



Evaluation of Gastroesophageal Reflux in Children as a Risk for Post-operative Nausea and Vomiting: An Observational Study

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Abstract

Background: Anaesthesia is known to reduce gastric emptying and motility, which can cause gastroesophageal reflux (GER) in some patients. Monitoring pH is a reliable method for detecting reflux. In this study, we aimed to show whether GER is a risk factor for post-operative nausea and vomiting (PONV) with oesophageal reflux measures in paediatric patients undergoing laparoscopic appendectomy.

Methods: After obtaining approval from ethics committee, 55 paediatric patients were included. An oesophageal pH metre catheter was inserted through the nasal passage to 3 cm above the lower oesophageal sphincter. pH measurements were evaluated with DeMeester score. It was accepted as acid reflux if the score was >14.7. The patients' demographic data, history of GER and verbal descriptive scale (VDS) to assess PONV and pH values were analysed with Statistical Package for the Social Sciences (SPSS) version 21 (IBM SPSS Corp.; Armonk, NY, USA).

Results: Of the 55 patients, 41.8% were girls, 58.2% were boys, the mean age was 13.2 years, the mean fasting period was 7.47 hours and the mean operation time was 1.1 hours. Mean fasting and operation times did not differ statistically according to VDS. There was no significant association between VDS group and gender or pH. None of the patients had a history of GER. Thirteen patients had DeMeester score >14.7.

Conclusion: This is the first study about the relationship between gastric pH and PONV in paediatric patients. Although some studies have shown an association between anaesthesia and reflux, we detected reflux in nine of our patients and reflux was not statistically associated with PONV in our study. Further studies with larger patient groups are needed to provide a clearer opinion.

Keywords: Gastroesophageal reflux, post-operative nausea and vomiting, appendectomy

Introduction

Gastroesophageal reflux (GER) is defined as the involuntary passage of gastric contents into the oesophagus. It can be physiological in infants. When it causes undesirable symptoms or complications such as esophagitis, cough or respiratory system disorders, it is called GER disease (GERD).¹ Anaesthesia is known to reduce the rate of gastric emptying and motility.² Reduced gastric emptying and motility can cause GER in some patients. Although the patient's history and symptoms are of primary importance when diagnosing GER, detecting reflux in patients under general anaesthesia is a challenge. Monitoring pH is a reliable and objective method used for the detection of reflux and is achieved using pH metre or pH impedance measurements. For GERD diagnosis, the results obtained with these methods are assessed using various scoring systems. Commonly used pH scoring systems for GERD diagnosis in paediatric patients are the DeMeester, Boix-Ochoa and Johnson-DeMeester scores.³ DeMeester score measures acid exposure during prolonged pH monitoring. This score has six components and mainly it is about number and the duration of episodes of reflux (pH < 4). The validity of the DeMeester score is confirmed by threshold value of 14.7.⁴ If it is higher than 14.7 then GER can be considered.

Despite new anaesthetic techniques and antiemetic drugs, post-operative nausea and vomiting (PONV) is a common complication of anaesthesia, with an incidence rate of approximately 30%. It occurs more frequently in children, which are a high-risk group, and can also be more challenging to manage than in adults. Because

describing post-operative nausea can be difficult for children, publications have mainly focussed on post-operative vomiting.⁵

Various factors such as age, strabismus surgery, duration of surgery and history of PONV in the family that might be associated with PONV in children have been investigated.⁵ However, there are no studies in the literature about whether reflux is associated with PONV. The objective of the present study was to investigate the relationship between the development of GER and PONV in paediatric patients undergoing laparoscopic appendectomy.

Methods

After obtaining the approval of the Ethics Committee of Mersin University Clinical Research (Number: 78017789/050.01.04/E.45809), 55 patients who underwent laparoscopic appendectomy for acute appendicitis in the Mersin University Department of Pediatric Surgery were included in the study.

