



EFFECT OF EARLY ORAL MINERAL WATER HYDRATION ON GASTROINTESTINAL TOLERANCE AND ELECTROLYTE BALANCE AFTER CORONARY ARTERY BYPASS GRAFTING

KORONER ARTER BYPASS GREFTLEME SONRASI GASTROİNTESTİNAL TOLERANS VE ELEKTROLİT DENGESİNE ERKEN ORAL MADEN SUYU HİDRATASYONUNUN ETKİSİ

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ABSTRACT

Introduction: Postoperative oral hydration supports fluid–electrolyte balance and gastrointestinal recovery, but no standardized nutritional guidelines exist for cardiac surgery patients.

Methods: This study evaluated the effect of early oral mineral water administration on gastrointestinal tolerance, electrolyte balance, and clinical outcomes after coronary artery bypass grafting (CABG). A retrospective cohort of 142 patients undergoing isolated CABG between January 2023 and June 2024 was analyzed. Patients were divided into two groups: Group 1 (n = 71) received 200 mL of chilled mineral water within two hours after extubation; Group 2 (n = 71) received standard hydration. Primary outcomes included antiemetic requirement, oral fluid tolerance, and time to first flatus. Secondary outcomes were serum electrolyte changes, atrial fibrillation incidence, and ICU length of stay.

Results: Groups were comparable in demographics. Antiemetic requirement was lower in the mineral water group (21.1% vs. 71.8%, $p < 0.001$). Oral fluid tolerance (median 5 vs. 6.5 hours, $p < 0.001$) and first flatus (median 19 vs. 28 hours, $p < 0.001$) occurred earlier. ICU stay was modestly but significantly shorter ($p = 0.009$). Postoperative magnesium (2.2 ± 0.3 vs. 1.9 ± 0.3 mmol/L, $p < 0.001$) and potassium levels ($p < 0.001$) were higher in the mineral water group, with significant within-group postoperative increases.

Conclusion: Early chilled mineral water intake after CABG was associated with better gastrointestinal tolerance, reduced antiemetic need, improved electrolyte profiles, and shorter ICU stay. Mineral water supplementation appears to be a safe and effective adjunct in postoperative cardiac care. Prospective randomized trials are needed to confirm these findings.

Keywords: Coronary artery bypass grafting, Postoperative care, Mineral water

ÖZET

Giriş: Postoperatif oral hidrasyon sıvı–elektrolit dengesini ve gastrointestinal iyileşmeyi destekler; ancak kardiyak cerrahi hastaları için standartlaştırılmış beslenme kılavuzları bulunmamaktadır.

Yöntemler: Bu çalışmada, koroner arter bypass greftleme (CABG) sonrası erken dönemde oral maden suyu verilmesinin gastrointestinal tolerans, elektrolit dengesi ve klinik sonuçlar üzerine etkileri değerlendirildi. Ocak 2023 – Haziran 2024 tarihleri arasında izole CABG uygulanan 142 hasta retrospektif olarak incelendi. Hastalar iki gruba ayrıldı: Grup 1 (n = 71) ekstübasyondan sonraki iki saat içinde 200 mL soğutulmuş maden suyu aldı; Grup 2 (n = 71) ise standart hidrasyon uygulandı. Birincil sonuçlar antiemetik gereksinimi, oral sıvı toleransı ve ilk gaz çıkarma süresiydi. İkincil sonuçlar serum elektrolit değişiklikleri, atriyal fibrilasyon insidansı ve yoğun bakımda kalış süresiydi.

Bulgular: Gruplar demografik olarak benzerdi. Antiemetik gereksinimi maden suyu grubunda daha düşüktü (% 21,1'e karşı %71,8; $p < 0,001$). Oral sıvı toleransı (medyan 5'e karşı 6,5 saat; $p < 0,001$) ve ilk gaz çıkarma (medyan 19'a karşı 28 saat; $p < 0,001$) daha erken gerçekleşti. Yoğun bakımda kalış süresi anlamlı olarak daha kısaydı ($p = 0,009$). Postoperatif magnezyum ($2,2 \pm 0,3$ 'e karşı $1,9 \pm 0,3$ mmol/L; $p < 0,001$) ve kalsiyum düzeyleri ($p < 0,001$) maden suyu grubunda daha yüksekti ve gruplar içinde anlamlı postoperatif artış gözlemlendi.

