Research Square

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Preoperative Oral Betahistine for the Prevention of Postoperative Nausea and Vomiting in Patients Undergoing Laparoscopic Cholecystectomy: A Randomized, Double-Blind, Placebo-Controlled Trial

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Abstract

Background

Postoperative nausea and vomiting (PONV) are a common complication after laparoscopic cholecystectomy, with incidence rates exceeding 50% in high-risk patients without prophylaxis. Betahistine, a histamine analogue with vestibular-modulating properties, has shown promise in reducing PONV in limited prior studies. This trial aimed to evaluate the efficacy and safety of preoperative oral betahistine as monotherapy for PONV prevention.

Methods

In this prospective, randomized, double-blind, placebo-controlled trial conducted from January 2019 to December 2021, 228 patients (ASA I–II, aged 20–60 years) scheduled for elective laparoscopic cholecystectomy were randomized to receive a single oral dose of betahistine 8 mg or identical placebo 2 hours preoperatively. No other prophylactic antiemetics were administered. The primary outcome was the incidence of PONV over 48 hours postoperatively. Secondary outcomes included nausea severity (verbal rating scale 0–10), vomiting episodes, rescue antiemetic requirements (time-to-event analyzed via Kaplan–Meier), pain scores, opioid consumption, time to oral intake, hospital discharge, patient satisfaction, and adverse events. Analysis was by intention-to-treat.

Results

PONV occurred in 36/111 patients (32.4%) in the betahistine group versus 63/111 (56.8%) in the placebo group ($P < 0.001$; relative risk reduction 42.9%, 95% CI 27.1–56.3%). Nausea severity was significantly lower in the betahistine group at most time points ($P < 0.05$). Rescue antiemetic use was reduced (25.2% vs. 45.9%; $P = 0.002$), with longer time to first dose (median 7.8 vs. 4.1 hours; log-rank $P = 0.008$). Betahistine accelerated oral intake (median 6.2 vs. 7.9 hours; $P = 0.028$), with a trend toward earlier hospital discharge (43.1 vs. 48.6 hours; $P = 0.056$) and higher patient satisfaction (8.4 ± 1.6 vs. 6.9 ± 2.1; $P < 0.001$). No serious adverse events occurred; mild adverse events (primarily headache and gastric upset) were slightly more frequent in the betahistine group (7.2% vs. 2.7%; $P = 0.121$).

Conclusion

Preoperative betahistine 8 mg effectively and safely reduces PONV incidence and severity after laparoscopic cholecystectomy, with benefits in early recovery and patient satisfaction. It represents a valuable prophylactic option warranting integration into clinical practice.

Introduction

Postoperative nausea and vomiting (PONV) remain one of the most common and distressing complications following general anesthesia, particularly in high-risk surgical procedures such as laparoscopic cholecystectomy. The incidence of PONV in patients undergoing laparoscopic cholecystectomy without prophylactic antiemetics has been reported to range from 30% to 80%, depending on patient- and procedure-related risk factors (1–3). This complication not only reduces patient satisfaction but also contributes to prolonged recovery room stay, delayed hospital discharge, increased healthcare costs, and rare but serious sequelae such as dehydration, electrolyte imbalance, and aspiration pneumonia (4, 5).

The pathophysiology of PONV is multifactorial, involving serotonergic, dopaminergic, histaminergic, and vestibular pathways in the central nervous system. Risk stratification tools, such as the simplified Apfel score, identify key predictors including female sex, history of motion sickness or previous PONV, non-smoking status, and postoperative opioid use (6, 7). In laparoscopic cholecystectomy, additional procedure-specific factors—such as pneumoperitoneum-induced abdominal distension and prolonged operative time—further elevate the risk, often classifying these patients as moderate to high risk according to consensus guidelines (4, 8).

Current management strategies emphasize multimodal prophylaxis, with serotonin (5-HT3) receptor antagonists (e.g., ondansetron), corticosteroids (e.g., dexamethasone), and dopamine antagonists (e.g., droperidol) as first-line agents (8, 9). However, despite these interventions, PONV persists in a significant proportion of patients, highlighting the need for alternative or adjunctive therapies with favorable safety profiles and novel mechanisms of action (10).