Inclusion criteria were being 2-18 years of age, American Society of Anesthesiologists (ASA) I-II patients, acceptance of the informed consent form (by parents) and undergoing laparoscopic appendectomy. Patients who were not within the target age range, who did not undergo laparoscopic appendectomy, having a congenital disease or syndrome and whose families did not provide informed consent were excluded from the study.

During preoperative evaluation, the families were asked to provide information regarding the presence of any comorbidities (eg, asthma, GERD) and fasting time. Prior to surgery, intravenous (IV) access was established using a 22- or 24-gauge cannula in the Department of Pediatric Surgery. Electrocardiogram, peripheral oxygen saturation and noninvasive blood pressure were monitored in the operating theatre. Anaesthesia was induced with IV 5 mg kg⁻¹ thiopental, 0.6 mg kg⁻¹ rocuronium and 2 µg kg⁻¹ fentanyl. Patients were ventilated through a mask for 3 minutes, then intubated

Table 1. Verbal Descriptive Scale

None	0
Mild nausea (gag once or twice per 30 minutes)	1
Moderate nausea (retching more than twice per 30 minutes)	2
Frequent vomiting (vomiting once or twice per 30 minutes)	3
Severe vomiting (vomiting more than twice per 30 minutes)	4

with endotracheal tube suitable for their age. Sevoflurane 2% and 50% N₂O+ 50% O₂ mixture were used to maintain anaesthesia. Hydration was provided with 10 mL kg⁻¹ h⁻¹ IV infusion of 3.33% dextrose and 0.3% sodium chloride (1/3 IZODEKS, Eczacıbaşı-Baxter, Turkey). Ventilation parameters were adjusted as tidal volume of 6-8 mL kg⁻¹ and positive end-expiratory pressure of 5 cm H₂O for target end-tidal CO₂ value of 38 ± 4 mm Hg.

Following endotracheal intubation, a pH metre catheter 180 cm in length and 2.1 mm in diameter was inserted nasally to 3 cm above the lower oesophageal sphincter by using Strobel formula (oesophageal length = 5 + 0.252 × length of the child) and confirmed with chest radiograph. The pH metre has two sensors, which allows to measure from both proximal and distal part of the oesophagus. Measurements were obtained by both the distal and proximal sensors of the pH metre, and the DeMeester score was calculated based on these values. DeMeester 1 reflects measurements taken from the proximal oesophagus and indicates that the reflux has reached the upper oesophageal sphincter. DeMeester 2 is calculated based on the pH value in the distal oesophagus. A DeMeester score >14.7 measured from either the distal or proximal end was accepted as acid reflux.

A data collection form prepared for this study was completed for each patient including their demographic data, fasting time, history of GER, Verbal Descriptive Scale (VDS) (Table 1) evaluating PONV and oesophageal pH values. In VDS scoring “Mild Nausea” means gag once or twice per 30 minutes, “Moderate Nausea” means retching more than twice per 30 minutes, “Frequent Vomiting” means vomiting once or twice per 30 minutes and “Severe Vomiting” means vomiting more than twice per 30 minutes. VDS scores were recorded within the first 30 minutes post-operatively. None of the patients included in the study had a history of GER.

All surgeries were performed by the same surgical team, so, the difference in surgical technique was excluded. The carbon dioxide insufflation pressures for laparoscopic surgery were set as hourly rate to be 3 and total pressure as 8 cm H₂O.

Intravenous paracetamol (10 mg kg⁻¹ h⁻¹) was given to patients in the beginning of the surgery for post-operative analgesia. Opioids were not used.

Main Points

- Post-operative nausea and vomiting are still a discomforting problem despite all the developments. And all the risk factors should be explained. Gastroesophageal reflux (GER) had not been studied as a risk factor for PONV before. In this study, GER was evaluated as a risk factor.
- Standardization of the study group is important; the surgery team, the type of anaesthesia and surgery and pressure limits were all standardised to increase the value of the study.
- GER is a common disease of gastrointestinal system, and indicating the correlation between GER and PONV which is a frequent complication of anaesthesia is noteworthy for the literature.

