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Main Article

The effect of pharyngeal packing on gastric volume in patients undergoing nasal surgery: a randomised, controlled trial

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Abstract

Objective. To explore the effects of pharyngeal packing on antral cross-sectional area, gastric volume and post-operative complications.

Methods. In this prospective, randomised, controlled study, 180 patients were randomly assigned to a control group or a pharyngeal packing group. Gastric antral dimensions were measured with pre- and post-operative ultrasound scanning. Presence and severity of post-operative nausea and vomiting and sore throat were recorded.

Results. Post-operative antral cross-sectional area and gastric volume were significantly larger in the pharyngeal packing group compared to the control group. The incidence and severity of post-operative nausea and vomiting were significantly less in the pharyngeal packing group. More frequent and severe sore throat was observed in the control group within the ward. An increased Apfel simplified risk score and post-operative antral cross-sectional area were associated with post-operative nausea and vomiting during the first 2 hours, whereas septorhinoplasty and functional endoscopic sinus surgery, absent pharyngeal packing, and lower American Society of Anesthesiologists' physical status were associated with post-operative nausea and vomiting within the ward.

Conclusion. Regardless of operation type, pharyngeal packing use resulted in smaller gastric volume, which was associated with reduced post-operative nausea and vomiting frequency and severity, and lower sore throat incidence.

Introduction

Well-vascularised mucosa of the nasal cavity and paranasal sinuses may lead to considerable bleeding during nasal surgery.[1] If drainage of the blood into the digestive tract is not prevented, this may increase the incidence of post-operative nausea and vomiting and the risk of aspiration.[2,3] In order to eliminate blood ingestion, pharyngeal packing is widely used to create a physical barrier in nasal surgery.[4,5] Although studies have investigated the role of pharyngeal packing in nasal surgery for its effect on post-operative nausea and vomiting incidence and severity,[4–8] its effect on gastric volume[9] has not been adequately explored.

Ultrasound scanning is used to evaluate gastric content and volume, to assess the risk of aspiration peri-operatively.[9,10] If pharyngeal packing acts as a protective barrier for the aerodigestive tract, gastric ultrasound imaging would give information about gastric volume change due to blood ingestion. Our aim was primarily to investigate the effects of pharyngeal packing on the antral cross-sectional area in particular, and hence gastric volume, by ultrasound scanning, and secondarily to investigate the effects on post-operative nausea and vomiting and sore throat.

Materials and methods

Following institutional ethics committee approval (number: 2020/1421) and written informed consent from patients, the current prospective, randomised, controlled study was conducted between January 2021 and September 2021, and registered prospectively to ClinicalTrials.gov (registration number: NCT04819659).

Patients requiring general anaesthesia for elective nasal surgery were included, with homogeneous numbers in terms of surgical indications (septoplasty, septorhinoplasty, and functional endoscopic sinus surgery (FESS) for chronic rhinosinusitis with or without nasal polyps). Exclusion criteria were: age of less than 18 years, American Society of Anesthesiologists' physical status classification of higher than III, pre-operative vomiting or anti-emetic drug therapy, intubation requiring more than two attempts, body mass index (BMI) of more than 30 kg/m^2, coagulation disorders or diseases, and conditions affecting gastric volume or motility.

Patients received no pre-medication. They were randomised using a computer-generated random number sequence into one of two groups: a control group (who received no pharyngeal packing) or a pharyngeal packing group. Pharyngeal packing was applied following endotracheal intubation, using a soft, wet 20 × 45 cm gauze sponge placed in the hypopharynx with gentle manoeuvres to avoid injury to the soft palate; the tag end was fixed on the cheek with a plaster.

Anaesthesia was induced with intravenous propofol 2–2.5 mg/kg, fentanyl 1 μg/kg, with rocuronium 0.6 mg/kg administered to facilitate intubation. All patients were intubated via a reinforced, appropriately sized endotracheal tube, and the cuff was inflated within a limit of cuff pressure at 25 cmH_2O. Anaesthesia was maintained using nitrous oxide in oxygen (50 per cent oxygen) and sevoflurane (0.8 minimum alveolar concentration) accompanied by remifentanil infusion. All patients received intravenous dexamethasone 8 mg, ranitidine 50 mg, tenoxicam 20 mg and paracetamol 1 g; no prokinetic or anti-emetic drugs were administered intra-operatively. At the end of the surgery, atropine 0.5 mg and neostigmine 1.5 mg were administered to reverse neuromuscular blockade. All operations were performed by the same surgical team. Patients were observed for 2 hours in the post-operative recovery room (post-anaesthesia care unit) and then transferred to the ward. Oral intake of clear fluids was allowed at 4 hours at the earliest after recovery from general anaesthesia.