Betahistine, a histamine analogue, acts primarily as a weak H1 receptor agonist and a potent H3 receptor antagonist, enhancing histamine release and turnover in the brainstem and vestibular nuclei (11, 12). This mechanism modulates vestibular input and inhibits emetic signaling, making it effective for vertigo-associated conditions such as Ménière's disease. Emerging evidence suggests betahistine may also mitigate PONV, particularly in procedures involving vestibular stimulation or high emetic risk (13, 14). Small-scale trials have demonstrated its efficacy as an adjunct in middle ear surgery and laparoscopic gynecological procedures, reducing both nausea/vomiting and dizziness with minimal side effects (13, 15). A recent study in laparoscopic cholecystectomy similarly reported reduced PONV severity with betahistine (15).

Despite these promising findings, prior studies have been limited by small sample sizes, short follow-up periods (often ≤ 24 hours), and restricted outcome measures, potentially underestimating delayed PONV or functional recovery benefits. To address these gaps, we conducted a large-scale, randomized, double-blind, placebo-controlled trial to evaluate the efficacy and safety of preoperative oral betahistine (8 mg) in preventing PONV over 48 hours postoperatively in patients undergoing elective laparoscopic cholecystectomy, with comprehensive assessment of nausea severity, rescue antiemetic requirements, and recovery milestones. The monotherapy approach was chosen to isolate betahistine's effect, with ethical safeguards including rescue antiemetics for any PONV episodes.

Materials and Methods

Study Design and Setting

This was a prospective, randomized, double-blind, placebo-controlled clinical trial conducted at Imam Khomeini Hospital, Urmia University of Medical Sciences, Urmia, Iran, from January 2019 to December 2021. The study was approved by the Ethics Committee of Urmia University of Medical Sciences (Ethical Code: IR.UMSU.REC.1397.248) registered in the Iranian Clinical Trials Registry (IRCT20170408033280N2; registered on 2019-01-02). The trial was performed in accordance with the Declaration of Helsinki. This placebo-controlled design was ethically justified given that PONV is a self-limiting complication with available rescue antiemetic therapy (ondansetron 4 mg IV as needed). The study aimed to evaluate betahistine as monotherapy in moderate-to-high risk patients. All participants were informed of the potential risks, including the possibility of receiving placebo and experiencing PONV, and provided written informed consent acknowledging this.

Participants

Patients aged 20–60 years with American Society of Anesthesiologists (ASA) physical status I–II scheduled for elective laparoscopic cholecystectomy due to uncomplicated gallstone disease were eligible for inclusion. Exclusion criteria were: obesity (BMI ≥ 35 kg/m²), pregnancy or breastfeeding, gastroesophageal reflux disease, chronic opioid use, known allergy to betahistine, pheochromocytoma, severe renal or hepatic impairment, asthma, peptic ulcer disease, or inability to provide informed consent. History of motion sickness/PONV was assessed as a baseline risk factor to ensure inclusion of moderate-to-high risk patients, consistent with Apfel PONV risk scoring. Written informed consent was obtained from all participants.

Randomization and Blinding

Patients were randomly allocated in a 1:1 ratio to either the betahistine group or the placebo group using computer-generated random sequence (block randomization with block sizes of 4 and 6). Allocation concealment was ensured using sequentially numbered, opaque, sealed envelopes. The study was double-blinded: patients and outcome assessors (recovery room nurses and ward staff) were blinded to group assignment. The investigational drugs (betahistine and identical placebo tablets) were prepared and coded by a pharmacist not involved in the study.

Intervention

Two hours before surgery, patients in the betahistine group received a single oral dose of betahistine 8 mg, while the placebo group received an identical placebo tablet. Standard anesthetic protocol was identical in both groups: premedication with midazolam 1 mg IV, induction with propofol 2 mg/kg and

fentanyl 2 μg/kg, maintenance with sevoflurane in oxygen/air, and muscle relaxation with atracurium 0.5 mg/kg. Anesthesia was maintained with sevoflurane at 1–2% end-tidal concentration (adjusted to maintain 0.8–1.2 minimum alveolar concentration [MAC]) in a 50% oxygen/air mixture, with intraoperative fluids administered as crystalloids at 5–10 mL/kg/h based on standard institutional protocols. No nitrous oxide was used. No prophylactic antiemetics other than the study drug was administered. Postoperative analgesia was provided with IV paracetamol 1 g every 6 hours and rescue opioids (pethidine) as needed.