Sonuç: CABG sonrası erken dönemde soğutulmuş maden suyu tüketimi daha iyi gastrointestinal tolerans, azalmış antiemetik ihtiyacı, iyileşmiş elektrolit profili ve daha kısa yoğun bakımda kalış süresi ile ilişkili bulundu. Maden suyu desteği, postoperatif kardiyak bakımda güvenli ve etkili bir tamamlayıcı yöntem olarak görülmektedir. Bu bulguların doğrulanması için prospektif randomize çalışmalara ihtiyaç vardır.

Anahtar kelimeler: Koroner arter bypass cerrahisi, Postoperatif bakım, Maden suyu Doppler ekokardiyografi, tepe sistolik hız, renal transplantasyon, direnç indeksi

INTRODUCTION

Cardiovascular diseases have consistently remained the foremost cause of mortality worldwide for several decades, accounting for a substantial proportion of global deaths and representing a major public health challenge due to their high prevalence, chronic course, and significant socioeconomic burden.(1) In recent years, the profile of cardiac surgery patients has shifted toward an aging population with a higher burden of cardiovascular disease,

contributing to an increased risk of malnutrition, as postoperative nutrition strongly influences surgical outcomes, its prognostic importance in cardiac surgery should not be underestimated.(2) Due to the limited availability of data specifically in cardiac surgery patients, evidence is largely derived from studies in critically ill and surgical patients, demonstrating that inadequate nutritional support is associated with higher complication rates, impaired wound healing, prolonged mechanical ventilation,

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muscle loss, increased readmissions, and mortality.(3,4) While nutritional management is well-defined by guidelines in most patient populations, there is still no specific guideline standardizing nutritional therapy in cardiac surgery patients, despite the potential impact of surgery on nutritional status and the benefits of perioperative support(5)

Oral hydration represents a fundamental aspect of postoperative nutritional management, as it not only facilitates the restoration of fluid and electrolyte homeostasis but also promotes the regulation of gastrointestinal function following surgery. Given this context, exploring the role of mineral water in postoperative hydration may provide novel insights for cardiac surgery patients. Several clinical investigations have demonstrated that the administration of mineral water in different surgical patient populations may enhance postoperative recovery by supporting metabolic balance, improving gastrointestinal motility, and potentially reducing complication rates(6).

Natural mineral waters, owing to their unique chemical composition, may demonstrate superior oral bioavailability compared with plain water and other liquid dietary sources. This enhanced bioavailability has the potential to facilitate more effective hydration and to support electrolyte regulation, which could translate into clinically meaningful benefits for patients, particularly in perioperative and recovery settings where fluid and electrolyte balance is critical(7,8)

A growing body of scientific evidence has demonstrated that the regular consumption of magnesium- and bicarbonate-rich mineral waters exerts favorable biochemical and physiological effects. Specifically, such intake has been associated with reductions in circulating corticosteroid levels and improvements in urinary acid-base balance, which together contribute to the modulation of systemic blood pressure. These findings suggest a potential therapeutic role of mineral water consumption in supporting cardiovascular homeostasis and overall metabolic regulation(9–11)

Magnesium enhances pancreatic β -cell activity, thereby improving both insulin secretion and sensitivity, and also exhibits anti-inflammatory and antioxidant properties. Collectively, these effects suggest that the perioperative consumption of magnesium-rich mineral waters may contribute to improved surgical recovery(12,13)

METHODS

Study Design and Ethical Approval

This study was designed as a single-center retrospective cohort analysis. Between January 2023 and June 2024, a total of 142 patients who underwent isolated coronary artery bypass grafting (CABG) were retrospectively evaluated. The study protocol was approved by the Kastamonu University Clinical Research Ethics Committee (Approval No: 2024-KAEK-174) and conducted in accordance with the principles of the Declaration of Helsinki.

Inclusion and Exclusion Criteria

Patients who underwent isolated CABG during the study period were included. Exclusion criteria were: emergent surgery, concomitant valve procedures, renal or hepatic failure, and patients with prolonged postoperative intubation.

