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General Characteristics and Clinical Outcomes of Patients Undergoing Percutaneous Endoscopic Gastrostomy During Medical Intensive Care Unit Stay

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Abstract

Aim: Percutaneous endoscopic gastrostomy (PEG) is a procedure performed to provide long-term enteral nutritional support and is sometimes carried out while the patient is still in the intensive care unit (ICU). This study aimed to examine patients who underwent PEG in the ICU, to better understand the characteristics of this intervention and assess its appropriateness in the ICU.

Study Design: We conducted a retrospective review of 42 patients who underwent PEG during their stay in the medical ICU of a university hospital between January 1, 2018 and December 31, 2021. Data collected included demographic characteristics, underlying comorbidities, ICU admission details, PEG procedure specifics, and both ICU and post-discharge outcomes. Patients were grouped based on ICU survival and the presence of PEG-related complications, and statistical comparisons were made between these subgroups.

Results: The median patient age was 76.5 years, and 57% were male. Hypertension (59.5%) was the most common comorbidity, and the leading cause of ICU admission was acute respiratory failure (83.3%). The median ICU length of stay was 52 days, with PEG performed on a median of the 27th ICU day. Seventeen patients (40.5%) died in the ICU; however, none of these deaths were related to the PEG procedure. Minor complications occurred in 11 patients (26.2%). While there was no statistically significant difference in survival between those who developed complications and those who did not, both ICU and hospital stays were significantly longer in patients who developed complications. Among the 25 patients discharged or transferred from the ICU, 24 died within a median of four months. Only one patient was still alive as of June 2024, indicating a maximum survival of 52 months.

Conclusions: Given that 17 patients died before ICU discharge and 24 died within four months afterward, PEG placement should be carefully considered in the ICU setting and potentially deferred until after ICU discharge. The patient's long-term prognosis should be critically evaluated before proceeding with PEG placement.

Keywords: Complication; Indication; Intensive care unit; Long-term outcome; Percutaneous endoscopic gastrostomy; Short-term outcome; Timing.

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Introduction

Nutritional status is a critical determinant of overall health, influencing bodily functions and significantly impacting prognosis in both acute and chronic illnesses. Timely assessment, continuous monitoring of patients' nutritional status, and adequate supplementation of essential nutrients are vital to preventing both short- and long-term morbidity and mortality.[1,2] Oral intake is the optimal route for providing nutrition. However, in certain situations, despite a functioning gastrointestinal system, patients may be unable to consume food orally, may not meet their nutritional requirements through oral intake alone, or may be restricted from oral feeding due to risks such as aspiration. In the short term, these patients often receive enteral nutrition via feeding tubes. For long-term nutritional support, however, a more durable solution is needed. Gastrostomy is one of the most commonly used methods for long-term enteral feeding,[3,4] and it can be performed surgically, radiologically, or endoscopically.[5] Among these methods, percutaneous endoscopic gastrostomy (PEG), first introduced by Gauderer et al. in 1980,[6] has become the preferred technique due to its ease of application, cost-effectiveness, lower complication rates, and overall efficiency.[7,8]

Enteral feeding remains the primary nutritional intervention for critically ill patients who have preserved gastrointestinal function but are unable to eat orally. Initially, this is typically achieved using nasogastric, nasoduodenal, or nasojejunal tubes.[9] However, for patients requiring prolonged stays in the intensive care unit (ICU), or those transitioning to home care, nursing homes, or palliative care centers, a PEG may be placed while the patient is still in the ICU to ensure safe and sustained enteral nutrition.[10] In this study, we aimed to evaluate the characteristics of patients who underwent PEG placement in the medical ICU of a university hospital. We also sought to assess these patients' short- and long-term outcomes and to determine the appropriateness of performing PEG procedures within the ICU setting.

Materials and Methods

This study was conducted in the medical ICU of Gazi University Hospital, a tertiary care facility with nine ICU beds and an annual admission volume of approximately 300–350 adult medical patients. All patients (n=1,185) admitted to the ICU between January 1, 2018 and December 31, 2021, were screened for inclusion in the study. Patients aged 18 years and older who underwent PEG procedure during their ICU stay were included. The exclusion criteria were: (1) patients who already had a gastrostomy at the time of ICU admission; (2) patients for whom PEG was planned during the ICU stay but performed after transfer to a hospital ward or after hospital discharge; and (3) patients with incomplete data. Data were collected retrospectively from the ICU's physical archives, electronic patient database, and the hospital's information management system. Collected data included the following: patient characteristics (age, gender, and underlying diseases), ICU admission and stay characteristics (date and source of ICU admission, severity of acute illness, presence of organ failure, risk of malnutrition, primary diagnosis for ICU admission, treatments received, infections present on admission or acquired during the ICU stay, and lengths of ICU and hospital stay), and PEG procedure characteristics (date, location, and operator of the procedure; pre-procedure laboratory investigations; presence of tracheostomy; use of prophylactic antibiotics; timing of enteral feeding initiation post-procedure; and classification of complications as early or late, minor or major). Additionally, ICU outcomes (survived or deceased) and the duration of survival following ICU discharge or transfer with PEG in place were recorded. Although the study group was relatively small, subgroup analyses were conducted to better characterize patient and procedure variables. Details of these groupings are provided in the Statistical Analysis section below.