Outcomes

Primary outcome

Incidence of postoperative nausea and vomiting (PONV) during the first 48 hours after surgery (0–6 h, 6–24 h, and 24–48 h intervals). PONV was defined as the occurrence of any nausea (verbal rating scale [VRS] score ≥ 1), retching, or vomiting episode. Nausea and vomiting were also assessed separately as secondary outcomes.

Secondary outcomes:

- Severity of nausea assessed using a 11-point Verbal Rating Scale (VRS: 0 = no nausea, 10 = worst imaginable nausea) at 2, 6, 24, and 48 hours postoperatively.
- Number of vomiting/retching episodes.
- Need for rescue antiemetic medication (ondansetron 4 mg IV) and time to first rescue dose. Rescue antiemetic (ondansetron 4 mg IV) was administered for moderate-to-severe nausea (VRS ≥ 4), persistent mild nausea (> 30 minutes), any retching/vomiting, or at patient request.
- Postoperative pain intensity using Visual Analogue Scale (VAS 0–10) at the same time points.
- Total opioid consumption (mg morphine equivalent) in 48 hours.
- Time to first oral intake and time to hospital discharge.
- Patient satisfaction with PONV control (0–10 scale) at 48 hours.
- Adverse effects potentially related to betahistine (headache, drowsiness, skin rash).

PONV was assessed by trained nurses blinded to allocation every 30 minutes in the PACU (first 2 hours) and then at 6, 24, and 48 hours in the ward. Patients were also instructed to report any episodes immediately. Assessments at 24 and 48 hours were conducted in the surgical ward by blinded nursing staff through direct patient interview and chart review, as patients typically remained hospitalized for at least 48 hours postoperatively.

Sample Size Calculation

Sample size was calculated assuming a baseline PONV incidence of 50% in laparoscopic cholecystectomy (based on literature). To detect a clinically relevant 40% relative reduction (to 30%) in the betahistine group with 90% power and α = 0.05, a minimum of 109 patients per group was required. Accounting for a 10% dropout rate, we aimed to recruit 120 patients per group (total n = 240). The study was originally powered for sample size of 70 patients based on the registered protocol; however due to higher-than-expected patient recruitment feasibility and the opportunity to increase statistical power for analyses without introducing bias, we ultimately enrolled and analyzed 240 patients.

Statistical Analysis

Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY). Normality was assessed with the Shapiro–Wilk test. Categorical variables were compared using Chi-square or Fisher's exact test and presented as frequencies and percentages. Continuous variables were compared using independent t-test or Mann–Whitney U test and reported as mean ± SD or median (IQR) as appropriate. Time-to-event outcomes (e.g., time to rescue antiemetic) were analyzed with Kaplan–Meier curves and log-rank test. A two-sided P-value < 0.05 was considered statistically significant. Intention-to-treat analysis was performed.

Reporting Guideline

This study is reported in accordance with the CONSORT 2025 guidelines for reporting randomized controlled trials, and the completed CONSORT checklist is provided as a supplementary file 1.

Results

A total of 240 patients were assessed for eligibility at Imam Khomeini Hospital, Urmia University of Medical Sciences, between January 2019 and December 2021. Of these, 12 patients were excluded (eight did not meet the inclusion criteria and four declined to participate). The remaining 228 patients were randomized equally to the betahistine and placebo groups (114 patients each). Six patients (three in each group) were lost to follow-up due to early discharge or incomplete data collection, resulting in 111 patients per group included in the intention-to-treat analysis. The per-protocol analysis included 222 patients (Fig. 1).

Baseline demographic and clinical characteristics were generally well-balanced between the two groups, with minor differences in age (P = 0.048) and body mass index (P = 0.092) that were not clinically significant. The mean age was 43.2 ± 11.8 years in the betahistine group and 41.5 ± 10.6 years in the placebo group. Female patients comprised 68.5% of the betahistine group and 75.7% of the placebo group (P = 0.214). Duration of surgery (69.8 ± 15.1 vs. 68.9 ± 14.3 min; P = 0.312), ASA physical status distribution, and Apfel PONV risk scores were comparable between groups (P > 0.05 for remaining comparisons) (Table 1).

