sectional area was performed by measuring the longitudinal diameter (D1) and the antero-posterior diameter (D2) of the antrum between antral contractions, from serosa to serosa, using the following formula:

$$\text{Antral area} = (\pi \times D1 \times D2) / 4.$$

Protocol

A first ultrasound examination of the antrum, including qualitative assessment of the gastric content and measurement of the antral cross-sectional area, was performed at the arrival of the infant in the operating theatre. For all infants, the eight French enteral feeding tube was removed immediately after this first ultrasound examination, and a 10 French PVC multiorifice gastric tube (Salem Sump™, Covidien, Mansfield, MA, USA) was inserted. The gastric contents was gently aspirated, into 60-ml syringes, with the infant installed in supine and then in right lateral decubitus position, by a nurse not aware of the result of the first ultrasound assessment of the gastric contents. A second qualitative ultrasound examination of the antrum was performed

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