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Semi-sitting position enhances gastric emptying of clear fluids in children: A randomized controlled trial

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ABSTRACT

Background: Enhancing gastric emptying would allow more liberal preoperative fasting guidelines in children. We evaluated the impact of semi-sitting position on gastric emptying of clear fluids compared to regular supine position in children.

Methods: A randomized controlled trial included 30 fasting children aged between 4 and 16 years old. Gastric ultrasound was performed to evaluate the antral cross sectional area. Baseline measurements were obtained. After receiving oral apple juice (200 mL), participants were randomized into either supine group (n = 20) or semi-sitting group (n = 10). Serial ultrasound measurements of the antral cross sectional area were conducted every 30 min till complete evacuation of the stomach. The primary outcome was the number of children whom stomach returned to the baseline measurement (denoting complete gastric emptying) after 30 min. Other outcomes included antral cross sectional area and hunger satiety score.

Results: After 30 min of fluid ingestion, 40% of the semi-sitting group showed complete gastric emptying; whilst, none of the children in the supine group showed complete gastric emptying after the same period (P = 0.008). Hunger satiety score increased in both groups after fluid ingestion; however, the duration of high hunger satiety score was shorter in the semi-sitting group.

Conclusion: Semi-sitting position enhances gastric emptying of clear fluids in fasting children compared to supine position.

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1. Introduction

Dealing with preoperative fasting requires a meticulous balance between conservative approach which ensures patient safety and liberal approach which minimizes patient's discomfort. Although fasting is a basic requirement for avoiding pulmonary aspiration [1,2], it is usually associated with patient hypoglycemia and dis-satisfaction [3,4]. According to the current guidelines for preoperative fasting of children, fasting is required for 2-h, 4-h, and 6-h period after ingestion of water, breast milk, and infant formula, respectively, [5]. There is a continuous trend towards more liberal fasting regimens for more patient satisfaction [6]. Gastric ultrasound had extensively contributed in recent developments in fasting guidelines because it is accurate and non-invasive [7,8]. Gastric ultrasound had been validated in adults and children for estimating the volume of gastric contents and evaluating gastric emptying [8,9]. Keeping patients in semi-sitting position might provide faster gastric emptying which might impact the preoperative fasting guidelines to be more liberal. The available data for the impact of patient positioning on gastric emptying are limited and controversial; most of these data were focusing on adults [10–13]. No evidence is available for the effect of semi-sitting position on gastric emptying in children. The aim of this work is to evaluate the effect of semi-sitting versus supine positions on gastric emptying of clear fluids in children.

2. Methods

A randomized controlled study was conducted in pediatric surgical department, Cairo university hospital after institutional research ethics committee approval (N-92-2018). The study was registered prior to patient enrollment at clinicaltrials.gov registry system (NCT03747796, principal investigator: Ahmed Hasanin, date of registration: 20 November 2018). The study was conducted from November 2018 till January 2019. Written informed consent was obtained from patient guardians. An online random number generator was used to create patient codes in a ratio 1:2. Patient codes were placed into sequentially numbered sealed opaque envelopes by a resident who was not involved in the study. The envelope was opened by a research assistant after obtaining the parent approval to participate in the study.

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The study was registered at clinical trials registry system on 20 November 2018 (Identifier: NCT03747796).The URL address: https://clinicaltrials.gov/ct2/show/NCT03747796?cond=NCT03747796&rank=1

Children, four to 16 years of age, fasting for elective surgery were included. Children with recent gastroenteritis, children with recent abdominal operations, and children with major systemic diseases that affect gastric emptying (e.g., Kidney and hepatic diseases) were excluded from the study.

Children were randomized into one of two groups: supine group (n = 20), and semi-sitting group (n = 10); patients in the later group were kept in a semi-sitting position at 45 degree using hospital stretcher trolley. Gastric ultrasound was performed before fluid ingestion in the supine position to obtain baseline records. A standard volume of 200 mL apple juice was ingested; then, the patient was allocated into one of the two groups. Gastric ultrasound scanning was repeated 5 min after apple juice ingestion, and was then repeated every 30 min for 3 h or till restoring the baseline measurements. None of the participants had received any pre-medication.