Table 1
Baseline Demographic and Clinical Characteristics

Characteristic	Betahistine Group (n = 111)	Placebo Group (n = 111)	P-value
Age (years), mean ± SD	43.2 ± 11.8	41.5 ± 10.6	0.048
Sex (female), n (%)	76 (68.5)	84 (75.7)	0.214
Body mass index (kg/m²), mean ± SD	27.8 ± 4.1	26.8 ± 3.7	0.092
ASA physical status, n (%)			0.612
I	62 (55.9)	58 (52.3)	
II	49 (44.1)	53 (47.7)	
Duration of surgery (min), mean ± SD	69.8 ± 15.1	68.9 ± 14.3	0.312
Apfel PONV risk score, n (%)			0.702
0–1	18 (16.2)	16 (14.4)	
2	47 (42.3)	46 (41.4)	
3–4	46 (41.4)	49 (44.1)	
History of motion sickness/PONV, n (%)	22 (19.8)	24 (21.6)	0.745

Primary Outcome: Incidence of PONV

The primary outcome, overall incidence of postoperative nausea and vomiting (PONV) during the first 48 hours, was significantly lower in the betahistine group compared with the placebo group (32.4% vs. 56.8%; $P < 0.001$), representing a relative risk reduction of 42.9% (95% CI 27.1–56.3%). Most PONV episodes consisted of nausea alone, while the incidence of vomiting (at least one episode) was 14.4% in the betahistine group versus 28.8% in the placebo group ($P = 0.009$) (Table 2).

Table 2
Incidence of Postoperative Nausea and Vomiting (PONV) by Time Interval

Time Interval	Betahistine Group n (%)	Placebo Group n (%)	P-value	Relative Risk Reduction (95% CI)
0–6 hours	23 (20.7)	43 (38.7)	0.003	46.5% (23.4–65.2%)
6–24 hours	18 (16.2)	36 (32.4)	0.006	50.0% (24.8–71.8%)
24–48 hours	9 (8.1)	16 (14.4)	0.138	43.8% (-12.5–74.3%)
Overall (0–48 hours)	36 (32.4)	63 (56.8)	< 0.001	42.9% (27.1–56.3%)
Vomiting (≥ 1 episode, overall)	16 (14.4)	32 (28.8)	0.009	50.0% (23.1–73.4%)

When stratified by time interval, the incidence of PONV remained lower in the betahistine group, particularly in early periods. In the 0–6-hour period, PONV occurred in 20.7% vs. 38.7% (P = 0.003). During 6–24 hours, 16.2% vs. 32.4% (P = 0.006), and in the delayed period (24–48 hours), 8.1% vs. 14.4% (P = 0.138), showing a trend without reaching significance (Table 2).

Secondary Outcomes

Secondary outcomes further supported the efficacy of betahistine. Nausea severity, assessed using an 11-point verbal rating scale, was significantly lower in the betahistine group at early time points: 2.1 ± 2.1 vs. 3.4 ± 2.6 at 2 hours (P = 0.001), 1.6 ± 1.9 vs. 2.9 ± 2.4 at 6 hours (P < 0.001), 1.1 ± 1.5 vs. 1.9 ± 2.0 at 24 hours (P = 0.012), and 0.5 ± 1.1 vs. 0.8 ± 1.4 at 48 hours (P = 0.089), showing a trend in the delayed period (Table 3).

Table 3
Severity of Nausea (Verbal Rating Scale, 0–10) at Different Time Points

Time Point	Betahistine Group (mean ± SD)	Placebo Group (mean ± SD)	Mean Difference (95% CI)	P-value
2 hours	2.1 ± 2.1	3.4 ± 2.6	-1.3 (-1.9 to -0.7)	0.001
6 hours	1.6 ± 1.9	2.9 ± 2.4	-1.3 (-1.9 to -0.7)	< 0.001
24 hours	1.1 ± 1.5	1.9 ± 2.0	-0.8 (-1.3 to -0.3)	0.012
48 hours	0.5 ± 1.1	0.8 ± 1.4	-0.3 (-0.6 to 0.0)	0.089

The median number of vomiting or retching episodes per patient was 0 (IQR 0–2) in the betahistine group compared with 1 (IQR 0–3) in the placebo group (P = 0.003, Mann–Whitney U test) (Table 4).