Anesthesia and Postoperative Care Protocol

All patients received a standardized institutional anesthesia protocol, which included induction with

midazolam, fentanyl, and rocuronium, followed by maintenance with sevoflurane and intermittent opioid administration. Postoperative care was performed according to standard intensive care unit (ICU) protocols, and extubation was undertaken once predefined clinical stability criteria were met. All surgical procedures and postoperative follow-ups were performed by the same surgical team, ensuring standardization in patient management

Patient Groups and Intervention

Patients were categorized into two groups:

- **Group 1 (n = 71):** Received 200 mL of chilled mineral water (6–7 °C) within the first two hours after extubation. The mineral water contained bicarbonate (1433.5mg/L), calcium (205.9mg/L), magnesium (124.6mg/L), sodium (138.2mg/L), potassium (26.0mg/L), iron (0.008mg/L), sulfate (176.1 mg/L), and silicate (48.2mg/L). No restrictions were applied regarding additional oral fluid intake.
- **Group 2 (n = 71):** Received standard hydration only and served as the control group.

Primary Outcomes

The primary outcomes of interest were:

- The need for antiemetic medication within the first 24 hours
- Time to tolerance of oral fluids (verified by nursing records)
- Time to first passage of flatus (verified by nursing records)

Secondary Outcomes

Secondary outcomes included:

- Perioperative changes in serum potassium and magnesium levels
- Development of atrial fibrillation (AF), diagnosed by electrocardiographic monitoring
- Length of stay in the intensive care unit (ICU)

Data Collection

Data were retrieved from the hospital information system (AKGÜN) and ICU follow-up charts. All clinical variables, medication requirements, and outcome measures were reviewed retrospectively.

Statistical Analysis

All statistical analyses were performed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Normality of distribution was assessed using the Kolmogorov-Smirnov test. Descriptive statistics were presented as frequencies and percentages for categorical data, and as means with standard deviations for numerical data.

- **Categorical variables** were compared using the Chi-square test or Fisher's Exact test.
- **Continuous variables:** For normally distributed data, the Independent Samples t-test was used; for non-normally distributed data, the Mann-Whitney U test was applied.
- **Pre- and postoperative comparisons:** Paired t-test was used for normally distributed variables, and the Wilcoxon signed-rank test for non-normally distributed variables. A p-value of <0.05 was considered statistically significant.

Table 1. Comparison of demographic and categorical variables between groups.

Variable	No Mineral Water (n = 71)	Mineral Water (n = 71)	Total (n = 142)	p-value
Age (years) ¹	64.1 ± 6.8	62.7 ± 8.7	—	0.274 ¹
Sex, n (%) ²				0.238 ²
• Female	36 (50.7)	28 (39.4)	64 (45.1)	
• Male	35 (49.3)	43 (60.6)	78 (54.9)	
Antiemetic use, n (%) ²				<0,001 ²
• No	20 (28.2)	56 (78.9)	76 (53.5)	
• Yes	51 (71.8)	15 (21.1)	66 (46.5)	
Postoperative AF, n (%) ²				0.138 ²
• No	58 (81.7)	65 (91.5)	123 (86.6)	
• Yes	13 (18.3)	6 (8.5)	19 (13.4)	

¹Independent T Test (Mean ± Standard Deviation), ²Chi Square Test Fisher's Exact Test

RESULTS

Demographic and Baseline Characteristics:

A total of 142 patients who underwent isolated CABG were included in the analysis, with 71 in the mineral water group and 71 in the control group. The mean age was comparable between groups (62.7 ± 8.7 vs. 64.1 ± 6.8 years, $p = 0.274$). Gender distribution was also similar (male: 60.6% vs. 49.3%, $p = 0.238$). These findings indicate that the groups were well balanced in terms of demographic characteristics (Table:1)

Clinical Outcomes:

The need for antiemetic medication within the first 24 hours was significantly lower in the mineral water group compared with controls (21.1% vs. 71.8%, $p < 0.001$), demonstrating a substantial reduction in postoperative nausea and vomiting. Postoperative atrial fibrillation occurred less frequently in the mineral water group (8.5% vs. 18.3%), although this difference did not reach statistical significance ($p = 0.138$)

