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Complications and factors associated with mortality in patients undergoing percutaneous endoscopic gastrostomy

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ABSTRACT

Objective: The aim of our study was to examine the factors associated with mortality in patients who underwent percutaneous endoscopic gastrostomy (PEG) and identify biomarkers that may guide clinical practice.

Methods: This retrospective observational study included adults who underwent PEG placement in our center. Demographic data, date of PEG placement, inpatient ward, PEG indication, time from admission to PEG placement, post-PEG complications, and outcome (discharge/mortality) were recorded. Logistic regression analysis was performed to identify factors associated with 90-day and 6-month mortality.

Results: Of 100 patients included in the study, 52% were men and the median age was 73 years. The most common indication for PEG was malignancy (n=25, 25%). The most common minor complication was minor peristomal bleeding and peristomal infection requiring tube removal The most common major complication was aspiration pneumonia. Thirty-eight patients (38.0%) died within 90 days and 52 patients (52.0%) died within 6 months of PEG placement. The odds of 90-day mortality were 57.5% lower per 1-unit increase in total serum protein level (odds ratio [OR]: 0.425, 95% CI: 0.230–0.888; p=0.021), 1.6% higher per 1-unit increase in serum CRP (OR: 1.016, 95% CI: 1.006–1.027; p=0.003), and 13.6 times higher in patients with aspiration pneumonia (OR: 13.631, 95% CI: 2.997–61.988; p=0.001). For 6-month mortality, a 1-unit increase in serum albumin level was associated with 81.4% lower odds (OR: 0.186, 95% CI; 0.081–0.430; p<0.001) and aspiration pneumonia with 22 times higher odds (OR: 21.984, 95% CI: 2.412–200.342; p=0.006).

Conclusion: Aspiration pneumonia, low total serum protein and albumin levels, and high CRP level were associated with higher mortality.

Keywords: PEG, indication, complication, mortality, biomarker

INTRODUCTION

Enteral nutrition (EN) is recommended for malnourished patients.[1] It is most commonly given by orogastric or nasogastric route or via a percutaneous endoscopic gastrostomy (PEG). PEG is indicated in patients who have dysphagia for any reason and have been fed by nasogastric tube for six weeks or more, have a neurological disease (such as stroke, Guillain-Barre syndrome, advanced dementia), have a diagnosis of obstructive cancer (such as head, neck, esophagus, or stomach tumor or malignant bowel obstruction), have dysphagia secondary to head trauma, or require gastric decompression.[2]

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Although PEG feeding is a well-established method used for many years, studies have shown that short-term mortality after PEG can be as high as 25%.[3-5] Some patients do not benefit from this invasive and expensive procedure but instead develop complications and impaired quality of life.[6] Thus, caution should be exercised in the selection of patients with indications for PEG. In the literature, possible predictive factors for complications and mortality after PEG include hypoalbuminemia, older age, high anesthesia risk, dementia, low body mass index, and high Charlson comorbidity index.[7-10] Therefore, careful consideration and an evaluation of risk factors is warranted when PEG is indicated. The present study aimed to determine the factors associated with complications and mortality after PEG placement in Ataturk University Hospital Department of Gastroenterology.

MATERIALS AND METHODS

This retrospective observational study included patients over the age of 18 who underwent PEG in the gastroenterology department of our university between January 1, 2016 and April 1, 2022. Data were collected from the patients' medical records and the electronic records system of the hospital. Demographic data (age, sex, chronic diseases), date of PEG placement, the ward where the patient was hospitalized at the time of PEG placement, and the time from hospital admission to PEG placement (days) were noted. Complications occurring within the first 48 hours after the PEG procedure were categorized as early complications, and those occurring at least 48 hours later as late complications. Events classified as major complications included esophageal and gastric perforation, intramuscular hemorrhage in the esophagus, major bleeding-gastric wall hematoma, necrotizing fasciitis, injury to an adjacent organ, intestinal perforation, and aspiration pneumonia. Minor complications included minimal bleeding in the esophagus, minor peristomal bleeding, peristomal leakage, PEG tube dislodgement, gastric outlet obstruction, ileus, giant bezoar, tube occlusion, gastric wall necrosis, abdominal pain, abdominal distension, vomiting, diarrhea, and peristomal infection. We recorded the type of complications distinguishing them in early (occurred during the first 30 days after gastrostomy placement) and late (occurred 30 days or more after PEG placement) phases. Laboratory parameters evaluated at the time of PEG insertion, such as leukocyte, neutrophil, and platelet counts, mean platelet volume (MPV), hemoglobin, glucose, blood urea nitrogen (BUN), creatinine, sodium, potassium, aspartate aminotransferase (AST), alanine aminotransferase (ALT), total protein, albumin, CRP, erythrocyte sedimentation rate (ESR), and procalcitonin, as well as microorganisms cultured from the PEG insertion site and their antibiotic susceptibility, treatments applied, and outcome (e.g., transfer to intensive care, discharge, death) were recorded. The hospital records system and Death Notification System of the Republic of Turkey Ministry of Health were used to determine survival after PEG placement.