2.1. Ultrasound examination

Gastric ultrasound was performed by a well-trained anesthesiologist using a Curvilinear 4 MHz probe (SONOSITE – M TURBO model-FUJIFILM). Ultrasound examination was performed in the supine position in the two study groups. Children in the semi-sitting group were returned to their assigned position after completion of the examination. The probe was placed perpendicularly to obtain a cross-sectional view for the gastric antrum. gastric antrum was visualized in the sagittal plane at the level of the descending abdominal aorta between the pancreas and the left lobe of the liver. No images were obtained during peristaltic movements (defined as transient decreases in the diameter of gastric antrum). Images were saved and cross-sectional area of gastric antrum was measured independently by another anesthesiologist who was blinded to the study group. The two orthogonal diameters of gastric antrum (D1 and D2) were measured and the cross sectional area was calculated according to the standard formula for surface area of an ellipse (area of ellipse = D1 × D2 × π/4) [8]. Each measure was obtained two times and their average was used in analysis.

2.2. Outcomes

2.2.1. Primary outcome

Our primary outcome was the proportion of children who have complete gastric emptying 30 min after fluid ingestion (complete gastric emptying was defined as return of the antral cross sectional area to the baseline reading).

2.2.2. Secondary outcomes

Antral cross-sectional area corrected to the body weight (antral cross sectional area divided by the body weight): it was measured at the baseline, 5 min after fluid ingestion, and every 30 min for 3 h or till reaching total gastric emptying.

Proportion of children who have complete gastric emptying 30 min, 60 min, 90 min, and 120 min after fluid ingestion.

Hunger satiety score (a score ranging from zero to five where higher scores denote more satiety) [14] was measured at the baseline and then every 30 min for 3 h.

2.3. Statistical analysis

The primary outcome is the proportion of children with complete gastric emptying after 30 min. In a pilot study, the proportion of children with complete gastric emptying after 30 min in the supine position was 0%. Our intervention aimed to increase the proportion of children with complete gastric emptying to 50% at least. Sample size was calculated using G power software (version 3.1.9.2). We took into consideration that keeping a child in the semi-setting position is relatively not easy; thus, we used a ratio of 2:1 between the supine group and the semi-sitting group. The minimum number needed was been 30 children (10 patients in the semi-sitting group and 20 patients in the supine group) to have a study power of 80% and alpha error of 0.05. We increased the number by 20% to 36 children to compensate for expected dropouts.

Statistical package for social science (SPSS) software, version 15 for Microsoft Windows (SPSS Inc., Chicago, iL, USA) was used for data analysis. Categorical data were expressed as frequency (%). Continuous data were tested for normality using Shapiro-Wilk test and were presented as either mean (standard deviation) or median (quartiles) as appropriate. Categorical data were analysed using chi-squared test or fisher's exact test as deemed appropriate. Continuous data were analysed using student t-test (for normally distributed data) and using Mann Whitney test on ranks (for skewed data). We used separate generalizes estimating equation (GEE) models to assess the effect of each position on the antral cross sectional area and HSS, the models assumed an exchangeable working correlation structure, and robust standard errors were used. The estimate was adjusted for time, age, and sex for analysis of the antral cross-sectional area. The estimate was adjusted for time, age, sex, and weight for analysis of the HSS. The time was modelled as a categorical variable to assess each time point in relation to baseline. A P value of ≤ 0.05 was considered statistically significant.

3. Results

Forty-four patients were screened for eligibility; eight patients were excluded for not meeting our inclusion criteria, and thirty-six patients were randomized. Six children did not complete the intervention and thirty children completed the intervention and were available for final analysis (Figure 1). Patients in both groups were comparable with regard to demographic data and baseline characteristics (Table 1). Ultrasound examination needed average 3–4 min in all participants.

