Dicle Tıp Dergisi / Dicle Med J (2025) 52 (4) : 659-670

www.diclemedj.org

Original Article / Özgün Araştırma

Evaluation of Electrolyte Imbalances and Their Impact on Mortality in Percutaneous Endoscopic Gastrostomy Patients in the Emergency Department

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Received: 04.08.2025; Revised: 10.10.2025; Accepted: 13.10.2025

Abstract

Introduction: Percutaneous endoscopic gastrostomy (PEG) is a nutritional intervention used in patients with impaired oral intake but a functioning gastrointestinal system. PEG is considered the gold standard access route for long-term enteral nutrition. This study aims to evaluate the changes in serum electrolyte levels in patients with PEG presenting to the Emergency Department (ED) and to investigate their association with clinical outcomes, including morbidity and mortality.

Methods: In this single-center retrospective cohort study, 87 patients with PEG admitted to the ED between January 1, 2021, and January 1, 2025, were analyzed.

Results: The mean age was 70.2 ± 6.8 years, and 36.8% were female. The most common admission reason was tube obstruction/leakage (48.3%). Electrolyte disturbances were detected in 21.8% of patients. The overall mortality rate was 9.2%, with all deceased patients exhibiting electrolyte abnormalities($p<0.001$). Hypochloremia, hypophosphatemia, and elevated bicarbonate levels were significantly associated with mortality ($p<0.001$ for all). Normal calcium and potassium levels correlated with increased survival ($p<0.001$; $p=0.001$, respectively). Elevated inflammatory markers (LDH, WBC, CRP) were significantly higher in non-survivors ($p<0.05$). Logistic regression identified increased bicarbonate level as an independent risk factor for mortality (OR 1.36; 95% CI 1.08–1.72; $p=0.01$). No significant associations were found between electrolyte levels and morbidity, except higher magnesium and inflammatory markers in patients with neurological or infectious complications. **Conclusion**: Electrolyte disturbances, particularly hypochloremia, hypophosphatemia, and elevated bicarbonate, are strongly associated with mortality in PEG patients presenting to the ED. Close monitoring and correction of electrolytes may improve outcomes in this vulnerable population.

Keywords: Bicarbonate, Electrolyte Disturbance, Emergency Department, Mortality, Percutaneous Endoscopic Gastrostomy (PEG)

DOI: 10.5798/dicletip.1840507

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Acil Serviste Perkütan Endoskopik Gastrostomi Uygulanan Hastalarda Elektrolit Dengesizliklerinin Değerlendirilmesi ve Mortalite Üzerindeki Etkileri

Öz

Giriş: Perkütan endoskopik gastrostomi (PEG), oral alımı bozulmuş ancak gastrointestinal sistemi işlevsel olan hastalarda uygulanan bir beslenme yöntemidir. PEG, uzun dönem enteral beslenme için altın standart giriş yolu olarak kabul edilmektedir. Bu çalışmanın amacı, PEG taşıyan ve acil servise (AS) başvuran hastalarda serum elektrolit düzeylerindeki değişiklikleri değerlendirmek ve bu değişikliklerin morbidite ve mortalite gibi klinik sonuçlarla olan ilişkisini araştırmaktır.

Yöntemler: Bu tek merkezli, retrospektif kohort çalışmasında, 1 Ocak 2021 ile 1 Ocak 2025 tarihleri arasında AS'ye başvuran PEG'li 87 hasta analiz edilmiştir.

Bulgular: Hastaların ortalama yaşı 70,2 ± 6,8 yıl olup, %36,8'i kadındı. En sık başvuru nedeni PEG tüpü tıkanıklığı/sızıntısıydı (%48,3). Hastaların %21,8'inde elektrolit bozuklukları tespit edildi. Genel mortalite oranı %9,2 olup, hayatını kaybeden tüm hastalarda elektrolit bozukluğu mevcuttu (p<0,001). Hipokloremi, hipofosfatemi ve yüksek bikarbonat düzeyleri mortalite ile anlamlı düzeyde ilişkiliydi (tümünde p<0,001). Normal kalsiyum ve potasyum düzeyleri, sağkalım ile pozitif yönde ilişkiliydi (sırasıyla p<0,001 ve p=0,001). Artmış inflamatuar belirteçler (LDH, lökosit, CRP, CRP/albumin oranı) yaşamını yitiren hastalarda anlamlı olarak daha yüksekti (p<0,05). Lojistik regresyon analizinde artmış bikarbonat düzeyi, mortalite için bağımsız risk faktörü olarak saptandı (OR: 1,36; %95 GA: 1,08–1,72; p=0,01). Elektrolit düzeyleri ile morbidite arasında anlamlı ilişki bulunmazken, nörolojik veya enfeksiyöz komplikasyonları olan hastalarda magnezyum düzeyleri ve inflamatuar belirteçlerin daha yüksek olduğu görüldü.