Main Points

- A total of 100 patients who underwent PEG included in the study.
- The most common indication for PEG was malignancy.
- The most common minor complication was minor peristomal bleeding and peristomal infection requiring tube removal
- The most common major complication was aspiration pneumonia.
- Aspiration pneumonia, low total serum protein and albumin levels, and high CRP level were associated with higher mortality.

Statistics

The data were analyzed using SPSS version 21.0 statistical software package The Kolmogorov-Smirnov assessment was used to assess whether continuous variables fit the normal distribution. Accordingly, continuous variables were presented as median (maximum–minimum values). (Categorical data were compared between groups using chi-square test or Fisher's exact test, and continuous data were analyzed using the Student's t-test or Kruskal–Wallis and Mann–Whitney U tests as appropriate Categorical and continuous variables found to be significant in terms of mortality were used to create a multivariable logistic regression model (backward: LR; entry: 0.05 and removal: 0.10). P values less than 0.05 were considered statistically significant.

Ethical approval to conduct the study was obtained from the Atatürk University Faculty of Medicine Clinical Research Ethics Committee (date: 02.06.2022, decision number: 5).

RESULTS

Patient characteristics

The study included 100 patients who underwent PEG. The patients had a median age of 73 years (range: 21-96), and 52 (52.0%) were men. The reasons for PEG application are presented in Figure 1. The most common indication for PEG insertion was malignancy (n=25, 25.0%), of which the most common were esophageal cancer (n=18, 18.0%) and head and neck tumors (n=3, 3.0%). Of the patients with cerebrovascular disease, 17 (17.0%) had cerebral infarction and 7 (7.0%) had intracranial hemorrhage.

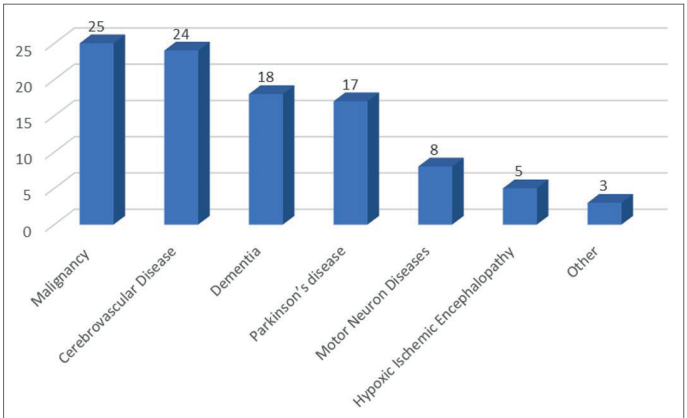

Figure 1. Indications for percutaneous endoscopic gastrostomy

The median time from hospital admission to PEG placement was 9 days (range: 1-10). The median number of diseases was 2 (range: 1-5). The patients' median Charlson Comorbidity Index score was 5 (range: 0-11). Hypertension, malignancy, and dementia were the most common chronic diseases.

Post-PEG Complications and Risk Factors

After the PEG procedure, 54 patients (54.0%) developed at least one complication and 16 patients (16.0%) developed two complications. The median ages of the patients with at least one complication and those with no complications were 74.5 years (range: 38-95) and 68.0 years (range, 21-96), respectively. Patients with at least one complication were significantly older (p=0.043). Of those who developed complications, 26 patients (48.1%) were male and 28 (51.9%) were female (p=0.404). The most common complication was aspiration pneumonia. No major complications such as necrotizing fasciitis, pneumoperitoneum, esophageal intramuscular bleeding, perforation, or adjacent organ injury were detected in any of the patients. The distribution of major, minor, and late complications after PEG placement is shown in Table 1. The most common minor complication was minor peristomal bleeding and peristomal infection requiring tube removal.

