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ORIGINAL ARTICLE

Gastric Ultrasound as a Predictor of Postoperative Vomiting in Pediatric Emergency Surgery: A Randomized Controlled Study.

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ABSTRACT

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Introduction: Postoperative nausea and vomiting (PONV) are common in pediatric surgery. This study compared peri-operative risk factors and gastric volume using ultrasound in pediatric traumatic and non-traumatic emergency surgeries. **Methods:** A double-blinded RCT at Aswan University Hospital included 50 patients (2-13 years) undergoing urgent surgery. Gastric ultrasound measured anteroposterior diameter (APD), craniocaudal diameter (CCD), and cross-sectional area (CSA) in supine and right lateral decubitus (RLD) positions. Risk scores for PONV were calculated, and data were analyzed using R software**. Results**: Traumatic cases (82%) showed lower risk scores than non-traumatic cases ($p<0.001$). In the RLD position, non-traumatic cases had higher APD ($p=0.03$). Pre-operative vomiting cases were older (10 vs. 5 years, $p=0.001$) and had higher risk scores ($p<0.001$). CCD was smaller in non-vomiting cases in the supine position ($p=0.011$). No significant differences were found in predicted gastric volume. **Conclusion:** Gastric ultrasound aids in assessing peri-operative risk in pediatric emergency surgery. Individualized risk assessment is crucial, particularly in traumatic cases and younger patients. Gastric ultrasound can help refine risk assessment and perioperative management strategies for pediatric emergency surgeries.

INTRODUCTION

Postoperative nausea and vomiting (PONV) are common complications after pediatric surgery and are often associated with pain. In view of the markedly increase in prevalence between pediatric patients, it is vital to discover the key PONV risk factors in order to enhance treatment approaches (1.)

In addition to its impact on patient well-being, PONV has been reported to affect both child and family satisfaction and sometimes cause statistically noteworthy resource usage, including prolonged hospital recovery time and unexpected hospitalization (2) Furthermore, serious medical complications may

occur, as aspiration, dehydration associated with electrolyte imbalance , post-operative bleeding, airway obstruction, increase in intracranial pressure and surgical sutures dehiscence. (3)

The technique of anesthetic induction also the airway management practices could vary between elective and urgent surgical procedures. Risk factors as trauma, opioid administration, and intra-abdominal procedures may challenge the usefulness of recommended NPO protocols and guidelines in having an empty stomach, aiming outcome free from preoperative vomiting and aspiration risks throughout typical induction procedures.(4)

Gastric ultrasound is a valuable non-invasive tool for assessing gastric content and volume in real time, helping predict postoperative vomiting and aspiration risk. Lots of previous studies have proved the efficacy of gastric ultrasound in assessing post-operative vomiting and aspiration risk then guiding the anesthetic practice decisions in pediatric patients experiencing both elective and emergency procedures (4) . Moreover, routine point-of-care ultrasound (POCUS) assessments have been revealed to modify anesthesia management strategies in trauma patients by exactly predicting the gastric volume and limit the risk of post-operative vomiting (5)

This study aims to evaluate and compare peri-operative risk factors in pediatric traumatic and non-traumatic surgical cases, with a specific focus on gastric volume assessments via gastric ultrasound measurements. Through identifying significant differences and correlations, this study aims to inform evidence-based perioperative management strategies. for pediatric patients undergoing emergency surgery.

PATIENTS AND METHODS

This study is derived from a double blinded randomized controlled (RCT) that was conducted in Aswan University hospital as a secondary analysis of a previous RCT.

The study enrolled pediatric patients aged 2-13 years who were scheduled for urgent surgery, defined as surgery that could not be postponed for more than 48 hours after clinical onset. Patients were divided into two groups: traumatic and non-traumatic surgical cases. Exclusion criteria included severely shocked patients, those with diffusely distended abdomens that could obstruct gastric ultrasound (US), patients with a history of hypersensitivity to famotidine, and those with hepatic or renal impairments.