Table 4
Secondary Outcomes and Functional Recovery

Outcome	Betahistine Group	Placebo Group	P-value
Rescue antiemetic required, n (%)	28 (25.2)	51 (45.9)	0.002
Number of vomiting/retching episodes, median (IQR)	0 (0–2)	1 (0–3)	0.003
Time to first oral fluid intake (hours), median (IQR)	6.2 (4.8–8.1)	7.9 (6.1–10.3)	0.028
Time to hospital discharge (hours), median (IQR)	43.1 (38–50)	48.6 (42–56)	0.056
Patient satisfaction with PONV control (0–10), mean ± SD	8.4 ± 1.6	6.9 ± 2.1	< 0.001
Total opioid consumption (mg morphine equivalent), mean ± SD	13.2 ± 5.8	13.1 ± 5.6	0.812

Fewer patients in the betahistine group required rescue antiemetic medication (25.2% vs. 45.9%; P = 0.002) (Table 4). Kaplan–Meier analysis demonstrated a significant delay in time to first rescue dose in the betahistine group (median 7.8 hours vs. 4.1 hours; log-rank P = 0.008) (Fig. 2).

Functional recovery showed benefits in time to first oral fluid intake (median 6.2 hours vs. 7.9 hours; P = 0.028) and a trend toward earlier hospital discharge (43.1 hours vs. 48.6 hours; P = 0.056). Patient satisfaction with PONV management was significantly higher in the betahistine group (8.4 ± 1.6 vs. 6.9 ± 2.1; P < 0.001) (Table 4).

Postoperative pain intensity and total opioid consumption over 48 hours remained similar between groups (13.2 ± 5.8 vs. 13.1 ± 5.6 mg morphine equivalent; P = 0.812).

Adverse Events

No serious adverse events attributable to betahistine were reported. Mild adverse events were slightly more frequent in the betahistine group, including headache (6 [5.4%] vs. 2 [1.8%]; P = 0.279) and gastric upset (3 [2.7%] vs. 1 [0.9%]; P = 0.621), with no instances of drowsiness or skin rash (Table 5).

Table 5
Adverse Events

Adverse Event	Betahistine Group n (%)	Placebo Group n (%)	P-value
Mild headache	6 (5.4)	2 (1.8)	0.279
Mild gastric upset	3 (2.7)	1 (0.9)	0.621
Drowsiness	0 (0)	0 (0)	—
Skin rash	0 (0)	0 (0)	—
Any adverse event	8 (7.2)	3 (2.7)	0.121

Discussion

The findings of this randomized, double-blind, placebo-controlled trial demonstrate that a single preoperative oral dose of betahistine 8 mg significantly reduces the incidence and severity of postoperative nausea and vomiting (PONV) in patients undergoing elective laparoscopic cholecystectomy. With an overall PONV incidence of 32.4% in the betahistine group compared to 56.8% in the placebo group ($P < 0.001$), along with lower nausea severity scores, reduced rescue antiemetic requirements, and improved functional recovery (shorter time to oral intake and hospital discharge), betahistine emerges as a promising, safe, and cost-effective prophylactic agent. These results align with the histaminergic mechanism of betahistine, which modulates vestibular and emetic pathways through H1 agonism and H3 antagonism, potentially offering advantages in procedures involving abdominal distension and vestibular perturbation (11, 12).

Prior studies on betahistine for PONV prophylaxis have yielded supportive but limited evidence. In a randomized trial involving 100 high-risk patients undergoing laparoscopic gynecological surgery, Cho et al. reported that combining betahistine with ondansetron was superior to ondansetron alone in reducing PONV and postoperative dizziness, with PONV incidence dropping to approximately 20% versus 50% in the early postoperative period (13). Similarly, Mukhopadhyay et al. found that adding betahistine to ondansetron in middle ear surgery significantly attenuated nausea, vomiting, and vertigo compared to placebo (vomiting rates 8% vs. 36% postoperatively) (14). These earlier trials, conducted with smaller cohorts ($n = 50–100$) and shorter follow-up (typically ≤ 24 hours), focused primarily on adjunctive use with 5-HT3 antagonists and in different surgical contexts.