The same experienced anaesthesiologist performed gastric ultrasound imaging (GE Healthcare Logiq™ e system), with a low-frequency curvilinear probe (2–5 MHz), in all patients, who were positioned in the right lateral decubitus position (Figure 1a), at two time points. The first assessment was conducted before anaesthesia induction (Figure 1b), and the second was performed before removal of the pharyngeal packing, following the completion of surgery (Figure 1c).

Gastric ultrasound imaging was executed as follows. The antrum was visualised in a parasagittal plane, just right of the midline, in the epigastric area, between peristaltic contractions. Imaging of the left lobe of the liver, abdominal aorta and superior mesenteric artery were used as internal landmarks. The maximal anteroposterior diameter and cranio-caudal diameter of the gastric antrum were measured from ‘serosa to serosa’ on the frozen image. Subsequently, the antral cross-sectional area was calculated using the formula proposed by Perlas *et al.*,[11] as follows: antral cross-sectional area = (anteroposterior diameter × cranio-caudal diameter × 3.4) / 4. After calculating the antral cross-sectional area, gastric volume was determined based on a linear model reported by Perlas and colleagues,[12] as follows: gastric volume (ml) = 27.0 + 14.6 × right lateral cross-sectional area (cm^2) − 1.28 × age.

Demographic data, post-operative nausea and vomiting risk (estimated using the Apfel simplified risk score[13]), operation type and duration, and suctioned blood volume (irrigation fluids were extracted from total volume measured visually on the cannister) were recorded.

The severity of post-operative nausea and vomiting was evaluated using Korttila’s scale:[14] no nausea or vomiting (0 points); mild post-operative nausea and vomiting (1 point) (defined as vomiting or nausea of any severity for less than 10 minutes, triggered by drinking, eating or movement); moderate post-operative nausea and vomiting (2 points) (defined as two vomiting episodes or moderate or severe nausea not brought on by a stimulus or single use of anti-emetic medication); and severe post-operative nausea and vomiting (3 points) (defined as three or more vomiting episodes or multiple use of anti-emetic medication). Moderate post-operative nausea and vomiting was treated with metoclopramide 10 mg, whereas severe post-operative nausea and vomiting was treated with granisetron 3 mg.

The severity of sore throat was evaluated using the following qualitative indices: no pain (0 points), mild pain (1 point), moderate pain (2 points) and severe pain (3 points). Patients with severe sore throat were given paracetamol.

Patients were followed up to determine the presence and severity of post-operative nausea and vomiting and sore throat. Data were recorded post-operatively at 2 hours (in the post-anaesthesia care unit) and at 24 hours (in the ward).

Statistical analysis

As the number of studies related to gastric antral cross-sectional area are limited, we chose a median effect size of Cohen’s D 0.5, with an α error = 0.05 and β error = 0.1,

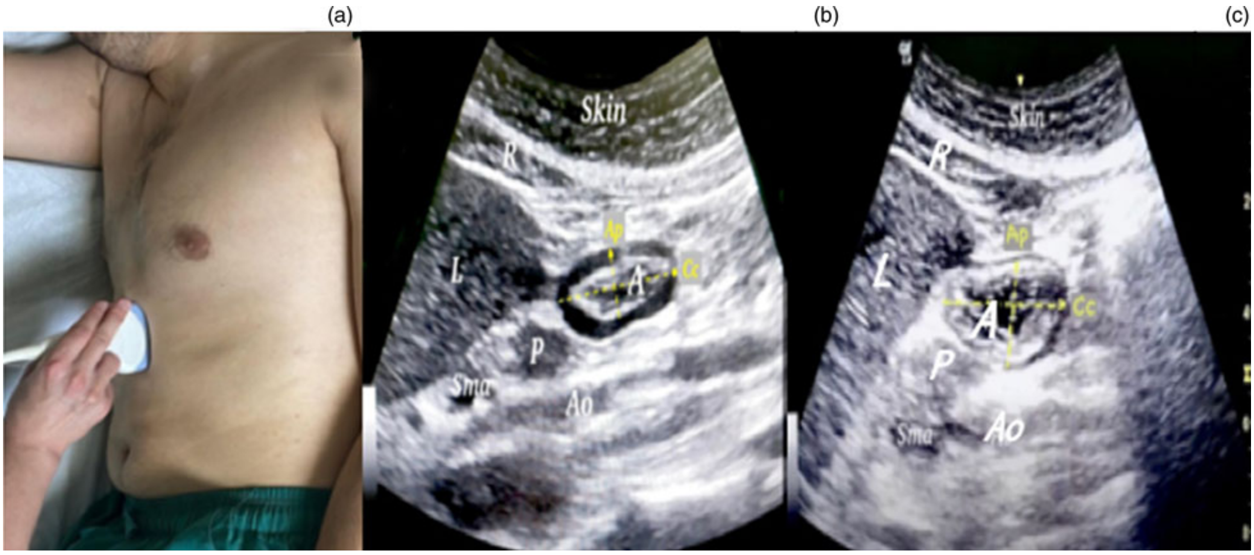

Figure 1. (a) Gastric ultrasound scanning of a patient in the right lateral decubitus position using a curved array low-frequency probe. (b) Gastric ultrasound scan of a patient before anaesthesia induction. (c) Gastric ultrasound scan of a patient before removal of the pharyngeal packing, following completion of surgery. R = rectus abdominis; Ap = anteroposterior; L = liver; A = antrum; Cc = cranio-caudal; P = pancreas; Sma = superior mesenteric artery; Ao = aorta