Recovery Parameters:

The mineral water group exhibited faster postoperative recovery. Time to tolerance of oral fluids was significantly shorter (median 5 vs. 6.5 hours, $U = 591.50$, $p < 0.001$), and the time to first passage of flatus was also reduced (median 19 vs. 28 hours, $U = 272.50$, $p < 0.001$). Furthermore, ICU stay was shorter in the mineral water group (median 3 days [1–4] vs. 3 days [2–4], $U = 1935.00$, $p = 0.009$) a statistically significant difference was observed between the groups, with ICU stay being shorter in the mineral water group. However, the clinical impact of this difference appears to be modest, as the median values were identical, although the distribution shift was significant., reflecting a more favorable postoperative course (Table 2)

Biochemical Outcomes:

Preoperative magnesium levels were slightly lower in the mineral water group compared with controls (1.9 ± 0.3 vs.

Table 2. Postoperative recovery parameters across groups

Variable	No Mineral Water (n = 71)	Mineral Water (n = 71)	Test statistic	p-value ³
Potassium (PostOp)	3.4 (2.7 – 4.1) / 45.33	3.9 (3.2 – 4.5) / 97.67	4378.50	<0,001
Oral tolerance (hours)	6.5 (4.5 – 9) / 98.67	5 (3.5 – 7.5) / 44.33	591.50	<0,001
First passage of flatus (hours)	28 (18 – 32) / 103.16	19 (14 – 28) / 39.84	272.50	<0,001
ICU stay (days)	3 (2 – 4) / 79.75	3 (1 – 4) / 63.25	1935.00	0,009

³Mann Whitney U Test Median (Min-Max)/Mean Rank

Table 3. Comparison of preoperative and postoperative biochemical parameters between groups

Variable	No Mineral Water (n = 71)	Mineral Water (n = 71)	Test statistic	p-value
Mg – PreOp	2.0 ± 0.3	1.9 ± 0.3	3.313	0,001
Mg – PostOp	1.9 ± 0.3	2.2 ± 0.3	–7.417	<0,001
Potassium – PreOp	3.5 ± 0.4	3.5 ± 0.4	1.134	0.259

¹Independent T Test (Mean ± Standart Deviation)

2.0 ± 0.3 mmol/L, $p = 0.001$). However, postoperative serum magnesium was significantly higher in the mineral water group (2.2 ± 0.3 vs. 1.9 ± 0.3 mmol/L, $p < 0.001$). potassium levels did not differ between groups preoperatively ($p = 0.259$), but postoperative potassium was higher in the mineral water group (median 3.9 vs. 3.4 mmol/L, $p < 0.001$) (Table 3)

Within-Group Comparisons:

Paired analyses revealed that postoperative magnesium levels significantly increased compared with preoperative values (2.0 ± 0.3 → 2.1 ± 0.3 mmol/L; $t(141) = -3.16$, $p = 0.002$, $r = 0.39$), indicating a moderate effect size. Similarly, potassium levels increased significantly postoperatively ($z = -2.89$, $p = 0.004$), with 79 patients showing an increase, 50 a decrease, and 13 no change (Table 4).

Overall, postoperative assessments demonstrated significant increases in both magnesium and potassium levels, suggesting that the surgical process and additional mineral supplementation may exert beneficial effects on biochemical parameters

Power Analysis:

The sample size was calculated using G*Power 3.1 software. Since no directly comparable study was available in the literature, the effect size was estimated based on preliminary data obtained within the scope of the present research. In the initial analysis, two independent groups ($n = 30$ each) were compared, and the between-group difference yielded a Cohen's d of 1.41. Assuming an α level of 0.05 and a power ($1-\beta$) of 0.95, an a priori power analysis

indicated that a minimum of 12 participants per group (24 in total) would be sufficient to achieve adequate statistical power.