All patients underwent gastric ultrasound assessments to evaluate gastric content and volume. The ultrasound measurements were taken in both the supine and right lateral decubitus (RLD) positions. The anteroposterior diameter (APD), craniocaudal diameter (CCD), and cross-sectional area (CSA) of the gastric antrum were measured. Predicted gastric volume (GV) was calculated based on these measurements.

Additionally, Data on patient demographics, surgical duration, pre-operative vomiting, and risk scores for post-operative nausea and vomiting (PONV) were collected. The risk scores were calculated based on factors such as age, duration of surgery, and type of surgery. The degree of risk was categorized as low, moderate, or high.

Analysis:

Analyses were conducted using the R Statistical language (version 4.1.2; R Core Team, 2021) on Windows 10 x64 (build 19045). The Kruskal. Test. function is used for non-normally distributed continuous data and is equivalent to Wilcox. Test when comparing two groups. For categorical data, we use the Chi-square test to compare categories when there are only two groups, while the Kruskal-Wallis Rank Sum Test is used for more than two groups. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Risk Factor for Vomiting and Scoring of Risk for Patients Undergoing Emergency Pediatric Surgery:

This table shows significant differences in the risk scores and degree of risk between traumatic and non-traumatic surgeries, with non-traumatic cases presenting a higher risk of vomiting. No significant differences were found for age, surgery duration, or pre-operative vomiting. The findings suggest that surgery type is a key factor in assessing vomiting risk.

Table 1 : Risk factor for vomiting and Scoring of risk for patients undergo emergency pediatric surgery

	Overall (n = 50)	**Traumatic** (n = 41)	**Non Traumatic** (n = 9)	p-value
Age (Years)	8.50 [5.00, 11.00]	8.00 [5.00, 11.00]	11.00 [7.00, 11.00]	0.647
Duration of Surgery (Min)	90.00 [60.00, 97.50]	90.00 [60.00, 90.00]	90.00 [60.00, 120.00]	0.359
Scoring of Risk	21.00 [13.00, 21.00]	21.00 [13.00, 21.00]	36.00 [21.00, 36.00]	**0.002**
Degree of Risk				**<0.001**
High risk	6 (12.0)	0 (0.0)	6 (66.7)	
Moderate risk	37 (74.0)	34 (82.9)	3 (33.3)	
Low risk	7 (14.0)	7 (17.1)	0 (0.0)	
Gender = male	41 (82.0)	33 (80.5)	8 (88.9)	0.908
Pre-operative Vomiting	33 (66.0)	26 (63.4)	7 (77.8)	0.663

Data presented, Median - [IQR] , n(%)

There was no significant difference between the Traumatic and non- Traumatic groups regarding the age or duration of surgery (p = 0.647 and p 0.359, respectively). Most patients had a moderate risk score (74%), while 12% had a high-risk score. Although two other risk factors were included, none of the 50 patients had a history of previous PONV or were predisposed to multiple opioid doses (**Table 1**).

Table 2: Type of Emergency Pediatric Surgery

Comment: Traumatic surgeries comprised 82% of the cases, with orthopedic fractures being the most common (46%). The table highlights the diversity in surgical types, with non-traumatic surgeries representing a smaller proportion (18%). Significant differences were observed in risk scores and degree of risk between traumatic and non-traumatic groups.

Table 2 : Type of emergency pediatric surgery		
Type of surgery	**surgery Category**	**N (%)**
Orthopedic fracture trauma	Traumatic	23 (46%)
Soft Tissue trauma	Traumatic	12 (24%)
Abdominal Surgery	Non Traumatic	9 (18%)
Neuro-eye Trauma	Traumatic	4 (8%)
Compartmental Syndrome	Traumatic	2 (4%)

Our study included 50 patients with a median age of 8.5 years, of which 41 (82%) were male. Traumatic surgeries made up 82% of the cases, with orthopedic fracture repair being the most common (46%), followed by soft tissue trauma (24%) (**Table 2**). Non-traumatic surgeries accounted for 9 cases (18%). There is significant difference in the risk score and degree of risk traumatic and non-traumatic surgery ($p = 0.02$ and $p < 0.001$, respectively).