The baseline antral cross-sectional area (corrected to the body weight) was comparable between both groups. The effect of the semi-sitting position on the antral cross-sectional area in comparison to the supine position during the overall time period were comparable (GEE *P* value = 0.856). The antral cross-sectional area increased in all patients after fluid ingestion. However, the antral cross-sectional area returned to be comparable compared to the baseline reading at 90 min in the semi-setting group versus 120 min in the supine group. Furthermore, in the semi-sitting group the antral cross-sectional area became significantly lower than the

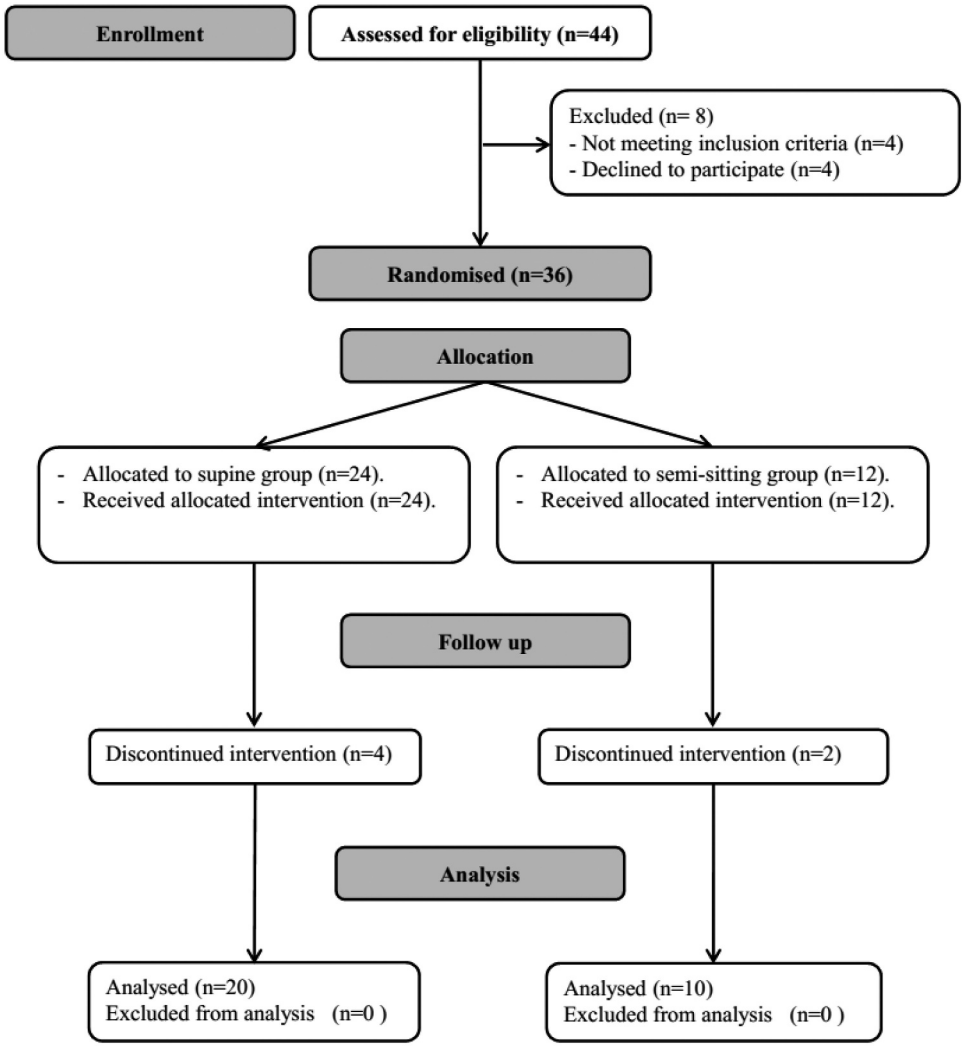

Figure 1. Flow chart showing patient recruitment.

Table 1. Demographic data. Data are presented as mean (standard deviation) and frequency (%).

