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Original Article

The effect of liberal fluid fasting on gastric fluid volume in patients undergoing painless gastroscopy: a randomized controlled study

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Abstract: Objective: This study assessed the impact of liberalized clear liquid intake on gastric fluid volume (GFV) in patients undergoing painless gastroscopy. Methods: 184 patients scheduled for elective sedation gastroscopy underwent 1:1 randomization to a liberal fasting group (n = 92) or a conventional fasting group (n = 92). The liberal protocol permitted clear liquid consumption (≤150 mL/h) until 30 minutes pre-procedure, whereas the conventional group maintained standard preoperative 2-hour fasting. GFV quantification was performed through dual-modality assessment (gastric ultrasound and endoscopic aspiration). The primary endpoint was GFV, with secondary outcomes comprising fasting duration modifications, protocol satisfaction, adverse event incidence, and inter-method agreement. Results: No significant GFV differences emerged between groups as demonstrated by ultrasound or endoscopy. The liberal group demonstrated substantially shorter fasting durations and higher satisfaction scores, with comparable adverse event rates. Strong inter-method agreement was confirmed. Conclusion: Liberal fasting achieves equivalent GFV control compared to conventional protocols while optimizing patient comfort, supporting its safe implementation in painless gastroscopy.

Keywords: Liberal fasting, gastric fluid volume, painless gastroscopy

Introduction

The purpose of preoperative fasting is to mitigate the risk of postoperative regurgitation and aspiration [1]. Although aspiration may lead to pneumonia or mortality, its reported incidence remains low at 1-10 cases per 10,000 operations [2-4]. Nevertheless, concerns about aspiration combined with the prevailing misconception that prolonged fasting enhances safety have resulted in excessively stringent dietary and fluid intake protocols [5]. Current consensus indicates that extended fasting prior to elective surgery is not only unnecessary for both pediatric and adult populations, but may also adversely affect patient health [6, 7].

Emerging evidence in pediatric patients suggests that liberalized fluid intake protocols offer multiple advantages, including improved operating room scheduling flexibility, reduced postoperative nausea and vomiting (PONV), and enhanced patient outcomes without increasing aspiration risk [8, 9]. In alignment with these findings, the European Society of Anaesthesiology and Intensive Care has revised its pediatric preoperative fasting guidelines, authorizing clear fluid intake up to one hour before anesthesia [10]. However, adult guidelines remain conservative due to insufficient supporting evidence. Notably, a large-scale study implementing liberalized fluid protocols in adults demonstrated significant reductions in preoperative thirst and improved perioperative experiences while maintaining aspiration risk parity [11].

The clinical relevance of gastric fluid volume (GFV) lies in its strong correlation with both the incidence and severity of aspiration events. Gastric ultrasound has gained widespread recognition as a validated GFV measurement modality [12, 13], whereas endoscopic aspiration of gastric contents remains the gold standard for direct volume quantification [14]. Therefore, this study aims to comparatively assess the effects of liberalized fasting protocols on GFV

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through concurrent implementation of gastric ultrasound and endoscopic aspiration measurements.

Materials and methods

Ethics statement

This study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Deyang People's Hospital (Approval No. 2023-03-028). The trial protocol was prospectively registered at the Chinese Clinical Trial Registry (Registration ID: ChiCTR2400081577). Written informed consent was obtained from all participants after detailed explanation of study procedures and potential risks. Patient confidentiality was protected through anonymized data management in compliance with China's Personal Information Protection Law.

Study participants

The study enrolled 184 patients aged 18-65 years with ASA physical status I-II undergoing elective gastroscopy. Exclusion criteria included: active upper respiratory infections; metabolic disorders (diabetes mellitus, obesity [BMI≥30 kg/m^2]); gastroparesis-related conditions (prior intestinal obstruction, gastroesophageal reflux disease); conditions predisposing to nausea/vomiting; elevated gastric fluid volume (>1.5 mL/kg on preprocedural ultrasound); anticipated difficult airway management; protocol deviations (fasting violations, consent withdrawal); new-onset gastrointestinal disorders prior to anesthesia; and investigator-assessed ineligibility.