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which calculated a sample size of 86 patients per group (determined using G-Power statistical power calculation software, version 3.1.9.2). Accounting for possible dropouts, 200 patients were screened.

The Kolmogorov–Smirnov test was performed to assess the normality of the distribution of data. Continuous variables, presented as mean ± standard deviation or median (range) values, were compared using the student's *t*-test or Mann–Whitney U test respectively. Repeated variables were compared with the Wilcoxon signed rank test. Categorical values, presented as number (percentage) values, were compared using the chi-square or Fisher's exact test. Binomial logistic regression was used to determine the effects of predictive factors of post-operative nausea and vomiting. A *p*-value of less than 0.05 was considered statistically significant.

Results

A study flow chart is shown in Figure 2. The results of a total of 180 patients (in the control and pharyngeal packing groups) were analysed. Patients' characteristics and surgery types are shown in Table 1. Suctioned blood volume during the surgery was significantly higher in the pharyngeal packing group.

Table 2 shows the ultrasound-derived data for the control and pharyngeal packing groups. In both groups, post-operative measurements of anteroposterior diameter, cranio-caudal diameter, calculated antral cross-sectional area and gastric volume were significantly greater than the pre-operative values. Despite similar findings in the pre-operative phase, all these parameters were greater in the control group compared to the pharyngeal packing group.

Post-operative median gastric volume according to the body weight of the patients was 1.95 ml/kg (range, 1–3.55 ml/kg) and 1.3 ml/kg (range, 0.79–1.96 ml/kg) in the control and pharyngeal packing groups, respectively. The incidence and severity of post-operative nausea and vomiting, both in the post-anaesthesia care unit and in the ward, were higher in the control group. The incidence of post-operative sore throat in the post-anaesthesia care unit was similar in both groups, whereas more patients in the control group suffered from mild sore throat on the ward.

A binomial logistic regression was performed to ascertain the effects of age, BMI, American Society of Anesthesiologists' physical status classification, Apfel simplified risk score, operation type, operation duration, presence of pharyngeal packing and post-operative antral cross-sectional area on the likelihood that participants have nausea and vomiting during post-anaesthesia care unit stay. The logistic regression model was statistically significant ($\chi^2(8) = 56.754$, $p < 0.0005$). The model explained 37.1 per cent (Nagelkerke R^2) of the variance in post-operative nausea and vomiting, and correctly classified 74.4 per cent of cases. Of the eight predictor variables, two were statistically significant: Apfel simplified risk score and post-operative antral cross-sectional area (Table 3). An increasing Apfel simplified risk score and post-operative antral cross-sectional area were associated with an increased likelihood of post-operative nausea and vomiting during post-anaesthesia care unit stay.

A further binomial logistic regression was performed to ascertain the effects of the same factors except antral cross-sectional area on the probability that participants have nausea and vomiting during the ward stay. In light of oral intake and the lack of repeated gastric ultrasound imaging in the post-operative period, we excluded post-operative antral cross-sectional area from the predictive factors for post-operative nausea and vomiting on the ward. The logistic regression model was statistically significant ($\chi^2(8) = 83.982$, $p < 0.0005$). The model explained 52.9 per cent (Nagelkerke R^2) of the variance in post-operative nausea and vomiting, and correctly classified 83.3 per cent of cases. Of the seven predictors, three were statistically significant: operation type, presence of pharyngeal packing and American Society of Anesthesiologists' physical status classification (Table 3). Septorhinoplasty and FESS, compared to septoplasty, and the absence of pharyngeal packing, were associated with an increased likelihood of post-operative nausea and vomiting, whereas increased American Society of Anesthesiologists' physical status classification was associated with decreased post-operative nausea and vomiting during the ward stay.