The comparison of chronic disease prevalence between patients with and without complications is shown in Table 2. There was no significant relationship between the development of complications and any chronic disease. In the complication subgroups, aspiration pneumonia was significantly more common among patients with dementia and cerebrovascular disease (p=0.010 and p=0.020, respectively). Diabetes mellitus was associated with a significantly higher rate of tube dislodgement (p=0.036). Other than these, there was no statistically significant relationship between complications and chronic diseases (p>0.05).

Table 1. Complications after PEG

Major Complications	**n (%)**
Aspiration pneumonia	14 (14.0)
Minor Complications	
Peritonitis	1 (1.0)
Minimal bleeding in the esophagus	7 (7.0)
Minor peristomal bleeding	13 (13.0)
Ileus	1 (1.0)
Tube occlusion	5 (5.0)
Late complications	
Tube dislodgement	7 (7.0)
Embedded bumper	8 (8.0)
Peristomal infection requiring tube removal	13 (13.0)

Comparisons of biomarkers evaluated at the time of PEG insertion between patients with and without post-PEG complications are shown in Table 3. Mean platelet volume and creatinine levels were significantly higher in patients with at least one complication (p=0.001 and p=0.008, respectively). Among the post-PEG complication subgroups, MPV was significantly higher in patients with minimal esophageal bleeding and minor peristomal bleeding (p=0.026 and p=0.026, respectively). We also noted significantly higher levels of CRP in patients with minimal bleeding in the esophagus (p=0.042), BUN in patients with minor peristomal bleeding (p=0.027), potassium in patients with tube occlusion (p=0.008), and sodium level and platelet count in patients with embedded bumper syndrome (p=0.033 and p=0.025, respectively).

Risk factors for 90-day and 6-month mortality after PEG

Thirty-eight patients (38.0%) died within 90 days and 52 patients (52.0%) died within 6 months of PEG placement. Comparisons of age, gender, chronic diseases, and biomarker values according to 90-day and 6-month mortality are presented in Table 4. There was no statistically significant relationship between gender and mortality. Patients who died within 6 months were significantly older (>65 year). Both 90-day and 6-month mortality were associated with longer median time from hospital admission to the PEG procedure. The 90-day mortality rate was significantly higher among patients with dementia and cerebrovascular disease, whereas the 6-month mortality rate was significantly higher in the presence of hypertension, COPD, and dementia and lower in the presence of Parkinson's disease. Among the biomarkers evaluated on the day of PEG placement, total protein and albumin were significantly lower in both the 90-day and 6-month mortality groups, while CRP, ESR,

Table 2. Distribution of chronic diseases according to the development of at least one complication and selected complication subgroups

Comorbidities	Complication, n (%)		p
	No (n=46)	Yes (n=54)	
Comorbidities	No (n=46)	Yes (n=54)	p
Hypertension	11 (26.1)	24 (44.4)	0.057
Diabetes mellitus	6 (13.0)	6 (11.1)	0.767
Coronary artery disease	7 (15.2)	13 (24.1)	0.270
Congestive heart failure	1 (2.2)	6 (11.1)	0.085
Chronic obstructive pulmonary disease	2 (4.3)	3 (5.6)	0.576
Dementia	10 (21.7)	13 (24.1)	0.782
Parkinson's disease	8 (17.4)	10 (18.5)	0.884
Cerebrovascular disease	9 (19.6)	16 (29.6)	0.247
Chronic liver disease	-	1 (1.9)	0.540
Peripheral vascular disease	-	2 (3.7)	0.289
Chronic kidney disease	1 (2.2)	1 (1.9)	0.711
Hypothyroidism	2 (4.3)	2 (3.7)	0.628
Hyperthyroidism	2 (4.3)	2 (3.7)	0.628
Malignancy	14 (30.4)	13 (24.1)	0.475
Amyotrophic lateral sclerosis	5 (10.9)	3 (5.6)	0.272
Multiple sclerosis	-	1 (1.9)	0.540
Huntington's disease	1 (2.2)	-	0.460
Major depression	1 (2.2)	1 (1.9)	0.711
Hypoxic ischemic encephalopathy	1 (2.2)	5 (9.3)	0.144
	Aspiration pneumonia, n (%)*		
	No (n=86)	Yes (n=14)	p
Dementia	16 (18.6)	7 (50.0)	0.010
Cerebrovascular disease	18 (20.9)	7 (50.0)	0.020
	Tube dislodgement, n (%)*		
	No (n=93)	Yes (n=7)	p
Diabetes mellitus	9 (9.7)	3 (42.9)	0.036

*Only statistically significant differences in chronic diseases between complication subgroups are presented.

and procalcitonin were significantly higher. Moreover, 6-month mortality was associated with significantly lower sodium and hemoglobin levels.