Randomization and blinding

Participants were allocated via computer-generated simple randomization to two parallel groups, with allocation concealment maintained through sequentially numbered, opaque sealed envelopes. Twenty-four hours preprocedure, research staff confirmed group assignments and delivered standardized instructions on fasting protocols. On procedure day, participants accessed the preparation area after verification of fasting compliance and fluid intake records. Blinded assessors conducted all outcome measurements, including ultrasound evaluations and visual analog scale (VAS) scoring. The endoscopic team, blinded to group assignments, performed all procedures using standardized techniques.

Study protocol

Twenty-four hours preprocedure, researchers delivered standardized preoperative instructions to all participants. The liberal fasting (LF) group was authorized to consume clear liquids (≤150 mL/h) until 30 minutes pre-examination, while the conventional fasting (CF) group maintained a standard 2-hour fast. Both groups received identical guidance prohibiting solid food intake for ≥6 hours prior to the procedure.

Ultrasonographic assessment of stomach

All participants underwent standardized gastric ultrasound 5 minutes pre-procedure in the preparation room. A single experienced anesthesiologist (2-year gastric ultrasound specialization) performed triplicate measurements using a color Doppler system (Mindray M-9; C60x transducer; 2-5 MHz frequency; abdominal mode). Scans were acquired in the right lateral decubitus (RLD) position with the probe positioned sagittally below the xiphoid. Gastric antrum visualization was optimized by lateral probe adjustments, confirmed by anatomical landmarks: left hepatic lobe, pancreas, abdominal aorta, superior mesenteric artery, and/or inferior vena cava [15]. Antral cross-sectional area (CSA) was calculated via: CSA = π(D1 × D2)/4, where D1 (anteroposterior) and D2 (craniocaudal) were measured outer-wall to outer-wall during peristaltic quiescence. Gastric fluid volume (GFV) was estimated using the validated Perlas formula [16]: GFV (Vol, in ml) = 27.0 + 14.6 × RLD CSA (cm^2) - 1.28 × age (years).

Assessments of secondary outcomes

Adverse events from anesthesia induction through PACU discharge included: bradycardia (<60 beats/min); involuntary body movement; hypotension (>20% blood pressure decrease from baseline or systolic pressure <90 mmHg); respiratory depression (apnea >15 seconds or SpO_2<90%); PONV; delayed awakening; and suspected aspiration. Patient satisfaction was assessed using a 100-mm visual analog scale (VAS) (0 = extreme dissatisfaction; 100 = maximal satisfaction).