The findings for a subgroup analysis according to operation type are shown in Table 4. The median operation times for septoplasty, septorhinoplasty and FESS were 102.5 minutes (range, 50–195 minutes), 185 minutes (range, 140–245 minutes) and 190 minutes (range, 120–250 minutes), respectively ($p < 0.001$). The operation time was significantly shorter for septoplasty compared to septorhinoplasty ($p < 0.001$) and FESS ($p < 0.001$). In all operation types, the use of pharyngeal packing resulted in higher suctioned blood volumes, whereas

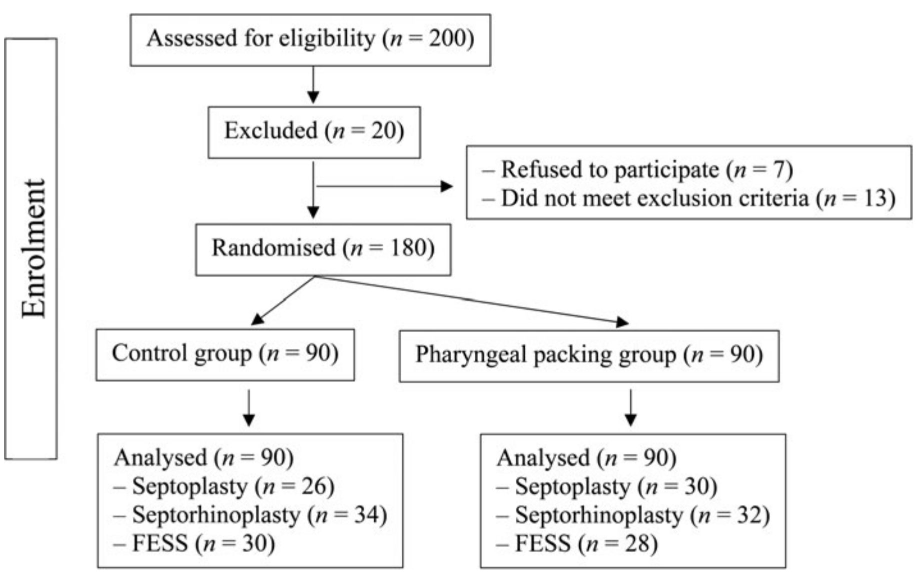

Figure 2. Flow chart of the study. FESS = functional endoscopic sinus surgery

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Table 1. Demographic and surgical characteristics of study groups

Characteristic	Control group*	Pharyngeal packing group†	*P*-value
Age (mean ± SD; years)	39.2 ± 11	38.3 ± 7.8	0.539
Sex (*n* (%))			0.881
– Male	47 (52.2)	46 (51.1)	
– Female	43 (47.8)	44 (48.9)	
Weight (mean ± SD; kg)	71.6 ± 13.8	72.2 ± 10.5	0.743
Height (mean ± SD; cm)	168 ± 0.1	169 ± 0.1	0.675
BMI (mean ± SD; kg/m^2)	25.1 ± 3.9	25.2 ± 2.7	0.846
ASA physical status (*n* (%))			0.173
– I	58 (64.4)	49 (54.4)	
– II	29 (32.2)	40 (44.4)	
– III	3 (3.3)	1 (1.1)	
Apfel simplified risk score (*n* (%))			0.607
– 0	23 (25.6)	28 (31.1)	
– 1	21 (23.3)	25 (27.8)	
– 2	33 (36.7)	26 (28.9)	
– 3	13 (14.4)	11 (12.2)	
– 4	0 (0)	0 (0)	
Surgery type (*n* (%))			0.812
– Septoplasty	26 (28.9)	30 (33.3)	
– Septorhinoplasty	34 (37.8)	32 (35.6)	
– FESS	30 (33.3)	28 (31.1)	
Surgery duration (mean ± SD; minutes)	157.8 ± 47.8	161.1 ± 45.9	0.640
Suctioned blood (mean ± SD; ml)	106.8 ± 32.7	165.7 ± 67.6	<0.001

**n* = 90; †*n* = 90. SD = standard deviation; BMI = body mass index; ASA = American Society of Anesthesiologists; FESS = functional endoscopic sinus surgery

antral cross-sectional area and gastric volume values were smaller. In the FESS group with pharyngeal packing, the incidence of post-operative nausea and vomiting was lower during the post-anaesthesia care unit stay, whereas the incidence and severity of post-operative nausea and vomiting on the ward was significantly lower in all groups with pharyngeal packing. The incidence of post-operative sore throat was similar in the post-anaesthesia care unit with or without pharyngeal packing, while patients with pharyngeal packing had a significantly lower incidence of sore throat on the ward following FESS.

Discussion

In this prospective, randomised, controlled study, we quantitatively determined by ultrasound scanning that nasal surgical procedures led to an increase in antral cross-sectional area and gastric volume, which were limited by the application of pharyngeal packing. Further analysis of all factors, including age, BMI, American Society of Anesthesiologists' physical status classification, Apfel simplified risk score, operation type, operation duration, presence of pharyngeal packing and post-operative antral cross-sectional area revealed that increasing Apfel simplified risk score and post-operative antral cross-sectional area were associated with post-operative nausea and vomiting in the first 2 hours in the post-anaesthesia care unit. However, during the following 22 hours, while on the ward, septorhinoplasty, FESS and the absence of pharyngeal packing were predictive factors for post-operative nausea and vomiting, whereas increased American Society of Anesthesiologists' physical status classification was associated with decreased post-operative nausea and vomiting.