Table 3: Gastric Ultrasound Measurement in Pediatric Patients by Surgery Category

In the supine position, no significant differences were found between traumatic and non-traumatic cases for APD, CCD, or CSA. However, in the RLD position, non-traumatic cases had a significantly higher APD ($p = 0.03$). Other measurements, such as gastric volume, did not show significant differences between the two groups.

Table3 : Gastric Ultrasound Measurement in Pediatric Patients by Surgery Category					
Position	Variables	Overall (n = 50)	Traumatic (n = 41)	Non Traumatic (n = 9)	p-value
Supine Position	APD	1.10 [0.90, 1.40]	1.10 [0.85, 1.40]	1.20 [1.10, 1.40]	0.34
	CCD	2.85 (0.54)	2.85 (0.56)	2.82 (0.47)	0.89
	CSA	2.64 (0.97)	2.62 (1.01)	2.73 (0.83)	0.78
RLD	APD	1.18 (0.25)	1.15 (0.25)	1.34 (0.24)	**0.03**
	CCD	2.95 [2.40, 3.30]	2.90 [2.50, 3.30]	3.00 [2.30, 3.20]	0.81
	CSA	2.62 (0.76)	2.55 (0.73)	2.94 (0.86)	0.16
	Predicted GV	104.85 (36.43)	101.03 (36.32)	122.29 (33.44)	0.11

Data presented Mean ± SD, Median - [IQR] , n(%)

In our study comparing traumatic and non-traumatic cases, we found that in the supine position, there were no significant differences between the two groups for anteroposterior diameter (APD), craniocaudal diameter (CCD), and cross-sectional area (CSA). However, in the right lateral decubitus (RLD) position, a significant difference was observed in APD ($p = 0.03$), with non-traumatic cases showing higher values. No significant differences were found in CCD, CSA, or predicted gastric volume (GV) in the RLD position. (**Table 3**).

Table 4: Risk Factor and Gastric Ultrasound Measurement in Patients Undergoing Emergency Pediatric Surgery by Pre-operative Vomiting

Non-vomiting patients were younger and had lower risk scores compared to vomiting patients, with significant differences observed. In the supine position, CCD was significantly smaller in non-vomiting cases. No significant differences were found in pre-operative gastric volume or RLD position measurements between the two groups.

Table4 : Risk factor and Gastric Ultrasound Measurement in the patients undergo emergency pediatric surgery by Pre-operative Vomiting

	Overall (n = 50)	**Vomiting** (n = 33)	**Non Vomiting** (n = 17)	p-value
Age (Years)	8.50 [5.00, 11.00]	10.00 [7.00, 12.00]	5.00 [3.00, 8.00]	**0.001**
Duration of Surgery (Min)	90.00 [60.00, 97.50]	90.00 [60.00, 90.00]	90.00 [60.00, 120.00]	0.438
Scoring of Risk	21.00 [13.00, 21.00]	21.00 [21.00, 21.00]	13.00 [13.00, 13.00]	**<0.001**
Degree of Risk				0.091
High risk	6 (12.0)	6 (18.2)	0 (0.0)	
Moderate risk	7 (14.0)	3 (9.1)	4 (23.5)	
Low risk	37 (74.0)	24 (72.7)	13 (76.5)	
Gender = male	41 (82.0)	28 (84.8)	13 (76.5)	0.732
Supine APD	1.10 [0.90, 1.40]	1.10 [0.91, 1.40]	1.10 [0.88, 1.30]	0.622
Supine CCD	2.85 (0.54)	2.98 (0.54)	2.58 (0.44)	**0.011**
Supine CSA	2.64 (0.97)	2.79 (0.99)	2.35 (0.89)	0.132
RLD APD	1.18 (0.25)	1.18 (0.29)	1.19 (0.18)	0.931
RLD CCD	2.95 [2.40, 3.30]	3.10 [2.50, 3.30]	2.70 [2.10, 3.00]	0.085
RLD CSA	2.62 (0.76)	2.71 (0.82)	2.45 (0.61)	0.243
Pre-Operative GV	104.85 (36.43)	100.32 (34.52)	113.65 (39.45)	0.224