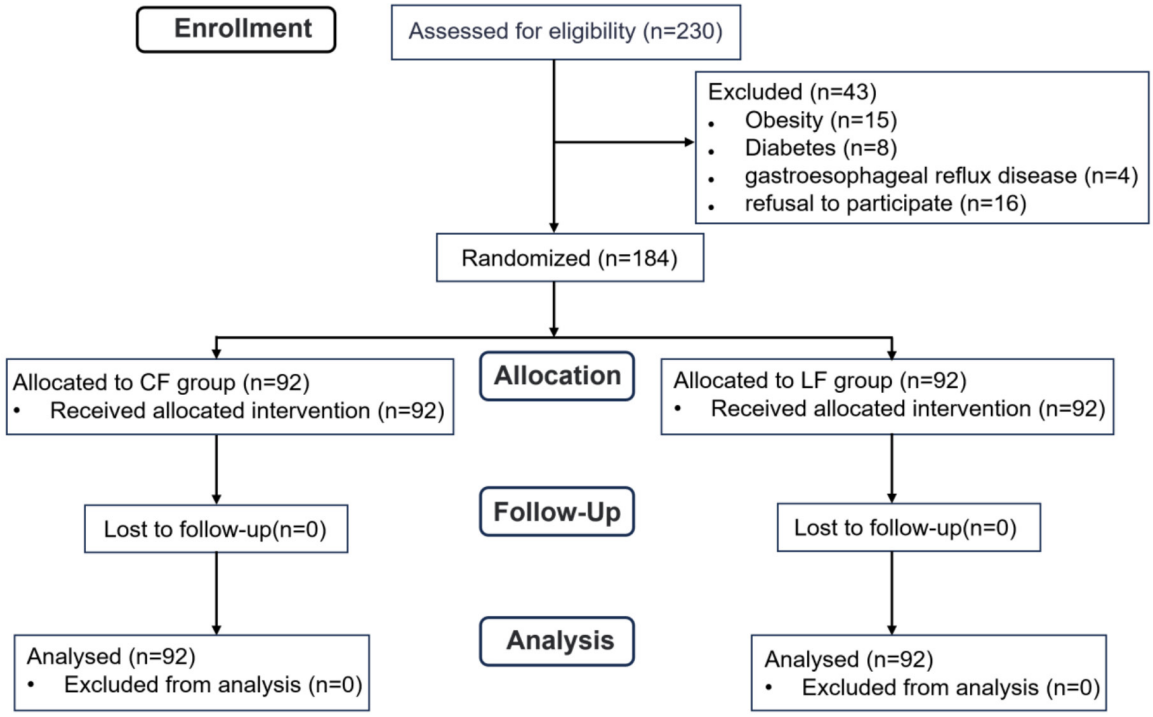

Figure 1. Patient inclusion flow chart.

Sample size calculation

The sample size calculation was based on non-inferiority testing of GFV as the primary endpoint. Preliminary unpublished data indicated mean GFV values of 50±12 mL (conventional fasting, CF) versus 60±13 mL (liberal fasting, LF). With a predefined non-inferiority margin of 5 mL and 1:1 allocation ratio, we specified α = 0.05 and β = 0.2. Accounting for 15% potential attrition, PASS 15.0 determined 184 participants (92 per group) as the required sample size.

Statistical analysis

Demographic characteristics were summarized using descriptive statistics. Normality of continuous variables was assessed via the Kolmogorov-Smirnov test; normally distributed data (mean ± SD) were analyzed with Student's t-test, while nonparametric data (median [IQR]) were analyzed using the Mann-Whitney U test, with 95% CI calculated through Hodges-Lehmann estimation. Categorical variables (n, %) were compared using χ^2 test or Fisher's exact test. Method agreement analysis included intraclass correlation coefficient (ICC), Bland-Altman analysis, and Spearman's rank correlation. Interpretation criteria: ICC≥0.80 (strong agreement); P<0.05 (statistical significance). All analyses were performed using SPSS 22.0 (IBM Corp.) and GraphPad Prism 9.0 (GraphPad Software).

Results

Patient baseline characteristics

Among the 227 initially screened patients, 43 were excluded (15 for obesity, 8 for diabetes mellitus, 4 for gastroesophageal reflux disease, and 16 declined participation), resulting in 184 participants (92 per group) being randomized (**Figure 1**). The CF and LF groups showed comparable baseline parameters in age, sex, height, weight, BMI, ASA, or solid-food fasting duration. The liquid fasting duration significantly differed between groups (CF: 11.45 [5.23] h vs LF: 1.30 [0.40] h; mean difference (Δ) 10.20 h, 95% CI 9.50-11.40; P<0.001). The LF group consumed 110 [58] mL of water during the 2-hour preprocedural period (**Table 1**).

Gastric volume

Based on the ultrasound findings, The CF group (5.57 [1.83] cm^2) and the LF group (5.89 [2.57]

Table 1. Patient baseline characteristics

	CF group (n = 92)	LF group (n = 92)	Absolute difference (95% CI)	*P* value
Age (year)	50.5 [22.0]	53 [20.5]	-0.2 (-5 to 1)	0.139[a]
Male	43 (46.74%)	42 (45.65%)		0.882[b]
Height (cm)	160.0 [12.0]	160.0 [10.0]	0 (-1 to 3)	0.578[a]
Weight (kg)	58.90 [13.67]	59.90 [16.78]	1 (-1.9 to 4)	0.450[a]
BMI (kg·m^{-2})	22.93 [4.38]	22.39 [3.88]	-0.18 (-0.60 to 0.98)	0.633[a]
ASA, I/II	9 (9.78%)/83 (90.22%)	7 (7.61%)/85 (92.39%)		0.601[b]
Fasting for solids (h)	15.20 [3.32]	15.60 [3.50]	-0.10 (-0.70 to 0.50)	0.694[a]
Fasting for liquids (h)	11.45 [5.23]	1.30 [0.40]	10.20 (9.50 to 11.40)	<0.001[a]
Consume fluid (mL)	0 [0]	110 [58]		