Swallowed blood during the surgery is believed to have an emetic effect.[15] However, the association between the amount of blood in the stomach and the incidence and severity of post-operative nausea and vomiting has not been elucidated. At the end of orthognathic surgery, Powell *et al.*[16] aspirated gastric content using a nasogastric tube and found bloody fluid in 66.7 per cent of the patients, irrespective of pharyngeal packing use, and demonstrated the ineffectiveness of pharyngeal packing as a barrier with regard to post-operative nausea and vomiting incidence. However, the authors did not provide detailed information about the pharyngeal packing, or give any data regarding the gastric volume aspirated or estimated blood loss. Theoretically, a tight-sealing pharyngeal packing would prevent blood ingestion, until it becomes saturated with fluid or blood as the gauze has a limited absorption capacity. Bajwa[17] mentioned the use of a long ribbon gauze with a double knot at the end for blocking the entry to the digestive tract. The author reported that the distal portion of the pharyngeal packing stayed dry and free of blood when it was removed, and underlined that the patients were free of post-operative nausea and vomiting.

Gastric ultrasound imaging is used to evaluate gastric content qualitatively (to differentiate between an empty stomach, clear fluid or solid food) and quantitatively (volume estimation).[9] Temel *et al.*[18] calculated antral cross-sectional area according to the measured gastric diameters by ultrasound scanning in patients undergoing nasal surgery, and found greater post-operative antral cross-sectional area values compared to pre-operative values, regardless of pharyngeal packing application. They also reported that antral cross-sectional area values were greater in groups without pharyngeal packing. These data demonstrate the limited barrier function of pharyngeal packing. Nevertheless, in that study, soft wet pharyngeal packings were used without further details about their dimensions. The authors also examined the incidence of post-operative nausea and vomiting according to operation type, and found that pharyngeal packing reduced the incidence of post-operative nausea and vomiting in the septoplasty group only at 2- and 4-hour follow-up time points post-operatively. Their results may depend on the unequal distribution of operations with different amounts of bleeding and the limited numbers of patients within the groups (31, 44 and 13 patients in the septoplasty, septorhinoplasty and FESS groups, respectively).

Similar to Temel and colleagues' work, our study also focused on the effect of pharyngeal packing on gastric dimension changes, but with two important differences: our patient population is larger with a narrower distribution of operation types, and we performed the measurements with the patients in the right lateral decubitus position. The gastric antrum is suitable for ultrasound examination and it can be used to gauge the stomach contents when in the right lateral or semi-sitting position.[11,19–21] Imaging performed with the patient in the right lateral decubitus position is more sensitive than it is when the patient is in a supine position, particularly in low gastric volume states.[12] In a fasting state such as the pre-operative period, gastric volume is expected to be low,[22] and the contents will be moved towards the dependent areas of the stomach

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Table 2. Ultrasound-derived data and post-operative complications

Variable	Control group*	Pharyngeal packing group†	P-value
Anteroposterior diameter (mean ± SD; mm)			
– Pre-operative	23.6 ± 2	23.6 ± 1.5	0.916
– Post-operative	30.3 ± 3.2	25.6 ± 6.7	<0.001
– *P*-value	<0.001	<0.001	
Cranio-caudal diameter (mean ± SD; mm)			
– Pre-operative	29.7 ± 2.5	29.6 ± 2.4	0.735
– Post-operative	38.4 ± 4.4	32.1 ± 2.3	<0.001
– *P*-value	<0.001	<0.001	
Antral cross-sectional area (mean ± SD; mm^2)			
– Pre-operative	599.1 ± 93	594.1 ± 71.5	0.686
– Post-operative	999.4 ± 202.1	701.1 ± 82.2	<0.001
– *P*-value	<0.001	<0.001	
Gastric volume (mean ± SD; ml)			
– Pre-operative	87.2 ± 13.5	86.5 ± 10.3	0.688
– Post-operative	134.5 ± 27.2	94.3 ± 11	<0.001
– *P*-value	<0.001	<0.001	
Post-operative gastric volume according to patient body weight (mean ± SD; ml/kg)	1.95 ± 0.56	1.3 ± 0.24	<0.001
Post-operative nausea & vomiting incidence in PACU (*n* (%))	42 (46.7)	23 (25.6)	<0.003
Post-operative nausea & vomiting severity in PACU (*n* (%))			<0.001
– None	48 (53.3)	67 (74.4)	
– Mild	1 (1.1)	21 (23.3)	
– Moderate	29 (32.2)	2 (2.2)	
– Severe	12 (13.3)	0	
Post-operative nausea & vomiting incidence on ward (*n* (%))	49 (54.4)	5 (5.6)	<0.001
Post-operative nausea & vomiting severity on ward (*n* (%))			<0.001
– None	41 (45.6)	85 (94.4)	
– Mild	12 (13.3)	3 (3.3)	
– Moderate	35 (38.9)	2 (2.2)	
– Severe	2 (2.2)	0 (0)	
Post-operative sore throat incidence in PACU (*n* (%))	32 (35.6)	32 (35.6)	1
Post-operative sore throat severity in PACU (*n* (%))			0.751
– None	58 (64.4)	58 (64.4)	
– Mild	27 (30)	29 (32.2)	
– Moderate	5 (5.6)	3 (3.3)	
– Severe	0 (0)	0 (0)	
Post-operative sore throat incidence on ward (*n* (%))	24 (26.7)	2 (2.2)	<0.001
Post-operative sore throat severity on ward (*n* (%))			<0.001
– None	66 (73.3)	88 (97.8)	
– Mild	24 (26.7)	2 (2.2)	
– Moderate	0 (0)	0 (0)	
– Severe	0 (0)	0 (0)	