Sonuç: Acil servise başvuran PEG hastalarında görülen elektrolit bozuklukları, özellikle hipokloremi, hipofosfatemi ve yüksek bikarbonat düzeyleri, mortalite ile güçlü şekilde ilişkilidir. Bu kırılgan hasta grubunda elektrolitlerin yakından izlenmesi ve zamanında düzeltilmesi, klinik sonuçları iyileştirebilir.

Anahtar kelimeler: Bikarbonat, Elektrolit Bozukluğu, Acil Servis, Mortalite, Perkütan Endoskopik Gastrostomi (PEG).

INTRODUCTION

Enteral nutrition is the preferred modality for patients with a functional gastrointestinal (GI) tract but inadequate oral intake, as it preserves mucosal integrity, immune function, and microbiota balance. For individuals needing long-term enteral feeding (over 2–3 weeks), the use of percutaneous endoscopic gastrostomy (PEG) is endorsed by the European Society for Clinical Nutrition and Metabolism (ESPEN)[1,2]. PEG, involving direct tube placement into the stomach via the abdominal wall, is commonly used in palliative and intensive care settings for patients expected to need feeding for ≥4 weeks.

Indications for PEG include chronic neurological disorders causing dysphagia, head and neck malignancies or trauma, prolonged mechanical ventilation, and perioperative nutritional needs[3–5]. Before PEG placement, diagnostic clarity, prognosis, expected duration of support, patient preferences, and quality of life considerations must be evaluated. PEG is favored for its minimally invasive nature, bedside applicability under mild sedation, and cost-effectiveness.

Studies have shown that hospital-based patients receiving PEG have higher mortality rates than those managed at home or in long-term care facilities[6]. A randomized study conducted in Sweden in 2023 involving 106 patients compared outcomes between PEG and radiologically inserted gastrostomy (RIG). The results demonstrated a significantly higher 30-day mortality rate in the RIG group (14%) compared to the PEG group (2%), with statistical significance reported at[7]. Grant et al.[8] reported cerebrovascular disease (17.8%), neoplasms (9.4%), electrolyte disturbances (9.2%), and recurrent aspirations (8.3%) as the leading indications. Given the risk of refeeding syndrome, healthcare teams must monitor electrolytes closely. Initiation of feeding in malnourished patients can trigger insulin and glucose surges, leading to sodium and water retention and extracellular fluid expansion[9].

The objective of this study is to evaluate the alterations in serum electrolyte levels in patients who have undergone PEG and present it to the Emergency Department for various clinical reasons. Furthermore, the study aims to investigate the potential association between these electrolyte disturbances and clinical outcomes, including morbidity and mortality, thereby contributing to the current literature and improving clinical prediction and management strategies.

This study aims to assess changes in serum electrolyte levels among patients with a history of percutaneous endoscopic gastrostomy (PEG) who present to the Emergency Department for diverse clinical indications. Additionally, it seeks to explore the relationship between these electrolyte abnormalities and clinical outcomes such as morbidity and mortality. By doing so, the study intends to enhance the existing body of knowledge and support the development of improved clinical assessment and management approaches.

METHOD

Ethical approval

All procedures involving human participants were carried out in compliance with the ethical principles outlined by the institutional and/or national research ethics board, as well as the Declaration of Helsinki. The study received ethical approval from the Clinical Research Ethics Committee of Prof. Dr. Cemil Tascioglu City Hospital. (Aproval date: 24.03.2025; Number: E-48670771-514.99-272288584). Written informed consent from the [patients/participants OR patients/participants legal guardian/next of kin] was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Data collection

Data were retrospectively collected from electronic medical records of a total of 87 patients who underwent PEG and subsequently presented to the Emergency Department (ED) between January 1, 2021, and January 1, 2025. The mean age of the patients was 70.2 ± 6.8 years, and 32 (36.8%) of the patients were female. Demographic information, comorbidities, indications for PEG, laboratory values including serum electrolyte levels (sodium, potassium, calcium, magnesium, phosphate), clinical presentations, treatment interventions, and clinical outcomes such as length of hospital stay, morbidity, and mortality were extracted and analyzed.