Data expressed as median (interquartile range) or frequency (%). [a]Mann-Whitney *U* test; difference in medians (95% CI) estimated using the Hodges-Lehmann method; [b]Chi-square test; difference in percentage (95% CI). Abbreviations: BMI, body mass index; ASA, American Society of Anesthesiologists; CF, conventional fasting; LF, liberal fasting; CI, confidence interval.

Table 2. Ultrasound findings, endoscopic aspiration, and patient satisfaction

	CF group (n = 92)	LF group (n = 92)	Absolute difference (95% CI)	*P* value
RLD CSA (cm^2)	5.57 [1.83]	5.89 [2.57]	-0.25 (-0.69 to 0.19)	0.249[a]
GFV (mL)	51.62 [28.93]	57.52 [31.43]	-1.68 (-7.25 to 3.86)	0.533[a]
GFVw (mL/kg)	0.85 [0.62]	0.93 [0.59]	-0.03 (-0.14 to 0.07)	0.584[a]
GFVw>1.5 (mL/kg)	0 [0]	0 [0]		
Aspiration (mL)	43 [26]	48 [29]	-3 (-8 to 3)	0.362[a]
Satisfaction	94 [7]	95 [6]	-1 (-2 to 0)	0.021[a]

Data expressed as median (interquartile range) or frequency (%). [a]Mann-Whitney *U* test; difference in medians (95% CI) estimated using the Hodges-Lehmann method. Abbreviations: RLD CSA, antral cross-sectional area in the right lateral decubitus; GFV, gastric fluid volume; GFVw, GFV/weight; CF, conventional fasting; LF, liberal fasting; CI, confidence interval.

cm^2, -0.25 (-0.69 to 0.19), *P* = 0.249) exhibited no statistically significant differences in CSA in the RLDP. Similarly, there were no significant differences in GFV between the CF group (51.62 [28.93] ml) and the LF group (57.52 [31.43] ml, -1.68 (-7.25 to 3.86), *P* = 0.533). Furthermore, no significant differences were observed in GFV/weight (GFVw) between the CF group (0.85 [0.62] ml/kg) and the LF group (0.93 [0.59] ml/kg, -0.03 (-0.14 to 0.07), *P* = 0.584). Notably, none of the participants exhibited a GFVw >1.5 ml/kg in either of the groups. There was no statistically significant difference in the GFV of endoscopic aspirated between the CF group (43 [26] ml) and the LF group (48 [29] ml, -3 [-8 to 3], *P* = 0.362). The patient satisfaction was higher in the LF group (94 [7]) compared to the CF group (95 [6], -1 (-2 to 0), *P* = 0.021) (**Table 2**). Ultrasonographic assessment demonstrated no significant intergroup differences in antral cross-sectional area (CSA) (CF: 5.57 [1.83] cm^2 vs LF: 5.89 [2.57] cm^2; Δ -0.25, 95% CI -0.69 to 0.19; *P* = 0.249) or gastric fluid volume (GFV) (CF: 51.62 [28.93] mL vs LF: 57.52 [31.43] mL; Δ -1.68, 95% CI -7.25 to 3.86; *P* = 0.533). GFV/weight ratios were comparable between groups (CF: 0.85 [0.62] mL/kg vs LF: 0.93 [0.59] mL/kg; Δ -0.03, 95% CI -0.14 to 0.07; *P* = 0.584), with no cases exceeding the 1.5 mL/kg safety threshold. Endoscopic aspiration volumes showed no significant disparity (CF: 43 [26] mL vs LF: 48 [29] mL; Δ -3, 95% CI -8 to 3; *P* = 0.362) (**Table 2**). Strong correlation existed between ultrasound and endoscopic GFV measurements (Spearman's ρ = 0.908, **Figure 2A**), supported by excellent agreement (ICC = 0.875, **Figure 2B**).