*n = 90; †n = 90. SD = standard deviation; PACU = post-anaesthesia care unit

(antrum) in the lateral position because of gravitation, while gaseous content moves away from the antrum, towards the least dependent body and fundus.[11,23] Hence, a strong correlation between the gastric volume and antral cross-sectional area measured in the right lateral decubitus position has been demonstrated.[11] Our data clearly showed that anteroposterior, cranio-caudal diameters and derived data including antral cross-sectional area and gastric volume increased post-operatively, independently of pharyngeal packing, but the increases were more prominent in the control group.

Nausea and/or vomiting is a common post-operative complaint with a multifactorial aetiology.[24,25] A recent

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Table 3. Significant predictors of post-operative nausea and vomiting in PACU and ward*

Variable	B	SE	Wald	df	*P*-value	OR (95% CI)
Post-operative nausea & vomiting in PACU						
Apfel simplified risk score	0.531	0.215	6.074	1	0.014	1.700 (1.115–2.593)
Post-operative antral cross-sectional area	0.006	0.002	6.998	1	0.008	1.006 (1.002–1.010)
Post-operative nausea & vomiting on ward						
Operation type			14.494	2	0.001	
– Septorhinoplasty	2.322	0.885	6.891	1	0.009	10.201 (1.801–57.773)
– FESS	3.775	1.017	13.784	1	<0.005	43.583 (5.941–319.695)
Pharyngeal packing	3.481	0.584	35.530	1	<0.005	32.482 (10.342–102.024)
ASA physical status	−1.157	0.566	4.172	1	0.041	0.314 (0.104–0.954)

*According to logistic regression analysis. PACU = post-anaesthesia care unit; B = regression co-efficient; SE = standard error; Wald = Wald chi-square test; df = degree of freedom; OR = odds ratio; CI = confidence interval; FESS = functional endoscopic sinus surgery; ASA = American Society of Anesthesiologists

meta-analysis showed a variable, time-dependent post-operative nausea and vomiting incidence following nasal surgical procedures performed with and without pharyngeal packing.[26] In the immediate post-operative phase, the reported post-operative nausea and vomiting incidence was higher in patients with pharyngeal packing compared to controls (19.7 per cent and 12.2 per cent, respectively), whereas the opposite results were observed at 2 hours post-operatively (34.8 per cent and 44.8 per cent, respectively). The incidences were similar at 24 hours (5.6 per cent and 5.5 per cent, respectively). The authors concluded that pharyngeal packing does not decrease post-operative nausea and vomiting incidence, but aggravates post-operative sore throat as well.[26] However, among the studies included in the meta-analysis, there are noticeable differences between primary endpoints, heterogeneity of anaesthetic methods, operation and pharyngeal packing types, and post-operative nausea and vomiting prevention and treatment.

Our results revealed variable post-operative nausea and vomiting predictors during the observation periods. Increased post-operative antral cross-sectional area was one identified predictor of early post-operative nausea and vomiting following surgery. The exact amount of bleeding during nasal operations is difficult to measure. We recorded the suctioned blood volume, which might reflect bleeding and the barrier function of pharyngeal packing. In the control group, the amount of suctioned blood was less than in the pharyngeal packing group, as some of the blood leaked down to the stomach. We used a 20 × 45 cm wet gauze sponge, the absorbing capacity of which is exceeded after a certain amount of blood. This may explain the variable protecting effect of pharyngeal packing on post-operative nausea and vomiting.