Inclusion criteria

i) Age ≥18 years; ii) History of PEG placement prior to ED admission; iii) Presentation to the ED for any clinical reason during the study period; iv) Availability of serum electrolyte measurements at ED presentation; v) Complete clinical and outcome data available in the medical records; vi) Willingness to participate voluntarily in the study; vii) No condition interfering with communication; viii) No diagnosed psychiatric disorder

Exclusion criteria

i) Incomplete or missing electrolyte data at the time of ED presentation; ii) PEG placement performed less than 48 hours prior to ED admission to exclude immediate procedural complications; iii) Patients with known end-stage renal disease on dialysis, as this may independently affect electrolyte balance; iv) Patients transferred from other hospitals without sufficient clinical documentation; v) Patients lost to follow-up or without adequate post-ED clinical data. vi) PEG was not performed in patients with tumors or lesions on the anterior abdominal wall or epigastrium that could obstruct the procedure, those with coagulopathy, pathologies contraindicating gastroscopy, gastric ulcers, ascites in the abdomen, or non-functioning bowel conditions were excluded from the study.

Percutaneous Endoscopic Gastrostomy (PEG) Procedure

The procedures were performed using a Fujinon VP-4450HD video endoscope and a Fujinon EG-590WR fiber endoscope. Patients received local oropharyngeal anesthesia with lidocaine and intravenous sedation with 3–4 mg of midazolam. Prophylactic antibiotics were not administered, except in cases where patients were already receiving antibiotics due to their primary illness. The PEG procedure in all patients was performed using the Ponsky-Gauderer "pull" technique[10]. This method involves initial identification of the insertion site through endoscopic transillumination of the abdominal wall. Following localization, a guidewire is introduced at the selected puncture point and retrieved orally using endoscopic biopsy forceps. The PEG tube is then attached to the guidewire and drawn externally through the abdominal wall. To ensure accurate placement and rule out complications, a final endoscopic inspection is conducted.

Complete blood count (CBC) results were obtained using an automated hematology analyzer (Sysmex XN-1000, Sysmex, Norderstedt, Germany). Routine biochemical parameters, including glucose, cholesterol, and albumin, were assessed using an automated clinical chemistry analyzer (COBAS 8000, Roche Diagnostics, Tokyo, Japan). Serum C-reactive protein (CRP) concentrations were determined via nephelometric analysis (Siemens Dimension, Munich, Germany). The serum procalcitonin (PCT) levels were determined using the commercial Human PCT ELISA Kit (Uscn Life Science Inc., ELISA Kit, USA) according to the manufacturer's directions.

Complete blood count (CBC) parameters were analyzed by an automated hematology system (Sysmex XN-1000, Sysmex, Norderstedt, Germany). Routine biochemical markers, including glucose, cholesterol, and albumin, were measured using an automated clinical chemistry analyzer (COBAS 8000, Roche Diagnostics, Tokyo, Japan). Serum C-reactive protein (CRP) levels were quantified via nephelometry (Siemens Dimension, Munich, Germany), while procalcitonin (PCT) concentrations were assessed using a commercial ELISA kit specific for human PCT (Uscn Life Science Inc., USA).

Statistical Analyses

Statistical analyses were conducted using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as counts (n) and percentages (%), while continuous variables were reported as mean ± standard deviation. The normality of data distribution was assessed using the Kolmogorov–Smirnov test alongside visual methods such as Q–Q plots and histograms. For comparisons of categorical data, either the Pearson chi-square test or Fisher's exact test was applied, depending on suitability. The Mann–Whitney U test or Student's t-test was used to evaluate differences between two independent groups, whereas the Kruskal–Wallis test or one-way ANOVA was employed for comparisons involving more than two groups. Correlations between continuous variables were examined using Spearman's correlation analysis. To identify independent predictors of mortality, multivariate logistic regression was performed using both Enter and Forward: LR methods. Model fit was assessed via the Hosmer–Lemeshow goodness-of-fit test. A p-value less than 0.05 was considered statistically significant.

RESULTS

The mean age of the patients was 70.2±6.8 years and 32 (36.8%) of them were female. The most common reason for admission was tube obstruction/leakage with 42 (48.3). The mean duration of percutaneous endoscopic gastrostomy (PEG) was 5.2±2.3. Electrolyte deficiency was present in 19 (21.8%) patients. A total of 8 patients (9.2%) died. The most common (44.8%) morbidity was related to infection (Table 1).