Patient satisfaction and adverse events

The LF group reported higher satisfaction scores (94 [7] vs CF: 95 [6]; Δ -1, 95% CI -2 to 0; *P* = 0.021) (**Table 2**). No significant intergroup differences were observed in bradycardia (*P* = 0.470), body movements (*P* = 0.636), hypotension (*P* = 0.650), or respiratory depression (*P* = 0.578). Neither group exhibited postoperative nausea/vomiting, delayed awakening, or aspiration events (**Table 3**).

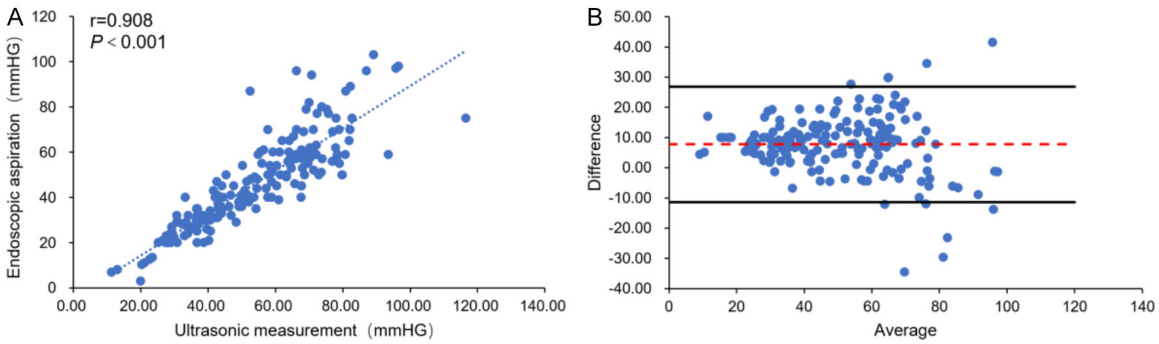

Figure 2. Correlation and concordance analysis of ultrasound and endoscopy. The Spearman correlation (A) and Bland-Altman plot (B) between ultrasonic measurement and endoscopic aspiration GFV.

Table 3. Adverse events

	CF group (n = 92)	LF group (n = 92)	*P* value
Bradycardia	3 (3.26%)	5 (5.43%)	0.470[a]
Body movement	9 (9.78%)	11 (11.95%)	0.636[a]
Hypotension	12 (13.04%)	10 (6.52%)	0.650[a]
Respiratory depression	8 (8.69%)	6 (6.52%)	0.578[a]
PONV	0	0	
Delayed awakening	0	0	
Aspiration	0	0	

Data expressed as frequency (%). [a]Chi-square Test.

Discussion

This randomized controlled trial demonstrates that a liberal fluid fasting protocol permitting clear liquid intake up to 30 minutes prior to painless gastroscopy achieves equivalent GFV control compared with conventional fasting, while significantly improving patient satisfaction. These findings challenge the longstanding assumption that prolonged preoperative fasting enhances safety in adult populations and align with emerging evidence advocating patient-centered fasting protocols.

Our data indicate no statistically significant difference in GFV between the LF group and the CF group, as measured by both gastric ultrasound and endoscopic aspiration. These findings align with prior studies. For instance, a study involving children aged 1-16 years demonstrated that liberal fluid intake does not increase gastric content volume [17]. Previous reports indicate that the gastric fluid volume in healthy volunteers after overnight fasting ranges from 0 to 115 mL, with a mean range of 25-27 mL, which diverges from our results [18]. This discrepancy may stem from differences in study population characteristics. Notably, nearly all participants in our cohort sought treatment for dyspepsia or upper abdominal pain, conditions associated with delayed gastric emptying and increased residual secretions due to impaired gastric motility. For example, common disorders in this population-such as functional dyspepsia or gallbladder disease-are known to reduce gastric motility and prolong fluid retention, consistent with our observations [19, 20]. Importantly, we observed strong agreement between ultrasonographic and endoscopic measurements, reinforcing the utility of ultrasound as a reliable tool for preoperative risk stratification. This corroborates findings by Van de Putte et al., who emphasized the clinical value of ultrasound in identifying high-risk gastric residual volumes [21].