It is not surprising that an increased Apfel simplified risk score was determined as another predictor of post-operative nausea and vomiting in the post-anaesthesia care unit. The predictive power of the Apfel simplified risk score for post-operative nausea and vomiting incidence had already been defined, whereby the frequency depends on the number of risk factors (female gender, history of motion sickness, history of post-operative nausea and vomiting, non-smoker, use of post-operative opioids).[13]

We think that the amount of bleeding, depending on the nasal operation type, has an important role in post-operative nausea and vomiting. Indeed, in our study, operation type and the absence of pharyngeal packing were found to be predictors of post-operative nausea and vomiting on the ward. These two factors highlight the importance of the amount of bleeding and the use of pharyngeal packing as a barrier in such operations, even if the absorbing capacity of ordinary gauze is limited. This finding may explain the heterogeneity of results regarding the effectiveness of pharyngeal packing on post-operative nausea and vomiting in the literature, if the quantity of bleeding was not considered.

Our post-operative nausea and vomiting incidence is higher than that reported in the aforementioned meta-analysis,[26] which may reflect the anaesthetic technique and follow-up time points. Volatile anaesthetics, including nitrous oxide and opioids, are independent anaesthesia-related post-operative nausea and vomiting predictors.[25] Furthermore, although studies showed that, compared to inhalation agents, anaesthesia maintenance with total intravenous anaesthesia is associated with less bleeding and a better surgical field quality, these studies utilised high concentrations of inhalation agents, resulting in vasodilation and more bleeding.[25,27] In this study, we used low-dose inhalation anaesthetics in combination with remifentanil infusion.

A decrease in American Society of Anesthesiologists' physical status classification was related to increased post-operative nausea and vomiting incidence on the ward, which might be due to younger age with no systemic diseases. As previously mentioned, younger people are more prone to post-operative nausea and vomiting.[25] Our patient population is relatively young and the number of patients with an American Society of Anesthesiologists' physical status classification of III is very low. These facts limit discussion regarding the role of American Society of Anesthesiologists' physical status classification on post-operative nausea and vomiting.

Post-operative sore throat was found to be similar within the post-anaesthesia care unit, but its incidence increased on the ward, and might be dependent on the more frequent and severe post-operative nausea and vomiting rather than pharyngeal packing usage.

The subgroup analysis according to operation type revealed that septorhinoplasty and FESS were associated with longer operation durations and more bleeding. Independent from the operation type, pharyngeal packing use resulted in smaller gastric antral dimensions and volume, which was reflected in reduced post-operative nausea and vomiting frequency and severity, and consequently mild sore throat incidence.

Pharyngeal packing may also have a protective function against pulmonary aspiration. Gastric volume of more than 1.5 ml/kg is related to a higher pulmonary aspiration risk.[10]

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Table 4. Results of subgroups according to operation type

Variable	Septoplasty			Septorhinoplasty			FESS		
	Control	Pharyngeal packing	*P*-value	Control	Pharyngeal packing	*P*-value	Control	Pharyngeal packing	*P*-value
Number of patients	26	30		34	32		30	28	
Surgery duration (mean ± SD; minutes)	100 ± 23	106 ± 25	0.389	180 ± 29	191 ± 26	0.09	183 ± 37	185 ± 22	0.762
Suctioned blood (median (range); ml)	65 (40–70)	100 (70–120)	<0.001	120 (100–150)	160 (120–260)	<0.001	130 (100–150)	240 (170–320)	<0.001
Post-op ACSA (median (range); mm^2)	766.3 (636.7–1039.4)	648.7 (508.6–839.3)	<0.001	1026.1 (816.3–1400.3)	709.4 (631.5–810.9)	<0.001	1116.6 (931.5–1474.6)	758 (638.3–905.2)	<0.001
Post-op gastric volume (median (range); ml)	103.2 (85.7–139.7)	87.2 (68.5–112.7)	<0.001	138.1 (110–188.3)	95.4 (85–109)	<0.001	150 (125.5–198.4)	102 (86–121.7)	<0.001
PONV incidence in PACU (*n* (%))	3 (11.5)	4 (13.3)	1	18 (52.9)	10 (31.3)	0.087	21 (70)	9 (32.1)	0.008
PONV severity in PACU (*n* (%))			0.075			<0.001			<0.001
– None	23 (88.5)	26 (86.7)		16 (47.1)	22 (68.8)		9 (30)	19 (67.9)	
– Mild	0 (0)	4 (13.3)		0 (0)	9 (28.1)		1 (3.3)	8 (28.6)	
– Moderate	2 (7.7)	0 (0)		9 (26.5)	1 (3.1)		18 (60)	1 (3.6)	
– Severe	1 (3.8)	0 (0)		9 (26.5)	0 (0)		2 (6.7)	0 (0)	
PONV incidence on ward (*n* (%))	7 (26.9)	0 (0)	0.003	18 (52.9)	3 (9.4)	<0.001	24 (80)	2 (7.1)	<0.001
PONV severity on ward (*n* (%))			0.01			<0.001			<0.001
– None	19 (73.1)	30 (100)		16 (47.1)	29 (90.6)		6 (20.0)	26 (92.9)	
– Mild	0 (0)	0 (0)		7 (77.8)	2 (22.2)		5 (16.7)	1 (3.6)	
– Moderate	6 (23.1)	0 (0)		11 (32.4)	1 (3.1)		18 (60.0)	1 (3.6)	
– Severe	1 (3.8)	0 (0)		0 (0)	0 (0)		1 (3.3)	0 (0)	
Post-op sore throat incidence in PACU (*n* (%))	0 (0)	1 (3.3)	1	16 (47.1)	17 (53.1)	0.806	16 (53.3)	14 (50)	1
Post-op sore throat severity in PACU (*n* (%))			0.348			0.325			0.251
– None	26 (100)	29 (96.7)		18 (52.9)	15 (46.9)		14 (46.7)	14 (50.0)	
– Mild	0 (0)	1 (3.3)		16 (47.1)	15 (46.9)		11 (36.7)	13 (46.4)	
– Moderate	0 (0)	0 (0)		0 (0)	2 (6.3)		5 (16.7)	1 (3.6)	
– Severe	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)	0 (0)	
Post-op sore throat incidence on ward (*n* (%))	0 (0)	0 (0)	NA	7 (5.9)	1 (3.1)	0.055	17 (56.7)	1 (3.6)	<0.001
Post-op sore throat severity on ward (*n* (%))									
– None	26 (100)	30 (100)	NA	27 (79.4)	31 (96.9)	0.030	13 (43.3)	27 (96.4)	<0.001
– Mild	0 (0)	0 (0)		7 (20.6)	1 (3.1)		17 (56.7)	1 (3.6)	
– Moderate	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)	0 (0)	
– Severe	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)	0 (0)	