Table I: Demographic and clinical characteristics of the patients (n=87) Characteristic

Characteristic	
Age (Year)	70.2±6.8
Sex (female)	32(36.8)
Duration of hospitalization (days)	5.2±2.3
Duration of percutaneous endoscopic gastrostomy (PEG) (Month)	5.5±2.0
Reason for admission to the hospital	
Fever	6(6.9)
Feeding Intolerance	12(13.8)
Nausea/Vomiting	27(31.0)
Tube Blockage/Leakage	42(48.3)
Electrolyte disturbance (yes)	19(21.8)
Nutritional deficiency (%)	
Normal	64(73.6)
Moderate and severe malnutrition	23(26.4)
Procalcitonin (µg/L)	0.1(0.1-0.1)
Procalcitonin	
Normal	67(77.0)
High	20(23.0)
Sodium (Na) (mmol/L)	138(133-142)
Sodium	
Low	26(29.9)
Normal	50(57.5)
High	11(12.6)
Chlorine (Cl) (mmol/L)	99(93-105)
Chlorine	
Low	35(40.2)
Normal	52(59.8)
Calcium (Ca) (mg/dL)	8.8(8.5-9.6)
Calcium	
Low	21(24.1)
Normal	66(75.9)
Potassium (K) (mMol/L)	3.7(3.5-4.3)
Potassium	
Low	17(19.5)
Normal	70(80.5)
Bicarbonate (HCO3) (mEq/L)	26.0(25-28)
Bicarbonate	
Normal	68(78.2)
High	19(21.8)
Phosphorus (P) (mg/dL)	3.2(2.6-4.2)
Phosphorus	
Low	19(21.8)
Normal	68(78.2)
Magnesium (Mg) (mg/dL)	2.3(1.9-2.5)
Magnesium	
Normal	87(100.0)
Lactate Dehydrogenase (LDH) (U/L)	123.0(86-163)
White Blood Cell (WBC) (10^3/µL)	8.4(7.3-9.3)

Albumin (g/dL)	3.3±0.4
Neutrophil (NEU) (10^3/μL)	7.2(5.1-11.1)
Lymphocyte (LYM) (10^3/μL)	1.3(0.9-2.0)
Prognostic Nutritional Index (PNI)	33.0±4.0
C-Reactive Protein (CRP) (mg/L)	75.0(45-136)
Morbidity (%)	
Neurological	22(25.3)
Infection	39(44.8)
Cancer	26(29.9)
Mortality (%)	8(9.2)

mean ± standard deviation, median (25.-75. Percentile), n(%)

All patients who died exhibited electrolyte imbalances ($p < 0.001$). Specifically, reduced levels of chloride and phosphorus, along with elevated bicarbonate (HCO_3), were observed consistently among non-survivors (each $p < 0.001$). Survival was significantly more frequent in individuals with normal serum calcium and potassium concentrations ($p < 0.001$ and $p = 0.001$, respectively). No statistically significant relationship was identified between mortality and magnesium levels ($p = 0.982$). Additionally, lactate dehydrogenase (LDH), white blood cell (WBC) count, and C-reactive protein (CRP) levels were notably higher in deceased patients compared to survivors ($p < 0.05$) (Table 2).

Table II: Evaluation of factors associated with mortality (n=87)