A comparison of complication rates according to mortality is presented in Table 5. Both 90-day and 6-month mortality were associated with statistically significantly higher rates of aspiration pneumonia. Tube displacement was significantly less frequent in patients with mortality at both 90 days and 6 months.

In order to determine independent risk factors for 90-day mortality after PEG placement, a multivariable logistic regression model was created with the presence of significant dementia and cerebrovascular disease, the development of aspiration pneumonia, and total protein, albumin, CRP, ESR, and procalcitonin values. It is presented in Table 6. The odds of 90-day mortality were 57.5% lower per 1-unit increase in total serum protein level (odds ratio [OR]: 0.425, 95% CI: 0.230–0.888; p=0.021), 1.6% higher per 1-unit increase in serum CRP (OR: 1.016, 95% CI: 1.006–1.027; p=0.003), and

Table 3. Comparisons of biomarkers evaluated at the time of PEG insertion between patients with and without post-PEG complications

Biomarker	At least one complication, median (range)		p
	No (n=46)	Yes (n=54)	
Leukocyte count (x10^3/µL)	7000 (2500 - 16800)	7080 (4030 - 20140)	0.616
Neutrophil count (mcL)	4980 (1700 - 15000)	4600 (2660 - 16420)	0.986
Lymphocyte count (mcL)	1335 (300 - 2920)	1510 (500 - 5750)	0.103
Platelet count (x10^3/µL)	216500 (21300 - 578000)	239500 (56000 - 532000)	0.213
Mean platelet volume (fL)	9.35 (6.10 - 12.20)	10.25 (6.80 - 14.20)	**0.001**
Hemoglobin (g/dL)	11.8 (7.6 - 16.9)	12.3 (7.7 - 15.5)	0.641
Glucose (mg/dL)	96.5 (61 - 226)	101 (63 - 354)	0.212
CRP (mg/L)	16.36 (4.21 - 36.4)	19.16 (3.74 - 36.92)	0.068
Creatinine (mg/dL)	0.47 (0.14 - 1.19)	0.62 (0.20 – 3.00)	**0.008**
Sodium (mg/dL)	138 (136 - 150)	138 (126 - 155)	0.773
Potassium (mmol/L)	3.94 (2.5 - 5.23)	4.03 (2.53 - 5.31)	0.686
AST (IU/L)	18.5 (6 - 100)	24 (6 - 631)	0.451
ALT (IU/L)	10.5 (2 - 94)	15.5 (1 - 172)	0.655
Total Protein (g/dL)	6.0 (4.2 - 8.2)	6.1 (4.6 - 8.4)	0.711
Albumin (g/dL)	3.01 (1.82 - 4.76)	3.05 (2.16 - 4.9)	0.790
CRP (mg/L)	25.95 (0.20 - 276.90)	21.25 (0.90 – 219.00)	0.879
ESR (mm/h)	31 (1 - 124)	33 (5 - 120)	0.594
Procalcitonin (ng/mL)	0.13 (0.01 - 1.40)	0.16 (0.02 - 16.78)	0.222
	Esophageal bleeding*		
	No (n=93)	Yes (n=7)	
Mean platelet volume (fL)	10.00 (6.10 – 14.20)	11.00 (9.30 – 11.90)	0.026
CRP (mg/L)	23.4 (0.2 – 276.9)	92.7 (19.1 – 134.4)	0.042
	Minor peristomal bleeding*		
	No (n=87)	Yes (n=13)	
Mean platelet volume (fL)	9.90 (6.10 – 14.20)	11.60 (9.30 – 11.90)	0.026
CRP (mg/L)	16.8 (3.7 – 36.9)	20.0 (8.8 – 33.4)	0.027
	Tube occlusion *		
	No (n=95)	Yes (n=5)	
Potassium (mmol/L)	4.00 (2.50 – 5.23)	4.58 (3.98 – 5.31)	0.008
	Embedded bumper syndrome*		
	No (n=92)	Yes (n=8)	
Sodium (mg/dL)	138 (124 – 155)	142 (136 – 147)	0.033
Platelet count (x10^3/µL)	221500 (21300 – 578000)	325000 (181000 – 532000)	0.025