Although GFV values increased, the GFV/weight ratio remained below the aspiration risk threshold (1.5 mL/kg), and no aspiration events occurred during the study, supporting the safety of the liberal fasting protocol. However, our findings contrast with pediatric studies reporting that liberal fasting regimens increase high-risk gastric content volume. This discrepancy may reflect developmental differences: the pediatric stomach is fundus-dominant (prone to fluid retention), whereas the adult stomach is antrum-dominant (facilitating rapid emptying) [22].

The LF group demonstrated a significantly shorter fasting duration and higher satisfaction

scores, underscoring the clinical relevance of minimizing preoperative discomfort. Notably, despite standardized preoperative instructions, both solid-food fasting duration and liquid fasting time substantially exceeded guideline recommendations, highlighting systemic challenges in protocol implementation. This pattern aligns with prior observations in fasting and fluid restriction studies [12, 23] and may reflect patient misconceptions regarding "absolute fasting" (participants erroneously associated prolonged fasting with enhanced safety), persistent preoperative anxiety, and excessive compliance [24, 25]. Furthermore, insufficient multidisciplinary coordination and institutional workflow inefficiencies likely contributed to prolonged fasting. These findings emphasize the necessity of systematic guideline adoption and targeted patient education to optimize adherence.

This study has several limitations. First, it is a single-center prospective controlled trial lacking multicenter clinical evidence; further validation through multicenter studies is warranted. Second, gastric volume was not measured at sequential time points, precluding assessment of gastric emptying kinetics. Finally, as the study was conducted exclusively in a Chinese population, our findings may lack generalizability to other ethnic groups due to potential physiological variations influencing gastric fluid dynamics.

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Disclosure of conflict of interest

None.

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References

[1] Brady M, Kinn S and Stuart P. Preoperative fasting for adults to prevent perioperative complications. Cochrane Database Syst Rev 2003: CD4423.

[2] Fawcett WJ and Thomas M. Pre-operative fasting in adults and children: clinical practice and guidelines. Anaesthesia 2019; 74: 83-88.

[3] Ng A and Smith G. Gastroesophageal reflux and aspiration of gastric contents in anesthetic practice. Anesth Analg 2001; 93: 494-513.

[4] Mccracken GC and Smith AF. Breaking the fast for procedural sedation: changing risk or risking change? Anaesthesia 2020; 75: 1010-1013.

[5] Zhu Q, Li Y, Deng Y, Chen J, Zhao S, Bao K and Lai L. Preoperative fasting guidelines: where are we now? Findings from current practices in a tertiary hospital. J Perianesth Nurs 2021; 36: 388-392.

[6] Awad S and Lobo DN. Metabolic conditioning to attenuate the adverse effects of perioperative fasting and improve patient outcomes. Curr Opin Clin Nutr Metab Care 2012; 15: 194-200.

[7] Noba L and Wakefield A. Are carbohydrate drinks more effective than preoperative fasting: a systematic review of randomised controlled trials. J Clin Nurs 2019; 28: 3096-3116.

[8] Disma N, Frykholm P, Cook-Sather SD and Lerman J. Pro-con debate: 1- vs 2-hour fast for clear liquids before anesthesia in children. Anesth Analg 2021; 133: 581-591.

[9] Andersson H, Zaren B and Frykholm P. Low incidence of pulmonary aspiration in children allowed intake of clear fluids until called to the operating suite. Paediatr Anaesth 2015; 25: 770-777.

[10] Disma N, Thomas M, Afshari A, Veyckemans F and De Hert S. Clear fluids fasting for elective paediatric anaesthesia: the European Society of Anaesthesiology consensus statement. Eur J Anaesthesiol 2019; 36: 173-174.

[11] Marsman M, Kappen TH, Vernooij LM, van der Hout EC, van Waes JA and van Klei WA. Association of a liberal fasting policy of clear fluids before surgery with fasting duration and patient well-being and safety. JAMA Surg 2023; 158: 254-263.