Characteristic	**Mortality**		**p value**
	No	**Yes**	
Duration of hospitalization (Day)	5.0(3.0)	7.0(6.0-8.0)	0.006
Electrolyte disturbance (%)			
No	68(86.1)	0(0.0)	<0.001
Yes	11(13.9)	8(100.0)	
Procalcitonin (μg/L)	0.1(0.1-0.1)	7.7(7.1-8.1)	<0.001
Sodium (Na) (mmol/L)	138(136-142)	122.5(120-124.7)	<0.001
Sodium			
Low	18(22.8)	8(100.0)	<0.001
Normal	50(63.3)	0(0.0)	
High	11(13.9)	0(0.0)	
Chlorine (Cl) (mmol/L)	100(94-105)	91.5(90-94)	0.001
Chlorine			
Low	27(34.2)	8(100.0)	<0.001
Normal	52(65.8)	0(0.0)	
Calcium (Ca) (mg/dL)	8.8(8.5-9.6)	8.2(8.1-8.3)	<0.001
Calcium			
Low	14(17.7)	7(87.5)	<0.001
Normal	65(82.3)	1(12.5)	
Potassium (mMol/L)	3.7(3.6-4.3)	3.4(3.2-3.6)	0.008
Potassium			
Low	12(15.2)	5(62.5)	0.001
Normal	67(84.8)	3(37.5)	
Bicarbonate (HCO3) (mEq/L)	26(24-28)	43(42.2-44.7)	<0.001
Bicarbonate			
Normal	68(86.1)	0(0.0)	<0.001
High	11(13.9)	8(100.0)	
Phosphorus (P) (mg/dL)	32.(2.7-4.2)	1.3(1.2-1.7)	<0.001
Phosphorus			
Low	11(13.9)	8(100.0)	<0.001
Normal	68(86.1)	0(0.0)	
Lactate Dehydrogenase (LDH) (U/L)	113(86-142)	318(284.5-402.7)	<0.001
White Blood Cell (WBC) (10^3/μL)	8.3(7.3-9.3)	23.8(20.4-28.6)	<0.001
C-Reactive Protein (CRP) (mg/L)	67(45-125)	208(173.2-222.5)	<0.001

Mann-Whitney U Test, Student T Test, Fisher's Exact Test, Pearson Chi-Square Test

The relationship between morbidity and patients' demographic or clinical characteristics was also examined. No significant association was detected between morbidity and the assessed clinical parameters ($p > 0.05$). However, median magnesium levels were significantly higher among patients with neurological conditions ($p = 0.015$), and median CRP values were elevated in those presenting with infectious symptoms ($p = 0.004$). These findings are summarized in Table 3.

Table III: Evaluation of factors associated with morbidity (n=87)

Characteristic	Morbidity			p value
	Neurological	*Infection*	*Cancer*	
Electrolyte disturbance (%)				
No	17(77.3)	29(74.4)	22(84.6)	0.614
Yes	5(22.7)	10(25.6)	4(15.4)	
Sodium (Na) (mmol/L)				
Low	6(27.3)	13(33.3)	7(26.9)	0.548
Normal	15(68.2)	19(48.7)	16(61.5)	
High	1(4.5)	7(17.9)	3(11.5)	
Chlorine (Cl) (mmol/L)				
Low	9(40.9)	16(41.0)	10(38.5)	0.976
Normal	13(59.1)	23(59.0)	16(61.5)	
Calcium (Ca) (mg/dL)				
Low	5(22.7)	11(28.2)	5(19.2)	0.698
Normal	17(77.3)	28(71.8)	21(80.8)	
Potassium (mMol/L)				
Low	6(27.3)	9(23.1)	2(7.7)	0.177
Normal	16(72.7)	30(76.9)	24(92.3)	
Bicarbonate (HCO3) (mEq/L)				
Normal	17(77.3)	29(74.4)	22(84.6)	0.614
High	5(22.7)	10(25.6)	4(15.4)	
Phosphorus (P) (mg/dL)				
Low	5(22.7)	10(25.6)	4(15.4)	0.614
Normal	17(77.3)	29(74.4)	22(84.6)	
Magnesium (Mg) (mg/dL)	2.5(1.9-2.6)	2.3(1.8-2.4)	2.4(2.3-2.6)	0.015
C-Reactive Protein (CRP) (mg/L)	54(42.7-104.5)	124(56-198)	48(40.5-80.2)	0.004

Kruskal-Wallis Test, Pearson Chi-Square Test

Among patients who died (n = 8), correlation analyses revealed a strong negative association between calcium and magnesium levels ($r = -0.736$, $p < 0.05$). Moreover, a very strong inverse correlation was found between calcium and procalcitonin levels ($r = -0.805$, $p < 0.05$), and a strong negative correlation was also observed between phosphorus and LDH levels ($r = -0.737$, $p < 0.05$) (Table 4).