*Only statistically significant differences in biomarkers between complication subgroups are presented.
MPV: Mean platelet volume, BUN: Blood urea nitrogen, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, CRP: C-reactive protein, ESR: Erythrocyte sedimentation rate, IU: International unit

Table 4. Comparison of age, gender, chronic diseases, and biomarker values according to 90-day and 6-month mortality with bivariate analysis

	90-day mortality, n (%)		p	6-month mortality, n (%)		p
	No (n=62)	Yes (n=38)		No (n=48)	Yes (n=52)	
Age, median (range)	72.5 (21 – 94)	74 (48 – 96)	0.245	70.5 (21 – 93)	76.5 (48 – 96)	0.016
Gender, n (%)						
Male	33 (53.2)	19 (50.0)	0.754	29 (60.4)	23 (44.2)	0.078
Female	29 (46.8)	19 (50.0)		19 (39.6)	29 (44.2)	
Days from admission to PEG, median (range)	7 (1 – 210)	12 (2 – 156)	**0.018**	5.5 (1 – 210)	12 (1 – 156)	**0.015**
Chronic disease, n (%)						
HT	22 (35.5)	14 (36.8)	0.891	11 (22.9)	25 (48.1)	**0.009**
DM	9 (14.5)	3 (7.9)	0.323	6 (12.5)	6 (11.5)	0.882
CAD	15 (24.2)	5 (13.2)	0.181	11 (22.9)	9 (17.3)	0.484
CHF	4 (6.5)	3 (7.9)	0.784	1 (2.1)	6 (11.5)	0.069
COPD	1 (1.6)	4 (10.5)	0.067	-	5 (9.6)	**0.035**
Dementia	9 (14.5)	14 (36.8)	**0.010**	6 (12.5)	17 (32.7)	**0.017**
Parkinson's disease	14 (22.6)	4 (10.5)	0.103	14 (29.2)	4 (7.7)	**0.005**
CVD	11 (17.7)	14 (36.8)	**0.032**	10 (20.8)	15 (28.8)	0.245
Chronic liver disease	1 (1.6)	-	0.620	1 (2.1)	-	0.480
PVD	1 (1.6)	1 (2.6)	0.618	1 (2.1)	1 (1.9)	0.732
CKD	1 (1.6)	1 (2.6)	0.618	-	2 (3.8)	0.268
Hypothyroidism	4 (6.5)	-	0.110	3 (6.3)	1 (1.9)	0.279
Hyperthyroidism	4 (6.5)	-	0.110	2 (4.2)	2 (3.8)	0.660
Malignancy	16 (25.8)	11 (28.9)	0.731	9 (18.8)	18 (34.6)	0.059
ALS	7 (11.3)	1 (2.6)	0.119	5 (10.4)	3 (5.8)	0.313
MS	1 (1.6)	-	0.620	1 (2.1)	-	0.480
Huntington's disease	1 (1.6)	-	0.620	1 (2.1)	-	0.480
Major depression	1 (1.6)	1 (2.6)	0.618	1 (2.1)	1 (1.9)	0.732
HIE	5 (8.1)	1 (2.6)	0.258	4 (8.3)	2 (3.8)	0.301
Biomarker, median (range)						
Leukocytes (x10^3/µL)	6895 (2500 - 20140)	7495 (4130 - 16800)	0.143	6860 (4030 - 20140)	7345 (2500 - 16800)	0.285
Neutrophils (mcL)	4225 (1700 - 16420)	5230 (2110 - 15000)	0.053	4180 (2530 - 16420)	4905 (1700 - 15000)	0.092
Lymphocytes (mcL)	1480 (300 - 5750)	1375 (320 - 2860)	0.398	1535 (300 - 5750)	1335 (320 - 2860)	0.081
Platelets (x10^3/µL)	206500 (21300 - 519000)	239500 (82000 - 578000)	0.238	216500 (21300 - 519000)	236000 (56000 - 578000)	0.661
MPV (fL)	10.05 (6.1 - 14.2)	9.9 (6.9 - 12.4)	0.589	10.15 (6.1 - 14.2)	9.9 (6.8 - 12.4)	0.874
Hemoglobin (g/dL)	12.5 (7.6 - 15.8)	11.05 (7.7 - 16.9)	0.053	13.25 (7.6 - 15.8)	11 (7.7 - 16.9)	**0.003**
Glucose (mg/dL)	99 (63 - 354)	100 (61 - 187)	0.859	98 (68 - 354)	101.5 (61 - 239)	0.684
BUN (mg/dL)	18.23 (3.74 - 36.92)	17.53 (5.14 - 36.4)	0.798	18.98 (3.74 - 33.40)	16.58 (5.14 - 36.92)	0.467
Creatinine (mg/dL)	0.60 (0.18 - 3)	0.60 (0.14 - 1.55)	0.499	0.6 (0.18 - 1.3)	0.6 (0.14 - 3)	0.983
Sodium (mg/dL)	138 (126 - 147)	139 (124 - 155)	0.929	139 (131 - 147)	137 (124 - 155)	**0.016**
Potassium (mmol/L)	4.04 (2.74 - 5.23)	3.89 (2.5 - 5.31)	0.201	4.13 (2.74 - 4.82)	3.84 (2.5 - 5.31)	0.120
AST (IU/L)	19.5 (6 - 283)	19 (6 - 631)	0.720	19 (9 - 283)	19.5 (6 - 631)	0.661
ALT (IU/L)	12.5 (1 - 172)	13 (2 - 153)	0.969	12.5 (1 - 172)	13 (2 - 153)	0.727
Total protein (g/dL)	6.25 (4.7 - 8.4)	5.8 (4.2 - 7.6)	**0.001**	6.30 (4.88 - 8.40)	5.85 (4.20 - 7.6)	**<0.001**
Albumin (g/dL)	3.32 (2.24 - 4.9)	2.76 (1.82 – 4.00)	**<0.001**	3.50 (2.24 - 4.76)	2.78 (1.82 - 4.9)	**<0.001**
CRP (mg/L)	16.8 (0.2 - 165.5)	56.1 (3.0 - 276.9)	**<0.001**	8.1 (0.2 - 165.5)	33.85 (2.3 - 276.9)	**<0.001**
ESR (mm/h)	27 (2 - 114)	34 (1 - 124)	**0.044**	24 (2 - 114)	35 (1 - 124)	**0.004**
Procalcitonin (ng/mL)	0.12 (0.01 - 1.4)	0.19 (0.05 - 16.78)	**<0.001**	0.10 (0.01 - 1.4)	0.12 (0.03 - 16.78)	**<0.001**