	Supine group (n = 20)	Semi-sitting group (n = 10)	P value
Age (years)	7 (2.2)	8.7 (2.3)	0.07
Male gender (%)	13 (64%)	4 (40%)	0.3
Weight (Kg)	24 (8)	27 (6)	0.3
Height (cm)	76 (27)	98 (33)	0.07
Race			
-Caucasian race	-17 (85%)	-8 (80%)	1
-Black race	-3 (15%)	-2 (20%)	

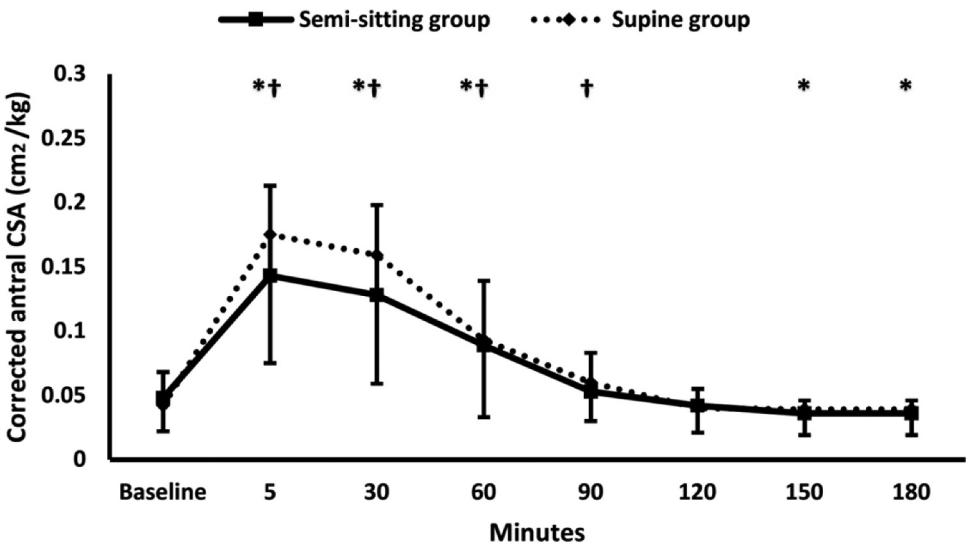

Figure 2. Antral cross sectional area (corrected to the weight). CSA: cross sectional area. * denotes significance compared to the baseline reading within the semi-sitting group. † denotes significance compared to the baseline reading within the supine group.

Table 2. Incidence of complete gastric emptying after 30, 90, and 120 min. Data are presented as frequency (%).

	Supine group (n = 20)	Semi-sitting group (n = 10)	P value
Number of patients with complete gastric emptying in 30 min (%)	0 (0%)	4 (40%) *	0.008
Number of patients with complete gastric emptying in 60 min (%)	6 (30%)	6 (60%)	0.14
Number of patients with complete gastric emptying in 90 min (%)	17 (85%)	9 (90%)	1
Number of patients with complete gastric emptying in 120 min (%)	17 (85%)	9 (90%)	1

* denotes statistical significance.

Table 3. Hunger satiety score. Data are presented as median (quartiles).

	Supine group (n = 20)	Semi-sitting group (n = 10)	P value
Baseline	1 (1–2)	2 (1–2.25)	0.2
After fluid administration	4 (4–5) *	4 (3–4.25) †	0.18
30 min	4 (3–5) *	3.5 (3–4.25) †	0.2
60 min	3 (2–4) *	3 (2–4) †	0.8
90 min	2 (1–2.75) *	3 (2–3.25) †	0.09
120 min	2 (1–2)	1.5 (1–3.5)	0.96
150 min	2(2–2)	1.5 (1–2)	0.4

*denotes significance compared to the baseline reading within the supine group. †denotes significance compared to the baseline reading within the semi-sitting group.

baseline reading at 150 and 180 min (Figure 2). The frequency of patients with complete gastric emptying after 30 min was higher in the semi-sitting group compared to the supine group {4(40%) versus 0(0%), P value = 0.008} (Table 2).

The effect semi-sitting position in relation to supine position on the HSS during the overall time period was comparable (GEE *P* value = 0.281). The HSS was higher than the baseline measurement in both groups at 5 min, 30 min, 60 min, and 90 min after juice ingestion, then it became comparable to the baseline measurement (Table 3).

4. Discussion

We found that gastric emptying of clear fluids was enhanced in the semi-sitting children compared to the supine children. This was more evident in the first 30 min where 40% of the semi-sitting children showed complete gastric emptying; whilst, none of the supine children showed complete gastric emptying during the same period. To the best of our knowledge; this is the first randomized controlled trial that investigate the impact of semi-sitting position on gastric emptying in children using the ultrasound.