Table IV: Correlation between the clinical parameter levels of patients who died (n=8)

	Sodium mmol/L	Chlorine mmol/L	Calcium mg/dL	Potassium mMol/L	Bicarbonate mEq/L	Phosphorus mg/dL	Magnesium mg/dL	LDH	PNI
Sodium									
Chlorine	.513								
Calcium	-.213	-.150							
Potassium	.700	.151	-.559						
Bicarbonate	.454	.126	-.621	.675					
Phosphorus	.012	-.589	.150	.151	.302				
Magnesium	-.018	.248	-.736*	.161	.025	-.652			
Lactate Dehydrogenase (LDH)	-.443	.368	-.097	-.390	-.488	-.737*	.494		
Prognostic Nutritional Index (PNI	-.054	-.062	.305	-.491	-.147	-.253	-.024	-.168	
Procalcitonin	.060	.117	-.805*	.196	.589	-.105	.642	-.072	.139

<0.25 very weak; 0.26-0.49 weak; 0.50-0.69 moderate; 0.70-0.89 high; 0.90-1.0 very high correlation *p<0.05 **p<0.01

In the evaluation of potential mortality predictors, an elevated serum bicarbonate level emerged as a statistically significant risk factor (odds ratio [OR]: 1.360; 95% confidence interval [CI]: 1.078–1.716). Other laboratory parameters did not independently predict mortality ($p > 0.05$) (Table 5).

Table V: Evaluation of Risk Factors Associated with Mortality in Patients (n=87)

Characteristic	Multivariate-Enter Method		Multivariate- Forward: LR Method	
	Odds ratio (OR) (95% CI)	P Value	Odds ratio (OR) (95% CI)	P Value
Bicarbonate (HCO3) (mEq/L)	1.826(0.924-3.611)	0.083	1.360(1.078-1.716)	0.01
Sodium (Na) (mmol/L)	0.814(0.522-1.267)	0.361	-	-
Chlorine (Cl) (mmol/L)	0.912(0.549-1.514)	0.721	-	-
Potassium (K) (mMol/L)	5.556(0.51-60.153)	0.473	-	-
Phosphorus (P) (mg/dL)	3.510(0.194-63.371)	0.395	-	-
C-Reactive Protein (CRP) (mg/L)	0.401(0.105-1.533)	0.319	-	-

Forward LR And Enter Methods Were Used For Logistic Regression Analysis.

Enter Model: Hosmer Lemeshow Test P= 0.938, Cox & Snell R2= 0.295, Nagelkerke R2= 0.642, -2 Log Likelihood= 23.066

Forward LR Model: Hosmer Lemeshow Test P= 0.987, Cox & Snell R2= 0.258, Nagelkerke R2= 0.563, -2 Log Likelihood= 27.416

DISCUSSION

Metabolic disturbances may arise due to underfeeding or overfeeding in patients receiving nutritional support. In undernourished individuals, inadequate intake of energy and protein can lead to conditions such as hyponatremia, hypokalemia, hypophosphatemia, and hypoglycemia[11]. Rapid and excessive nutritional supplementation in patients who have been fasting for prolonged periods can trigger refeeding syndrome. To prevent this, feeding should be initiated gradually. Fluid balance, plasma electrolyte levels (calcium, potassium, phosphate), as well as renal, cardiogenic, and neurogenic functions should be closely monitored and evaluated. In line with these concerns, our study found that 21.8% of patients with PEG presenting to the ED experienced electrolyte disturbances. Importantly, all patients who died (9.2%) had at least one electrolyte abnormality, with significant associations between mortality and low chloride, low phosphorus, and elevated bicarbonate levels ($p<0.001$ for all). Additionally, normal calcium and potassium levels were significantly associated with survival, while magnesium levels showed no statistical relationship with mortality. These findings underscore the critical need for vigilant electrolyte monitoring in PEG patients, particularly in emergency settings, to reduce the risk of life-threatening complications such as refeeding syndrome and to improve overall clinical outcomes.

Stenberg et al.[12], who reported that the elevated mortality observed in female patients and those with malignancies suggests that earlier PEG referral may be particularly beneficial in these subgroups. Furthermore, their analysis indicates that factors such as advanced age, presence of diabetes, heart failure, elevated CRP levels, and lower body mass index (BMI) are associated with an increased risk of unfavorable clinical outcomes. Similarly, in our study, a 9.2% mortality rate was observed, with all non-survivors presenting with electrolyte disturbances, emphasizing the critical role of metabolic balance. Moreover, the high rate of infection-related morbidity (44.8%) in our cohort aligns with prior evidence suggesting that infectious complications are a major clinical burden in PEG patients. Together, these findings reinforce the need for individualized risk assessment, early intervention, and close monitoring of both inflammatory and metabolic parameters in this vulnerable group.