HT: Hypertension, DM: Diabetes mellitus, CAD: Coronary artery disease, CHF: Congestive heart failure, COPD: Chronic obstructive pulmonary disease, CVD: Cerebrovascular disease, PVD: Peripheral vascular disease, CKD: Chronic kidney disease, ALS: Amyotrophic lateral sclerosis, MS: Multiple sclerosis, HIE: Hypoxic ischemic encephalopathy, MPV: Mean platelet volume, BUN: Blood urea nitrogen, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, CRP: C-reactive protein, ESR: Erythrocyte sedimentation rate, IU: International unit

Table 5. Comparison of complication rates according to mortality in bivariate analysis

Complication, n (%)	90-day mortality, n (%)		p	6-month mortality, n (%)		p
	No (n=62)	Yes (n=38)		No (n=48)	Yes (n=52)	
At least one complication	34 (54.8)	20 (52.6)	0.830	24 (50.0)	30 (57.7)	0.441
Major Complication						
Aspiration pneumonia	3 (4.8)	11 (28.9)	**0.001**	1 (2.1)	13 (25.0)	**0.001**
Minor Complication						
Peritonitis	1 (1.6)	-	0.620	1 (2.1)	-	0.480
Minimal bleeding in the esophagus	2 (3.2)	5 (13.2)	0.071	2 (4.2)	5 (9.6)	0.253
Minor peristomal bleeding	9 (14.5)	4 (10.5)	0.401	6 (12.5)	7 (13.5)	0.562
Ileus	-	1 (2.6)	0.380	-	1 (1.9)	0.520
Tube occlusion	4 (6.5)	1 (2.6)	0.368	2 (4.2)	3 (5.8)	0.538
Late Complication						
Tube dislodgement	7 (11.3)	-	**0.031**	6 (12.5)	1 (1.9)	**0.044**
Embedded bumper	7 (11.3)	1 (2.6)	0.119	6 (12.5)	2 (3.8)	0.110
Peristomal infection requiring tube removal	10 (16.1)	3 (7.9)	0.191	6 (12.5)	7 (13.5)	0.886
Late necrotizing fasciitis	-	1 (2.6)	0.380	-	1 (1.9)	0.520