Antiemetic drugs were not used routinely in the study. Any antiemetic drug was given for prophylaxis. If severe nausea or vomiting were occurred in the post-operative period, ondansetron ($0.1 \text{ mg kg}^{-1} \text{ IV}$) was given to the patient.

Statistical Analysis

The data were recorded in Statistical Package for the Social Sciences (SPSS) version 21 (IBM SPSS Corp.; Armonk, NY, USA) software and evaluated in the Mersin University Faculty of Medicine, Department of Medical Informatics and Biostatistics.

GER is one of the most seen diseases of gastrointestinal system, and the prevalence is changed according to the population of the study. In adults, it is reported that GER prevalence is between 34 and 38%. Because of the anatomic and physiological properties, GER is more common in children. If the ratios of reflux during laparoscopic surgery are higher than 24 hour reflux periods, it is thought that laparoscopic surgery increases the number of reflux clinically relevant. In the light of this information, estimated necessary patient number with minimum 80% power and maximum 5% type I error is calculated as 55.

For continuous variables, mean, standard deviation and median values were given as descriptive statistics. Categorical variables were expressed as number and percentage. Normality of distribution was tested using Shapiro–Wilk test. Fasting and operative time showed non-normal distribution, and the nonparametric Kruskal–Wallis test was used to evaluate differences in their median values between the VDS groups. Differences in mean age between the same groups were analysed using the parametric analysis of variance. Chi-square analysis was performed to investigate the relationship between the categorical variables gender and DeMeester scores and the categorical variable VDS group. For all statistical comparisons, a P value $<.05$ was considered significant.

Results

Of the patients, 41.8% ($n = 23$) were female and 58.2% ($n = 32$) were male. The patients' mean age was 13.2 ± 2.9 years, their mean fasting time was 7.47 ± 1.03 hours and the mean operative time was 1.1 ± 0.46 hours. None of the participants had congenital or acquired diseases.

The patients' distribution according to VDS score is shown in Table 2. Severe vomiting developed in any patient is shown in Table 2. There were no significant differences between the VDS groups in terms of age, gender, fasting time and operative time ($P > .05$) (Table 3). There was no statistically significant correlation between pH and VDS group ($P = .384$).

Table 2. Distribution of the Patients According to VDS Score

VDS	N	%
0	23	41.8
1	15	27.3
2	14	25.5
3	3	5.5
4	0	0
Total	55	100

The pH monitoring lasted 24 hours but for this study, only intraoperative measurements were taken into account. DeMeester score was >14.7 in 23.6% ($n = 13$) of the patients. In 5.4% ($n = 3$) distal oesophagus readings (DeMeester 2) were >14.7 , and in 20% ($n = 11$) of the patients, both DeMeester 1 and DeMeester 2 were >14.7 . Distribution of patients with high DeMeester 2 or both DeMeester 1 and 2 scores by VDS group is shown in Table 4. The changes with table positions and insufflations/desufflation period were not significantly important.

Discussion

Although there was no history of preoperative reflux in the 55 patients included in the study, perioperative reflux was detected upon assessment in 23.6% ($n = 13$) of the patients. Of these, three patients had DeMeester 2 score >14.7 . In 11 patients, both DeMeester 1 and DeMeester 2 were >14.7 . These scores reflected intraoperative period.

There are many factors that can cause GER by altering perioperative gastric acidity. The most important of these factors is anaesthesia. Although anaesthesia has been shown to cause GER in animal studies, different results were obtained in human studies.⁶ In a 2016 study by Waasdorp Hurtado et al.,⁷ pH impedance measurements were taken to demonstrate the effect of anaesthesia on gastric pH in paediatric patients, but no significant results were obtained. In another study on this subject from 2015, it was shown that gastric motility was reduced after anaesthesia, but a definitive conclusion regarding reflux could not be reached.⁸ However, reflux was detected in perioperative assessment in our patients despite no history of reflux. This suggests that anaesthesia may be among the causes of perioperative reflux.