In contrast to the negative prognostic implications of elevated bicarbonate observed in our study, Traunero et al.[13] reported a therapeutic benefit of bicarbonate administration via PEG in a patient with Kearns-Sayre syndrome, using continuous nocturnal infusion as a novel approach. While their case highlights the potential for targeted bicarbonate supplementation in specific mitochondrial disorders characterized by chronic acidosis, our findings suggest that non-selective or compensatory elevations in bicarbonate levels particularly in the context of metabolic alkalosis may be indicative of poor prognosis in PEG patients presenting acutely. The comprehensive review by Schrag et al.[14] identified a broad range of complications associated with PEG tube placement, including mechanical issues (e.g., tube dislodgement or blockage), infections, and metabolic disturbances, emphasizing their impact on patient outcomes and healthcare utilization.[1] In alignment with their findings, our study demonstrated that tube-related complications particularly obstruction and leakage were the most frequent reasons for emergency department admission (48.3%), and that infection accounted for the most common morbidity (44.8%). Moreover, while Schrag et al.[14] primarily highlighted infectious and mechanical complications, our data further

contribute by quantifying the prognostic significance of electrolyte imbalances, which were present in all patients who died. These results suggest that, in addition to mechanical management, routine biochemical monitoring may play a critical role in early detection of decompensation, ultimately improving survival in PEG-dependent patients.

Hypophosphatemia, observed in all deceased patients in our cohort, has been well documented in the literature as a predictor of poor outcomes in critically ill populations. According to Geerse et al.[15], low phosphate levels are associated with respiratory muscle weakness, impaired cardiac function, and increased mortality, particularly in malnourished or septic patients both of which are common in PEG-dependent individuals. Vieira et al.[9] examined the association between serum electrolyte disturbances and clinical outcomes in patients who underwent endoscopic gastrostomy. Their results indicated that electrolyte imbalances—particularly hyponatremia were common and linked to reduced survival, potentially signifying underlying severe systemic metabolic compromise. Their findings support the critical role of electrolyte homeostasis in the prognosis of PEG patients. Consistent with Vieira et al.[9], our study found that all deceased patients exhibited electrolyte disturbances, with low chloride and phosphorus levels and elevated bicarbonate concentrations correlating strongly with mortality. Additionally, survival was more common among patients with normal calcium and potassium levels. These parallels reinforce the importance of routine electrolyte monitoring and correction in patients receiving PEG to potentially reduce adverse outcomes. Moreover, the identification of bicarbonate as an independent risk factor for mortality in our cohort underscores the need for further investigation into acid-base balance as a prognostic marker in this population.

Hypochloremia has also gained recognition as a prognostic marker in acute and chronic illness. Studies such as that by Tani et al.[16] have shown that low serum chloride levels are independently associated with increased intensive care unit (ICU) mortality, likely due to their role in acid-base balance and renal function. The strong association between hypochloremia and mortality in our study supports this evidence. A total of 101 patients were evaluated, of whom 59 presented with electrolyte disturbances at the time of gastrostomy. The most frequently altered electrolyte was sodium, observed in 32 patients (31.7%), followed by magnesium and chloride in 21 patients each (20.8%). Potassium abnormalities were found in 14 patients (13.8%), while calcium and phosphorus levels were altered in 11 patients each (10.9%). Recent literature highlights the critical role of electrolyte disturbances in patients undergoing PEG. Muratori et al.[17] identified severe hypernatremia as a significant predictor of mortality post-PEG, emphasizing the need for vigilant sodium monitoring. Although Buffington and Abreo's[18] review focuses broadly on hyponatremia in critically ill patients, their insights into electrolyte management remain pertinent for PEG populations prone to complex imbalances. In our cohort of 101 PEG patients, 59 (58.4%) exhibited electrolyte abnormalities at the time of gastrostomy. Sodium alterations were observed in 32 patients (31.7%). These findings corroborate existing evidence that electrolyte imbalances are common and clinically significant in PEG patients, underscoring the necessity for comprehensive pre- and post-procedural electrolyte assessment to optimize outcomes. This contrast underscores the importance of individualized clinical evaluation, where the underlying etiology of electrolyte changes must be carefully considered before therapeutic intervention. In our study, electrolyte disturbances particularly

hypochloremia, hypophosphatemia, and elevated bicarbonate levels were strongly associated with increased mortality in PEG patients presenting to the emergency department. Together, these studies underscore the complexity of electrolyte disturbances in PEG patients and suggest that the prognostic impact of hypernatremia may vary according to clinical context and patient characteristics. Further research is warranted to clarify these differences and optimize risk stratification.