FESS = functional endoscopic sinus surgery; SD = standard deviation; post-op = post-operative; ACSA = antral cross-sectional area; PONV = post-operative nausea and vomiting; PACU = post-anaesthesia care unit; NA = not applicable

Although patients in the control group have larger gastric volumes in the post-operative period, we did not observe any pulmonary aspiration of gastric content. However, our study is too underpowered to analyse this outcome, as the baseline risk is approximately as low as 1:4000 in patients who have fasted for elective surgery.

- Intra-operative free entry of blood into the digestive tract may increase post-operative nausea, vomiting and aspiration
- Pharyngeal packing is used as a physical barrier to prevent blood ingestion during nasal surgery, but its effect on gastric volume is unclear
- A prospective, randomised study was conducted using gastric ultrasound imaging
- Gastric antral cross-sectional area and gastric volume increased with ingested blood during nasal surgery, but were restricted by pharyngeal packing
- Pharyngeal packing should be considered with a low physical status, high risk score, or in those undergoing septorhinoplasty or functional endoscopic sinus surgery
- This approach may decrease post-operative nausea and vomiting incidence on the 1st post-operative day

This study has several limitations. We recorded cumulative post-operative nausea and vomiting and throat pain data during patients' stay in the post-anaesthesia care unit and on the ward (at two time points), instead of more frequent follow up. Therefore, we cannot directly compare our results with previous work. The amount of bleeding was not measured precisely, which presumably affects gastric volume and post-operative nausea and vomiting incidence. We used standardised hypopharyngeal packs, hence our results cannot be applied to other types of packs or the localisation of packs. In addition, we excluded obese patients or those with an American Society of Anesthesiologists' physical status classification of higher than III, which may affect oesophageal sphincter or gastric function; these variables are of interest for future studies.

Conclusion

Gastric ultrasound imaging clearly demonstrated that gastric antral cross-sectional area and gastric volume both increase with the haemorrhaging of blood during nasal surgical procedures, but are restricted by the use of pharyngeal packing. Increased antral cross-sectional area and disposition to post-operative nausea and vomiting (reflected in higher Apfel simplified risk scores) results in increased post-operative nausea and vomiting incidence and severity in the post-anaesthesia care unit, whereas the absence of pharyngeal packing, the operation type (septorhinoplasty and FESS compared to septoplasty) and the low American Society of Anesthesiologists' physical status classification mainly affects the post-operative nausea and vomiting incidence later, when the patient is on the ward. Therefore, the use of pharyngeal packing should be considered in patients with a low American Society of Anesthesiologists' physical status classification, a high Apfel simplified risk score, or those undergoing septorhinoplasty or FESS where a higher amount of bleeding is expected. We believe that there is a need for further studies to determine pharyngeal packings with suitable absorption capacity or appropriate methods to prevent blood passage into the stomach during nasal surgery.

Competing interests. None declared.

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