More recent evidence reinforces our findings. A 2025 randomized trial by Al-Khafaji et al., specifically in laparoscopic cholecystectomy ($n = 120$), demonstrated that preoperative betahistine significantly lowered PONV incidence and severity compared to placebo over 48 hours, with benefits persisting in delayed phases and minimal side effects (15). This study mirrors our design and outcomes, reporting a relative risk reduction of approximately 40–50%, consistent with our 42.9% overall reduction. However, our trial, with a larger sample size ($n = 222$ analyzed), extended outcome assessment (including time-to-event analysis via Kaplan–Meier and comprehensive recovery metrics), and stricter blinding, provides

stronger evidence of betahistine's independent efficacy without combination therapy. The Fourth Consensus Guidelines for PONV management acknowledge betahistine's potential based on these adjunctive studies but note limited data for monotherapy; our results address this gap, suggesting betahistine as a viable single-agent option in moderate- to high-risk patients (7).

The strengths of this study include its robust sample size—exceeding most prior betahistine trials—enhancing statistical power for detecting differences in both early and delayed PONV (24–48 hours), a period often overlooked despite contributing up to 30% of cases.[7] The 48-hour follow-up, intention-to-treat analysis, and inclusion of patient-centered outcomes (e.g., satisfaction and discharge time) improve clinical relevance and generalizability. Betahistine's favorable safety profile, with no serious adverse events and low rates of mild headache comparable to placebo, supports its use as a low-cost alternative, particularly in resource-limited settings.

Nevertheless, several limitations warrant consideration. As a single-center study, external validity may be constrained by institutional anesthetic practices and patient demographics (predominantly middle-aged with moderate Apfel scores). We did not include a direct comparator arm with standard agents like ondansetron or dexamethasone, limiting head-to-head efficacy assessments; future trials should explore betahistine as monotherapy versus consensus-recommended regimens. Although no confounding from opioid use or pain was observed, unmeasured factors such as perioperative fluid management or genetic polymorphisms in histamine receptors could influence outcomes. Finally, while betahistine was well-tolerated, its contraindication in pheochromocytoma and caution in peptic ulcer disease necessitate careful patient selection. Additionally, while the placebo-controlled design without standard prophylaxis may diverge from routine clinical guidelines (Gan et al., 2020), it was approved by the ethics committee to assess betahistine monotherapy, with rescue medication ensuring patient safety and minimal harm.

Conclusion

In this randomized, double-blind, placebo-controlled trial, a single preoperative oral dose of betahistine 8 mg significantly reduced the incidence and severity of postoperative nausea and vomiting (PONV) following laparoscopic cholecystectomy, with benefits extending through the delayed postoperative period (up to 48 hours). The marked decrease in rescue antiemetic requirements, lower nausea scores, and improvements in functional recovery—including earlier oral intake and hospital discharge—highlight betahistine's clinical utility as a safe, well-tolerated, and inexpensive prophylactic option.

These findings provide robust evidence supporting betahistine as an effective monotherapy for PONV prevention in moderate- to high-risk patients undergoing laparoscopic procedures, addressing limitations of prior smaller studies and complementing current consensus guidelines. Given its favorable safety profile and novel histaminergic mechanism, betahistine may be particularly valuable in multimodal strategies or as an alternative for patients at risk of side effects from conventional antiemetics.

Incorporation of preoperative betahistine into perioperative protocols could enhance patient satisfaction, reduce healthcare resource utilization, and improve postoperative outcomes. Future multicenter trials

are recommended to validate these results across diverse populations, compare betahistine directly with first-line agents such as ondansetron or dexamethasone, and explore optimal dosing regimens or combinations for maximal efficacy.