In the study by Cúrdia et al.[19], percutaneous endoscopic gastrostomy (PEG) placement was significantly associated with a decrease in serum sodium levels. This finding suggests that beyond improving nutritional and functional outcomes, PEG may influence electrolyte balance, particularly serum sodium. The observed reduction in sodium could reflect changes in fluid status, nutritional repletion, or metabolic adjustments following PEG insertion. These results highlight the importance of monitoring serum electrolytes as part of the comprehensive care in patients undergoing PEG. Muratori et al.[17] reported that severe hypernatremia is a strong independent predictor of mortality following percutaneous endoscopic gastrostomy (PEG), highlighting the critical prognostic value of sodium imbalance in this patient group. Their findings suggest that close monitoring and correction of hypernatremia may improve survival outcomes. Conversely, Vieira et al.[9] observed different results, indicating that hypernatremia was not a significant predictor of mortality in their cohort undergoing endoscopic gastrostomy. This discrepancy may reflect differences in patient populations, study design, or electrolyte management protocols. These findings are consistent with previous research indicating that electrolyte imbalances are not merely laboratory abnormalities, but markers of physiological decompensation, especially in chronically ill or malnourished patients. This striking finding reinforces the critical role of metabolic stability in PEG patients. Specifically, hypochloremia, hypophosphatemia, and elevated bicarbonate levels were significantly associated with mortality.

In the study by Du et al.[20], 160 patients with swallowing disturbances were followed for two years; 72 received PEG and 88 received nasogastric tube (NGT) feeding. Although initial complication rates including pneumonia, gastrointestinal bleeding, reflux esophagitis, and electrolyte disturbances were statistically similar between groups, long-term follow-up revealed significantly fewer complications in the PEG group. Specifically, rates of aspiration pneumonia (40.3% vs. 56.8%), gastrointestinal bleeding (26.4% vs. 43.2%), reflux esophagitis (27.8% vs. 47.7%), and electrolyte disturbances (43.1% vs. 59.1%) were significantly lower in PEG patients compared to NGT. Mortality was also reduced in the PEG group (13 vs. 22 deaths). Both PEG and NGT feeding were found to be safe and effective in the short term. However, over the long term, PEG demonstrated superiority in improving nutrition and reducing common complications compared to NGT. Therefore, PEG may be the preferred method for patients with swallowing disorders requiring prolonged enteral nutrition. Future studies with larger cohorts and diverse primary diseases, as well as extended follow-up periods, are needed to validate these findings.

Study Limitations

This study has several limitations. First, it is a single-center, retrospective cohort study, which may introduce selection and information bias due to reliance on existing medical records. The relatively small sample size limits the generalizability of the findings to broader populations. Additionally, the retrospective design precludes the establishment of a causal relationship between electrolyte disturbances and mortality. Potential confounding factors, such as comorbidities and variations in clinical

management, may not have been fully accounted for.

CONCLUSION

Our study demonstrates a high prevalence of electrolyte disturbances in patients undergoing percutaneous endoscopic gastrostomy, with sodium alterations observed in nearly one-third of the cohort. These findings align with prior evidence emphasizing the clinical significance of electrolyte imbalances in this population. However, the variability in prognostic implications of specific disturbances, such as hypernatremia, noted between different studies highlights the need for individualized assessment and management. Comprehensive monitoring of multiple electrolytes before and after PEG placement is essential to optimize patient outcomes and guide therapeutic interventions. Electrolyte disturbances, particularly hypochloremia, hypophosphatemia, and elevated bicarbonate, are strongly associated with mortality in PEG patients presenting to the ED. Routine and proactive monitoring of electrolytes and inflammatory markers may improve risk stratification and outcomes in this high-risk population. Their findings highlight the clinical importance of electrolyte monitoring, particularly in identifying patients at higher risk of mortality.

Ethical approval: All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the Helsinki declaration. Approval for this study was granted by Prof. Dr. Cemil Tascioglu City Hospital Ethics Committee for Clinical Studies (Approval date: 24.03.2025; Number: E-48670771-514.99-272288584). Written informed consent from the [patients/participants OR patients/participants' legal guardian/next of kin] was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Conflict of Interest: The authors declared no conflicts of interest.

Financial Disclosure: The authors declared that this study has receivet no financial support.

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