The current evidence for the impact of gravity on gastric emptying is conflicting. Few reports were conducted in adults, and none in children. In line with our findings, Anvari et al. reported that gastric emptying of radiolabeled normal saline is faster in sitting position compared to left-lateral position in seven healthy adults [10]. Spiegel et al. had reported that gastric emptying was faster in sitting position compared to supine position in nine adult women [11]. Whilst, other authors had demonstrated different results. Doran et al. had reported that sitting position had no impact on gastric emptying of solid meal in eight volunteers [12]. Horowitz et al. had reported that gravity had little impact on oil emptying in 11 volunteers [13]. The only available report for the effect of positioning on gastric emptying in children was conducted by Da Silva et al. who demonstrated that gastric emptying is retarded in left lateral position compared to right lateral position in infants aged less than 2 years [15]. No studies had evaluated sitting nor semi-sitting groups in comparison to supine position.

In our study; the hunger satiety score increased after fluid ingestion (denoting higher satiety) in both groups. However, the score remained high for a longer period (4 time points: 5 min, 30 min, 60 min, and 120 min) within the supine group compared to the baseline value; whilst,

the duration of increased satiety was shorter within the semi-sitting group compared to its baseline value (Only 3 time points: 5 min, 30 min, and 60 min). This denotes that enhancement of gastric emptying in the semi-sitting position was associated with decreased duration of patient satiety after fluid ingestion. This finding is supported by previous studies which showed an interaction between gastric emptying and satiety [13,16].

Our study had the advantage of using gastric ultrasound which is reliable and non-invasive. Gastric ultrasound had shown promising results in the last years which would impact the future guidelines of preoperative fasting. Our study had also the advantage of adequate sample size compared to most of the previous studies which included 7–11 patients [10–13].

No data are available for the exact gastric residual volume which carries the highest risk for aspiration. Although a volume of 1.5 mL/Kg was previously suggested by Van De Putte and Perlas to be a probable high-risk volume, the same authors had recently debated this volume [17]. Thus, we used a solid conservative primary outcome in our study which is the proportion of children with complete gastric emptying after 30 min. We used the corrected antral cross sectional area to the weight of the participants to have fair comparison between children of different ages.

Our findings provide new insights towards modification of fasting guidelines. Pre-operative fasting is one of the essential requirements during perioperative patient optimization; however, the longer the fasting period, the more the patient stress and dissatisfaction. This patient dis-satisfaction is more evident in children. Thus, finding novel methods for minimizing preoperative fasting hours would increase patient satisfaction as long as the patient safety is not compromised. There had been a continuous trend for liberal preoperative fasting protocols [6]. The classic two-hour fasting period for clear fluids had been recently debated favouring shorter, one-hour fasting period [6]. Our findings suggest that keeping the patient in semi-sitting position might promote complete gastric emptying for clear fluids in 30 min in nearly 40% of patients. Our findings also might be helpful in emergency operations in which patients are operated without completion of the standard fasting hours. Children scheduled to emergency operations might benefit from the semi-sitting position if possible; however, we should clarify that our study was conducted in an elective and not emergency situation. Finally, we recommend further studies which replicate our findings in adults; this might provide a supplementary method for more liberal preoperative fasting guidelines.

Our study had some limitations: 1 – It is a single center study which needs to be confirmed by larger studies. 2 – Most of our patients were Caucasians; thus, extrapolation of our findings in other population needs more research. 3 – We excluded patients with gastrointestinal motility disorders. 4 – We evaluated the gastric emptying of clear fluid. 5 – Keeping a child in the semi-sitting position for a long time was not easy; thus we calculated our sample size with a ratio of 1:2 between semi-sitting and supine position. 6 – The findings need to be confirmed in larger studies.

In conclusion, semi-sitting position might enhance the gastric emptying of 200 mL of clear fluid in fasting children compared to supine position. Larger studies are warranted to confirm this finding.

Disclosure statement

No potential conflict of interest was reported by the authors.

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