Declarations

Conflicts of Interest

The results of this study are not in conflict with the author's interests.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Urmia University of Medical Sciences (IR.UMSU.REC.1397.248) and registered in the Iranian Clinical Trials Registry (IRCT20170408033280N2; registered on 2019-01-02). All participants or their legal guardians provided written informed consent following the principles outlined in the Declaration of Helsinki.

Consent for publication

Not applicable.

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Author Contribution

E. H. Conceptualization, Methodology, Data acquisition, Formal analysis. R. N. Supervision, Conceptualization, Project administration, and Critical revision of the manuscript for important intellectual content. A. M. Validation, Data interpretation, and Critical revision of the manuscript.

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Data Availability

The dataset generated and analyzed during the current study are available from corresponding author on reasonable request.

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Figures

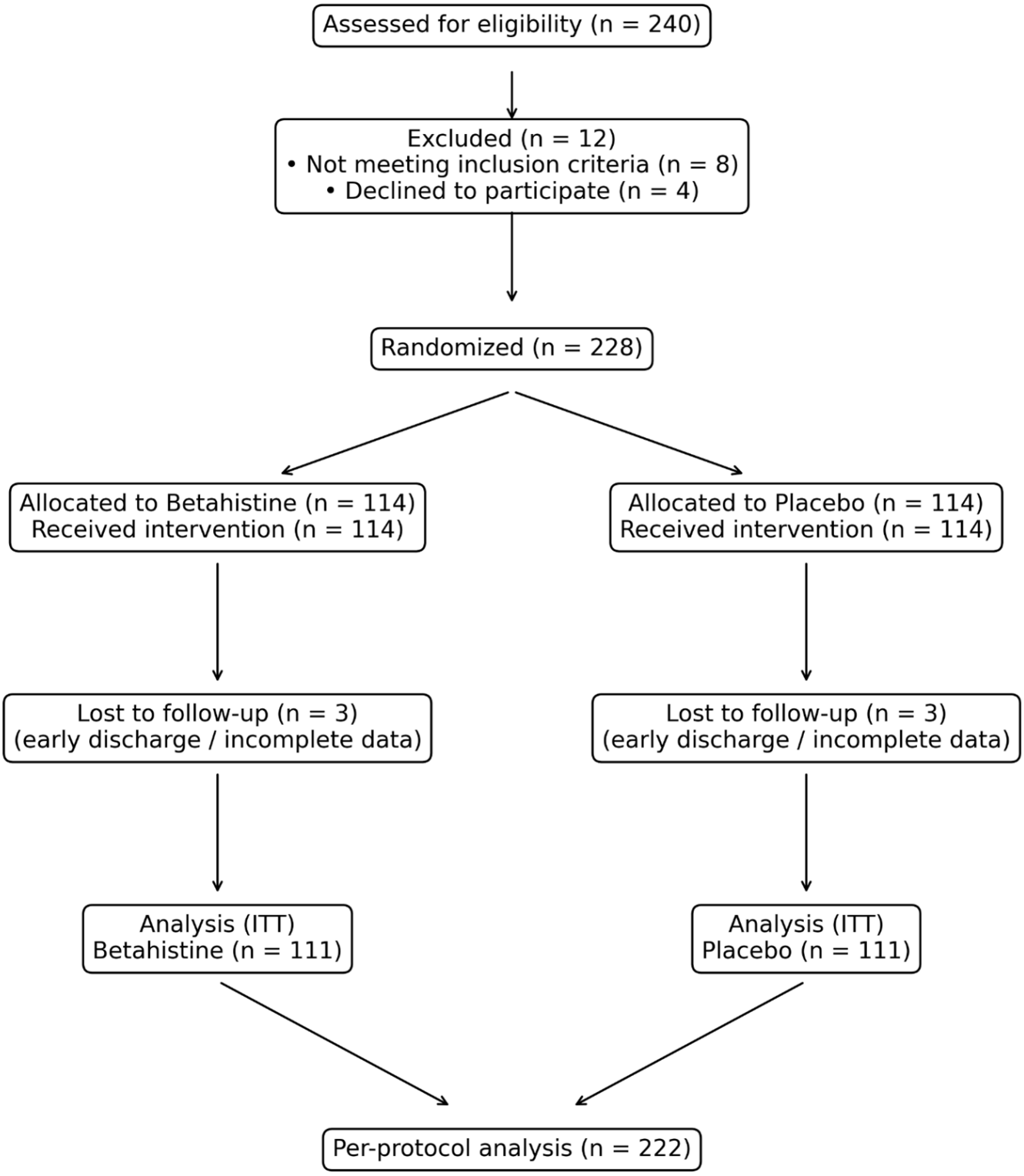
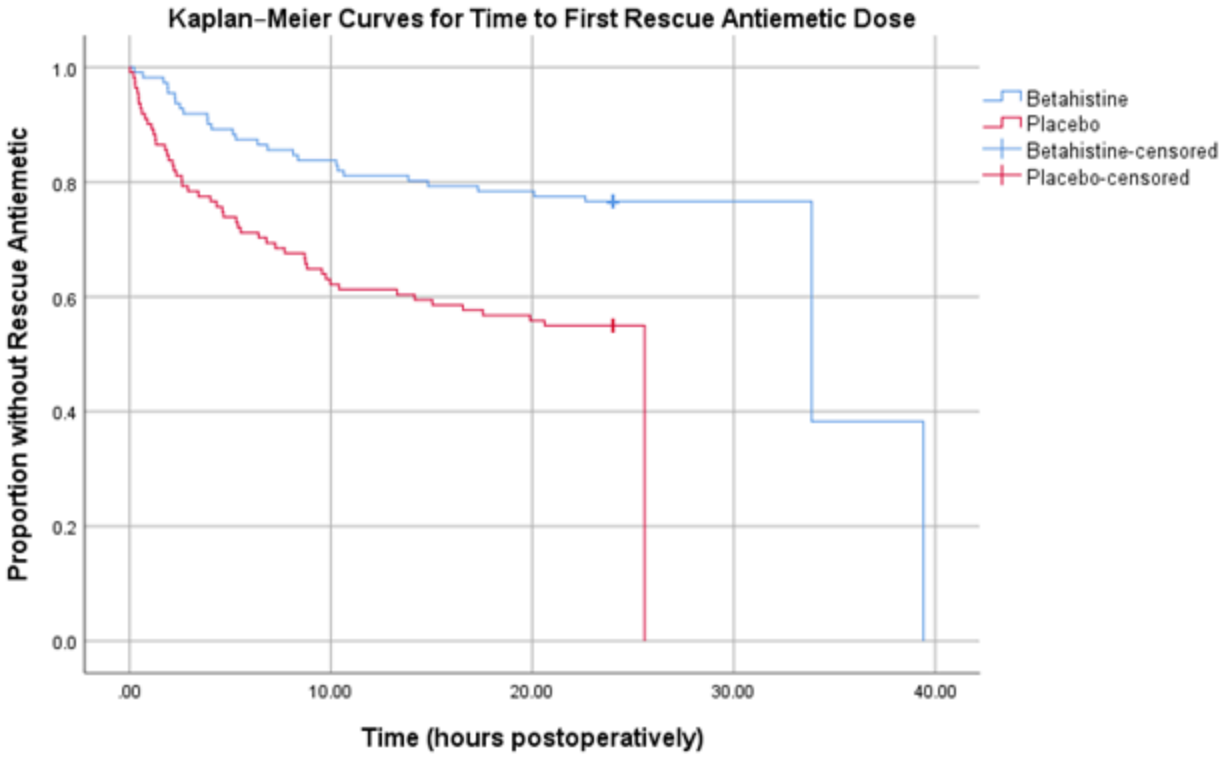


Figure 1

CONSORT flow diagram showing the progress of patients through the phases of the randomized, double-blind, placebo-controlled trial (enrollment, allocation, follow-up, and analysis). ITT, intention-to-treat.



	0	4	8	12	16	24	48
Betahistine	111	103	96	92	90	87	86
Placebo	111	87	76	69	66	61	59

Figure 2

Kaplan–Meier curves for time to first rescue antiemetic dose in patients receiving preoperative betahistine or placebo. Patients in the betahistine group had a significantly longer time to requiring rescue medication compared with the placebo group (median 7.8 hours vs. 4.1 hours; log-rank P = 0.008). The table below the graph shows the number of patients at risk at selected time points.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementaryfile1.docx