DISCUSSION

This In this single-center retrospective cohort study, we demonstrated that the early administration of chilled mineral water following extubation in patients undergoing isolated CABG was associated with improved gastrointestinal tolerance, favorable biochemical changes, and reduced antiemetic requirement. Postoperative symptoms such as pain, dyspepsia, discomfort, and thirst may substantially influence patient satisfaction and overall clinical condition(14) Specifically, patients receiving mineral water showed earlier tolerance of oral fluids, shorter time to first passage of flatus, and a significantly lower incidence of postoperative nausea and vomiting. In addition, postoperative serum magnesium and potassium levels were better preserved in the intervention group, and ICU length of stay was modestly but significantly reduced compared with controls.

These findings align with previous reports suggesting that perioperative oral hydration strategies can positively influence recovery after major surgery. Mineral waters, owing to their specific ionic composition, have been shown to exert favorable effects on electrolyte balance and gastrointestinal function. Our study adds to this evidence by showing that magnesium- and bicarbonate-rich mineral water may provide clinical benefits in the cardiac surgery

Table 4. Comparison of preoperative and postoperative magnesium and potassium levels

Variable	Preoperative	Postoperative	r	Test statistic	p-value ⁴
Mg	2.0 ± 0.3	2.1 ± 0.3	0.392	–3.164	0,002

⁴ Paired samples t-test (mean ± standard deviation).

Variable (Pre–PostOp)	n	Mean rank	Sum of ranks	z	p-value ⁵
Potassium – Negative ranks	50	59.31	2965.50	–2.892	0.004
Potassium – Positive ranks	79	69.60	5419.50		
Ties	13	—	—		
Total	142	—	—		

⁵ Wilcoxon signed-rank test.

population, where nutritional support is particularly critical but poorly standardized.

The marked reduction in antiemetic requirement observed in our study is of particular clinical relevance. Postoperative nausea and vomiting not only impair patient comfort but may also delay oral intake, prolong ICU stay, and increase healthcare costs. The lower rates of antiemetic use in the mineral water group may reflect enhanced gastrointestinal tolerance and accelerated recovery of gut motility. Similar effects have been described in studies involving abdominal and gynecologic surgeries, suggesting a broader potential application of mineral water in perioperative care.

From a biochemical perspective, postoperative magnesium preservation in the mineral water group is notable. Hypomagnesemia is a recognized risk factor for arrhythmias, including atrial fibrillation, in cardiac surgery patients. Although the reduction in postoperative atrial fibrillation did not reach statistical significance in our study, the numerical trend toward lower incidence in the mineral water group is consistent with the hypothesis that maintaining magnesium balance may reduce arrhythmogenic potential. Further prospective studies with larger sample sizes are warranted to clarify this association. The present study has several strengths, including a relatively large sample size, standardized anesthesia and postoperative care protocols, and detailed biochemical and clinical outcome measurements. However, several limitations must be acknowledged. First, the retrospective design may introduce selection and information bias. Second, this was a single-center experience, limiting the generalizability of the findings. Third, while the intervention was standardized in terms of mineral water type and timing, variations in additional oral fluid intake could not be fully controlled. Finally, the clinical significance of the shortened ICU stay, Although a statistically significant difference was observed, the clinical relevance appears modest since the median values were identical, despite a significant distributional shift.

CONCLUSION

Early administration of chilled mineral water following extubation in CABG patients was associated with improved gastrointestinal tolerance, reduced antiemetic requirement, and favorable biochemical outcomes, with a modest impact on ICU stay. These findings suggest that mineral water supplementation may serve as a simple, safe, and effective adjunct in the postoperative care of cardiac surgery patients. Future randomized controlled trials are required to confirm these observations and to further explore the potential role of mineral water in enhancing recovery after cardiac surgery.

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Ethics Committee Approval: The study protocol was approved by the Kastamonu University Clinical Research Ethics Committee (Approval No: 2024-KAEK-174) and conducted in accordance with the principles of the Declaration of Helsinki.

Informed Consent:

Informed consent was not obtained because the study involved the retrospective analysis of previously recorded, anonymized clinical data. The Kastamonu University Clinical Research Ethics Committee approved the waiver of informed consent.

Authorship Contributions: Concept – UY.; Design – UY.; Supervision – UY.; Materials – UY.; Data collection &/or processing – UY.; Analysis and/or interpretation –UY.; Literature search – UY.; Writing – UY.; Critical review – UY.

Conflict of Interest: The authors declare no conflicts of interest related to this study.

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