Data presented Mean ± SD , Median - [IQR] , n(%)

In our study comparing Pre-Operative vomiting and non-vomiting cases, we found significant differences in several variables. non-vomiting cases were younger (median age 5 years) compared to vomiting cases (median age 10 years) with a p-value of **0.001**. The scoring of risk was also significantly different, with non-vomiting cases having a lower median score (13) compared to vomiting cases (21), and a p-value of less than **0.001**. No significant differences were observed in the duration of surgery, gender distribution, or pre-operative gastric volume. In the supine position, the craniocaudal diameter (CCD) was significantly smaller in non-vomiting cases (**p = 0.011**), while other measurements such as anteroposterior diameter (APD) and cross-sectional area (CSA) showed no significant differences. In the right lateral decubitus (RLD) position, no significant differences were found in APD, CCD, or CSA between the two groups. (**Table 4**).

DISCUSSION

Our present study aimed to compare gastric volume, risk scores, and pre-operative risk factors between traumatic and non-traumatic pediatrics emergency surgical cases and their relation to post-operative

vomiting as a common complication. Our study included 50 patients with a median age of 8.5 years, of which 41 (82%) were male. Traumatic surgeries made up 82% of the cases, with orthopedic fracture repair being the most common (46%), followed by soft tissue trauma (24%). Non-traumatic surgeries accounted for 9 cases (18%). There is significant difference in the risk score and degree of risk between traumatic and non-traumatic surgery ($p = 0.02$ and $p < 0.001$, respectively).

There was no significant difference between the Traumatic and non- Traumatic groups regarding the age or duration of surgery ($p = 0.647$ and p 0.359, respectively). Most patients had a moderate risk score (74%), while 12% had a high-risk score. In alignment to these findings,(6) found a PONV prevalence of 27% and 28% in children aged 1–12 and 13–24 months, respectively. Studies of children under 14 years of age found a sharp increase in PONV at 3 years of age (7) , with an increase of 0.2%–0.8% per year up to puberty (8) . (9) estimated an average PONV prevalence rate of 40% in children aged 3 years and older.

Although two other risk factors were included, none of the 50 patients had a history of previous PONV or were predisposed to multiple opioid doses. This is important factors to be considered as (10) and (7) reported that opioid administration during anesthesia induction is not by itself a risk factor for PONV, but the application of it is an important stimulus on the matter when opioids were re-applied at time of surgery or in the post-operative period. Consequently "multiple opioid dose" converts to be a single-important risk factor of PONV in the "VPOP-score" which was created by (10) , along with age (>3 and ≤13), time of anesthesia duration (>45 min), surgery procedures at risk like (tympanoplasty, tonsillectomy, and strabismus surgery), and the pre-disposition to any (previous personal history , previous motion sickness attaches ,positive familial history of any pre-disposing factor).

Besides, Operations that lasts (30 min) duration and anesthesia time over (45 min) have been recognized as possible risk factors in scoring PONV risks in children as (8) (10) proved. Also, the PONV prevalence rate could rise from (34% to 48%) (11) The cause could be the longer exposure to emetogenic substance (12)

In our study comparing traumatic and non-traumatic cases, we found that in the supine position, there were no significant differences between the two groups for anteroposterior diameter (APD), craniocaudal diameter (CCD), and cross-sectional area (CSA). However, in the right lateral decubitus (RLD) position, a significant difference was observed in APD ($p = 0.03$), with non-traumatic cases showing higher values. No significant differences were found in CCD, CSA, or predicted gastric volume (GV) in the RLD position.

These findings are in line with previous study representing that gastric content distribution varies with patient positioning and how it can affect ultrasound measurements of the antrum (13) . (5) also confirmed that the antral CSA is more surely evaluated in the RLD position in comparison to the supine position, signifying that gravitational effects boost the sensitivity of gastric volume estimation.