It is known that PONV may be caused by various risk factors such as age, preoperative fasting time, operative time, anaesthetic agents used and history of motion sickness.⁹ The reported incidence of PONV in paediatric patients is 33–82% in the literature,¹⁰ and the rate calculated in our study is close to this value. Less nausea and vomiting are seen in shorter operations (19 minutes). In our study, the mean

Table 3. Relationships Between age, Fasting Time and Operative Time and VDS Group

VDS	0		1		2		3		P
	n = 23		n = 15		n = 14		n = 3		
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	
Age (years)	13.21	2.96	12.06	3.55	11.78	4.29	13.0	3.46	.616
Gender									.237
Female	7		9		5		2		
Male	16		6		9		1		
Fasting time (hours)	7.47	1.03	7.46	1.59	7.64	1.27	7.33	0.57	.848
Operative time (hours)	1.11	0.46	1.08	0.32	1.39	0.48	1.33	0.57	.251

Table 4. Distribution of Patients with DeMeester > 14.7 According to VDS Group

VDS	Number	DeMeester		Total
		<14.7	>14.7	
0	n	19	4	23
	%	45.2	30.8	41.8
1	n	10	5	15
	%	23.8	38.5	27.3
2	n	10	4	14
	%	23.8	30.8	25.5
3	n	3	0	3
	%	7.1	0	5.5
Total	n	42	13	55
	%	100	100	100

operative time was 1.1 hours, which is a normal duration for laparoscopic appendectomy. However, no significant correlation was detected between operative time and VDS group. The incidence of post-operative vomiting is reported to increase with age (>3 years).¹⁰ But we found no significant correlation between age and VDS group. In 2012, Apfel et al.⁹ shown that female gender has high risk for nausea and vomiting in adult patients, and it has not been identified as a risk factor in paediatric patients. The relationship between gender and VDS group was not statistically significant in our study.

There are conflicting reports on the correlation between pre-operative fasting time and PONV in paediatric patients. Tudor-Drobjewski et al.¹¹ demonstrated that oral carbohydrate intake reduces the incidence of PONV in the paediatric age group. However, in a 2018 study, Schmidt et al.¹² concluded that there was no change in the incidence of PONV in children who fasted for 6 hours and were given clear fluid carbohydrate 2 hours preoperatively. In our study, the emergency status of our patients and long test periods

did not enable short preoperative fasting periods and administration of fluids 2 hours prior to surgery, which are part of our paediatric patient practice. Despite all of these negative factors that might affect PONV, no statistically significant difference was detected in our study between fasting time and VDS.

Almost all the reasons that cause PONV have been searching for many years, the effect of GER was not investigated as a risk factor for PONV. Evaluation of patients assessed as having perioperative GER using VDS revealed no significant correlation between reflux and PONV. Our study demonstrated that GER is not a significant risk factor for PONV.

Limitations of the Study

The sample size of the study could be larger but because of the device problem we collected only the data of 55 patients. Although we cared about the reliability of the study variables, the small size of the study group affected the outcomes. This study group had laparoscopic surgery, so increased intraabdominal pressure may be the cause of the reflux. Also, children with appendicitis can have reduced gastric emptying. The severity of acute appendicitis did not take into account but when we discuss with paediatric surgeons, they claimed that the severity does not make significant difference about reflux. The difference in pH monitoring due different table position or insufflation/desufflation period of CO₂ did not measure.

Conclusion

In this study, no significant correlation could be detected between GER detected via pH metre measurements during laparoscopic appendectomy and PONV, which was our primary aim. However, as there are no similar previous studies, we believe that this result is important. In addition, we also analysed various factors that may cause PONV such as gender, age, preoperative fasting time and discussed the

results. Although studies including larger sample sizes or using different reflux detection methods could yield different outcomes, we believe that this study focussing on the paediatric age group is valuable and will contribute to the literature.

Ethics Committee Approval: Ethical committee approval was received from the Mersin University Clinical Research (78017789/050.01.04/E.45809).

Informed Consent: Verbal informed consent was obtained from parents of the children who participated in this study.

Peer-review: Externally peer-reviewed.

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