[12] Chen L, Wang N, Xie G, Wang M, Yu Y, Wang H and Fang X. The safety of preoperative carbohydrate drinks in extremely elderly patients assessed by gastric ultrasonography: a randomized controlled trial. BMC Anesthesiol 2024; 24: 78.

[13] Zhang Y, Li H, Zeng H, Li Q, Qiu L and Dai R. Ultrasonographic evaluation of gastric emptying after ingesting carbohydrate-rich drink in young children: a randomized crossover study. Paediatr Anaesth 2020; 30: 599-606.

[14] Wang J, Shuai Y, Cheng Y and Zhang Y. Ultrasound assessment of gastric residual volume in patients over 60 years of age undergoing gastroscopy under sedation: a prospective co-

hort study. Can J Anaesth 2023; 70: 1315-1322.
[15] Bouvet L, Miquel A, Chassard D, Boselli E, Allaouchiche B and Benhamou D. Could a single standardized ultrasonographic measurement of antral area be of interest for assessing gastric contents? A preliminary report. Eur J Anaesthesiol 2009; 26: 1015-1019.
[16] Perlas A, Mitsakakis N, Liu L, Cino M, Haldipur N, Davis L, Cubillos J and Chan V. Validation of a mathematical model for ultrasound assessment of gastric volume by gastroscopic examination. Anesth Analg 2013; 116: 357-363.
[17] Schmidt AR, Buehler KP, Both C, Wiener R, Klaghofer R, Hersberger M, Weiss M and Schmitz A. Liberal fluid fasting: impact on gastric ph and residual volume in healthy children undergoing general anaesthesia for elective surgery. Br J Anaesth 2018; 121: 647-655.
[18] Lobo DN, Hendry PO, Rodrigues G, Marciani L, Totman JJ, Wright JW, Preston T, Gowland P, Spiller RC and Fearon KCH. Gastric emptying of three liquid oral preoperative metabolic preconditioning regimens measured by magnetic resonance imaging in healthy adult volunteers: a randomised double-blind, crossover study. Clin Nutr 2009; 28: 636-641.
[19] Chang J, Kim H, Won D, Lee J, Jung J, Min S and Hwang J. Ultrasound assessment of gastric content in fasted patients before elective laparoscopic cholecystectomy: a prospective observational single-cohort study. Can J Anaesth 2020; 67: 810-816.
[20] Tan Y, Wang X, Yang H, Pan C, Luo N, Li J, Yang F, Bei Y, Cahilog Z, Chen Q, Liu Z and Yang X. Ultrasonographic assessment of preoperative gastric volume in patients with dyspepsia: a prospective observational study. BMC Anesthesiol 2022; 22: 21.
[21] Perlas A, Arzola C, Portela N, Mitsakakis N, Hayawi L and Van de Putte P. Gastric volume and antral area in the fasting state: a meta-analysis of individual patient data. Anesthesiology 2024; 140: 991-1001.
[22] Schmidt AR, Buehler KP, Both C, Wiener R, Klaghofer R, Hersberger M, Weiss M and Schmitz A. Liberal fluid fasting: impact on gastric ph and residual volume in healthy children undergoing general anaesthesia for elective surgery. Br J Anaesth 2018; 121: 647-655.
[23] Jeong JY, Ahn JH, Shim J, Lee SH, Ryu K, Lee S and Cho E. Gastric emptying of preoperative carbohydrate in elderly assessed using gastric ultrasonography: a randomized controlled study. Medicine (Baltimore) 2021; 100: e27242.
[24] Zhu Q, Li Y, Deng Y, Chen J, Zhao S, Bao K and Lai L. Preoperative fasting guidelines: where are we now? Findings from current practices in a tertiary hospital. J Perianesth Nurs 2021; 36: 388-392.
[25] Marsman M, Kappen TH, Vernooij LM, van der Hout EC, van Waes JA and van Klei WA. Association of a liberal fasting policy of clear fluids before surgery with fasting duration and patient well-being and safety. JAMA Surg 2023; 158: 254-263.