Table 6. Last row of logistic regression models for 90-day and 6-month mortality risk factors

90-day mortality *	B	Standard error	Odds ratio	95% CI for EXP(B)		P
				Lower	Upper	
Constant	3.157	2.119	23.502			0.036
Total protein	-.794	.345	0.425	0.230	0.888	0.021
CRP	.016	.005	1.016	1.006	1.027	0.003
Aspiration pneumonia	2.612	.773	13.631	2.997	61.988	0.001
6-month mortality**						
Constant	5.041	1.330	154.646			<0.001
Albumin	-1.681	0.427	0.186	0.081	0.430	<0.001
Aspiration pneumonia	3.090	1.127	21.984	2.412	200.342	0.006

Omnibus tests; *Model chi-square: 33.992, degrees of freedom: 3, p<0.001 **Model chi-square: 33.481, degrees of freedom: 2, p<0.001 Hosmer and Lemeshow tests; * Model chi-square: 2.006, degrees of freedom: 8, p=0.981 **Model chi-square: 6.056, degrees of freedom: 8, p=0.641

13.6 times higher in patients with aspiration pneumonia (OR: 13.631, 95% CI: 2.997–61.988; p=0.001). Similarly, a multivariable logistic regression model was created with the presence of significant dementia and COPD, development of aspiration pneumonia complications, sodium, hemoglobin, total protein, albumin, CRP, ESR, and procalcitonin levels to predict 6-month mortality after PEG placement. In this model, a 1-unit increase in serum albumin level was associated with 81.4% lower odds (OR: 0.186, 95% CI; 0.081–0.430; p<0.001) and aspiration pneumonia with 22 times higher odds (OR: 21.984, 95% CI: 2.412–200.342; p=0.006).

DISCUSSION

PEG is a safe and effective method for the enteral feeding of patients experiencing dysphagia for various reasons. In our study including 100 patients with an average age of 73 years, we determined that high serum CRP and low total protein were independent risk factors for 90-day mortality, while low serum albumin was an independent risk factor for 6-month mortality after undergoing PEG. Both 90-day and 6-month mortality were associated with longer median time from hospital admission to the PEG

procedure. Moreover, the development of aspiration pneumonia was a strong risk factor for both 90-day and 6-month mortality.

There are different observations in the literature regarding major and minor complications of PEG. The rate of major complications was reported by Richards et al. as 8.7% in their study of patients with malignancy[11] and as 7.4% by Grant et al. in a meta-analysis of patients diagnosed with head and neck cancer.[12] In studies conducted in patient groups other than cancer, the rate of major complications varies between 1% and 9%.[13-15] It has been debated in the literature whether aspiration pneumonia should be considered a complication or a result of the underlying disease.[16] Previous studies also showed that aspiration pneumonia was more common in patients with dementia.[17] In our study, aspiration pneumonia was classified as a major complication and was common (14%). It was significantly more frequent among patients with dementia and cerebrovascular disease. While it remains unclear whether this complication is associated with the PEG procedure itself or the underlying disease, the presence of aspiration pneumonia was identified as an independent risk factor for both 90-day and 6-month mortality.

The most common minor complications of PEG are minor peristomal bleeding and peristomal infection requiring tube removal, which occurred in our study at rates of 13% and 7%, respectively. Major bleeding was not observed in any of our patients. In the literature, bleeding rates vary between 1.2% and 3.3%.[18-20] A recent study reported that 0.4% of bleeding was directly attributable to PEG, while other bleeding occurred secondary to gastric or duodenal ulcer, the biopsy site, or nasogastric trauma.[20] The use of H2 blockers or proton pump inhibitors (PPI) in patients with low bleeding risk has been proposed as an explanation.[18] Although prior use of H2 blockers or PPIs was not investigated in our study, our results showed that CRP values were higher in patients with minimal esophageal bleeding and BUN values were higher in patients with minor peristomal bleeding. The relatively high bleeding rates in our study can be explained by the patients' worse general condition and greater likelihood of bleeding in patients with uremia.