Moreover, a study done by (4) reported that the RLD position delivers a more accurate assessment of gastric content, mostly in emergency situations where fasting status is undefined. Their conclusions

support the concept that variances in antral measurements between traumatic and non-traumatic cases could be related to variations in stress-related gastric motility or to delayed emptying due to opioid use. In the same way, (14) described that in case of emergency surgery, patients had a more prevalence of high gastric volume, that accentuate the need for detailed peri-operative ultrasound assessments to evaluate possible vomiting risks.

Despite differences in APD in the RLD position, CCD, CSA, and GV showed no significant differences. This aligns with conclusions by (15), who highlighted that despite the fact that gastric volume assessment models are useful, they should be taken in conjunction with qualitative ultrasound results for better risk stratification. Moreover, (16) emphasized that while the RLD position is perfect for volume assessment, variances in antral measurements may not constantly associate with an increased risk of aspiration, predominantly in pediatric patients.

In our study comparing Pre-Operative vomiting and non-vomiting cases, we found significant differences in several variables. non-vomiting cases were younger (median age 5 years) compared to vomiting cases (median age 10 years) with a p-value of **0.001**. These findings align with previous study showing that younger pediatric patients often show faster gastric emptying and lower gastric volumes preoperatively, dropping their possibility of perioperative nausea and vomiting (PNV) (14)

The scoring of risk was also significantly different, with non-vomiting cases having a lower median score (13) compared to vomiting cases (21), and a p-value of less than **0.001**. No significant differences were observed in the duration of surgery, gender distribution, or pre-operative gastric volume. In the supine position, the craniocaudal diameter (CCD) was significantly smaller in non-vomiting cases (**p = 0.011**), while other measurements such as anteroposterior diameter (APD) and cross-sectional area (CSA) showed no significant differences. In the right lateral decubitus (RLD) position, no significant differences were found in APD, CCD, or CSA between the two groups.

This supports findings by (15), who verified that differences in CCD might reflect changes in gastric accommodation and motility. A comparable study by (17) start that while overall gastric volume did not vary significantly between patients with delayed gastric emptying predisposing factors (DGEF) and those without, antral CSA and CCD measurements varied, suggesting altered gastric motility and compliance in higher-risk patients.

Furthermore, the absence of significant differences in APD, CSA, or predicted gastric volume (GV) between vomiting and non-vomiting cases in the right lateral decubitus (RLD) position is constant with findings from (4) .Their study noted that while variations in antral diameter can be position-dependent, overall gastric emptying dynamics remain constant across patient clusters with different vomiting tendencies. (14) further has added proof to an account this by representing that RLD positioning increases imagining of gastric content but not essentially interpret to differences in gastric volume between high- and low-risk groups.

The clinical implications of these findings support the importance of individualized risk assessment policies in perioperative stage management. Granting that preoperative vomiting is a multifactorial situation —including surgery type, patient age, the opioid administration, and stressful conditions

specially at time of emergency—ultrasound-based measurement tools present valuable insights into gastric motility forms and risk stratification patterns. Certain the significant differences detected in age and risk scores between specific patient groups, upcoming studies should see the sights whether specific medical prophylactic interventions, as antiemetic prophylaxis or adapted fasting protocols, can improve perioperative clinical outcomes specially in high-risk pediatric patients.

We hypothesize that gastric ultrasound can identify differences in gastric volume and risk factors between traumatic and non-traumatic pediatric emergency surgeries, thereby improving risk stratification for postoperative vomiting.

Study limitations:

- Small sample size (n=50) may limit generalizability.

- Lack of control for opioid doses and preoperative fasting durations.

CONCLUSION

This study suggests that gastric ultrasound could be integrated into perioperative assessment protocols to refine risk stratification in pediatric emergency surgery. Larger studies are needed to validate gastric ultrasound's predictive value for PONV.").

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