Studies have shown that 30-day mortality after PEG is lower in Eastern countries compared to Western countries. Rates of 2.3% to 4% have been reported in studies conducted in Eastern countries.[21-25] This has been attributed to a potential cultural barrier to PEG feeding in Eastern countries, as the PEG procedure is considered too invasive for older patients.[26,27] In a study of patients with cerebrovascular disease, the 30-day post-PEG mortality rate was found to be 2.4%.[18] In another study conducted in Turkey, Karasahin et al. reported a 30-day mortality rate of 28.3%.[28] In our study, 38% of the patients died within 90 days and 52% within 6 months. Our high mortality rates can be explained by the fact that a large proportion of our patients had malignancy and comorbidities were common.

Albumin and CRP levels are used as acute and short-term prognostic indicators in patients undergoing PEG.[29,30] In a study conducted by Blomberg et al., CRP level higher than 10 mg/L and albumin level lower than 3.0 g/dL were shown to be independent risk factors for post-PEG mortality. In the same study, a mortality rate of up to 20.5% was reported in patients with both elevated CRP levels and hypoalbuminemia.[29] Similarly, another study demonstrated that mortality was up to 60% among patients with CRP level higher than 21.5 mg/L and albumin level lower than 3.15 g/dL.[18] It was also reported that CRP levels over 50 mg/L after PEG increased mortality by up to 18%. In that study, albumin levels lower than 2.8 g/dL were shown to be an independent risk factor for mortality in patients with dementia.[31] Similarly, in the Turkish study conducted by Karasahin et al., CRP level higher than 78.3 mg/L and albumin level lower than 2.71 g/dL were found to be independent risk factors for mortality.[28] Consistent with the literature, our results indicated that a 1-unit increase in albumin level reduced the risk of 6-month mortality by 0.186 times, while a 1-unit increase in CRP level increased the risk of 90-day mortality by 1.016 times. Hypoalbuminemia may be associated with anorexia resulting from cytokine release in chronic inflammatory conditions. There is also evidence in the literature associating the coexistence of hypoalbuminemia and CRP with numerous diseases.[32,33]

The European Society for Clinical Nutrition and Metabolism (ESPEN) does not recommend PEG in patients with short life expectancy, terminal cancer, or advanced dementia.[6] Likewise, the European Society of Gastrointestinal Endoscopy (ESGE) does not recommend PEG for patients with a life expectancy of less than 30 days.[34] It is also important to determine the medical and ethical indications of the patients. A reduction in quality of life has been demonstrated after the PEG procedure in people with serious comorbidities. Although the relationship between PEG and mortality has been examined in the literature, the timing of the procedure may also be important. Dietrich et al.[35] reported that early PEG placement could help prevent weight loss and the catabolic process. The ESGE guideline (2021) also recommends that PEG be performed in patients with chronic degenerative diseases or some malignancies who have weight loss despite oral nutrition therapy.[34] However, in patients with severe malnutrition or advanced disease, PEG is risky and increases mortality. In addition, several studies have shown that survival is longer in those

with high serum albumin levels.[18,30,36,37] This information is consistent with our findings that lower serum albumin levels and longer time from hospital admission to PEG were associated with higher mortality at both 90 days and 6 months.

Although this study is among the few examining PEG complications and their relationship with on mortality in our country, it has certain limitations. Firstly, the study was conducted retrospectively with a small number of patients from a single center. In addition, although we suspect the low total protein levels may be associated with malnutrition, the study did not include a malnutrition screening or assessment. Furthermore, this study does not clearly establish whether aspiration pneumonia occurs as a result of PEG or the underlying condition that led to PEG placement. To better understand this relationship, patients who developed aspiration pneumonia after PEG should be examined in more detail in terms of their underlying diseases and history of aspiration pneumonia before PEG. Finally, parameters such as body mass index and preoperative American Society of Anesthesiologists (ASA) score, which may also be associated with mortality, were not analyzed.

CONCLUSION

In this study, mortality was found to be negatively associated with albumin level at the time of PEG placement and positively associated with the development of aspiration pneumonia. Hypoalbuminemia caused by malnutrition and is considered an indication for PEG. Post-PEG mortality is higher in patients at high risk of aspiration. Those diagnosed with cerebrovascular disease and dementia should be monitored closely.

Ethical approval: The study was approved by the Atatürk University Faculty of Medicine Clinical Research Ethics Committee (5/02.06.2022).

Informed consent: Since our study was a retrospective study, written consent was not obtained from the patients.

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