Ethical Considerations

Ethics committee approval was obtained from the Gazi University Clinical Research Ethics Committee (Decision No: 361, Date: 16.05.2022).

Statistical Analysis

Descriptive statistics were first performed for all included patients. Continuous variables were reported as medians with interquartile ranges (1st-3rd quartiles), while categorical variables were presented as frequencies and percentages. The study population was then divided into subgroups for comparative analysis: (1) survivors vs. non-survivors in the ICU, and (2) patients with vs. without complications following the PEG procedure. Demographic data, ICU admission characteristics, and PEG procedure details were compared between groups.

The Mann-Whitney U test was used to compare continuous variables, while Pearson's chi-square test or Fisher's exact test (as appropriate) was used for categorical variables. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). A p-value of <0.05 was considered statistically significant.

Results

A total of 42 patients who underwent PEG during their ICU stay at Gazi University Hospital were included in the study between January 1, 2018 and December 31, 2021. The median age of the patients was 76.5 years [58-84.25], and 24 (57.1%) were male. The most common underlying conditions were hypertension (25 patients, 59.5%) and neurological disorders, including cerebrovascular accidents (CVA), Alzheimer's disease, dementia, Parkinson's disease, and amyotrophic lateral sclerosis, which were present in 23 patients (54.8%). The leading reasons for ICU admission were acute respiratory failure (35 patients, 83.3%) and sepsis or septic shock (25 patients, 59.5%).

Patients were admitted to the ICU from the emergency department (14 patients, 33.3%), other ICUs (13 patients, 31%), internal medicine or other hospital wards (13 patients, 31%), and other hospitals (two patients, 4.8%) (Table 1).

Severity Scores and Clinical Course

The median admission scores at ICU admission were as follows: Acute Physiology and Chronic Health Evaluation (APACHE) II: 20 [16-25.25], Sequential Organ Failure Assessment (SOFA): 6 [5-8.25], Glasgow Coma Scale (GCS): 11.5 [8-13], and Modified Nutrition Risk in the Critically Ill (mNUTRIC): 5 [4-7]. The median time from hospital admission to ICU admission was 6 days [2-14.75]. The median ICU length of stay was 52 days [35-78.25], and the median total hospital stay was 72.5 days [49.75-114]. Most patients (40 patients, 95.2%) required invasive mechanical ventilation (IMV), with a median IMV duration of 54.5 days [36.5-77.25]. Nosocomial infections were observed in 41 patients (97.6%), most commonly ventilator-associated pneumonia (VAP) (39 patients, 92.9%) and catheter-related bloodstream infections (28 patients, 66.7%).

All patients received enteral nutrition via feeding tubes prior to PEG placement. Nine patients (21.4%) also received supplementary parenteral nutrition. In addition to PEG, tracheostomy was performed in 36 patients (85.7%) during their ICU stay (Table 1).

PEG Procedure Characteristics

The PEG procedure was performed on a median of the 27th ICU day [11.75-40]. Swallowing assessments were documented prior to the procedure in only four patients (9.5%). The majority of PEG procedures were performed by gastroenterologists (36 patients, 85.7%), while general surgeons conducted the remaining six procedures (14.3%). During the Coronavirus Disease 2019 (COVID-19) pandemic period, 28 patients (66.7%) were tested for Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) via polymerase chain reaction (PCR) prior to the procedure; all results were negative. All PEG procedures were performed in the endoscopy unit, under sedation and analgesia, with anesthesiologist supervision. Accordingly, anesthesiology consultations were arranged for all patients prior to the procedure. Based on the American Society of Anesthesiologists (ASA) Physical Status Classification System, six patients (14.3%) were classified as ASA III and 36 patients (85.7%) as ASA IV (Table 2).

Enteral feeding was initiated at a median of 8 hours [6-21] following PEG placement, typically using low-dose standard nutritional formulas. Only one patient (2.4%) received prophylactic antibiotics; however, 35 patients (83.3%) were already receiving antibiotics at the time of procedure. Laboratory parameters measured within 24 hours prior to the procedure were within normal limits (Table 2).

Post-PEG Complications

Complications were categorized as early (within 48 hours) or late (≥1 week post-procedure). Early complications included peristomal bleeding (one patient, 2.4%) and leakage (one patient, 2.4%). Late complications included tube dislodgement (two patients, 4.8%), peristomal infection (five patients, 11.9%), leakage (one patient, 2.4%), and feeding intolerance (one patient, 2.4%). None of these was classified as major complications. One patient with feeding intolerance required conversion to a PEG-J (a feeding tube that extends from the gastrostomy to the jejunum). In two patients (4.8%) with late complications, the original gastrostomy tubes were removed and reinserted at new sites (Table 2).

Table 1. General characteristics of patients who underwent percutaneous endoscopic gastrostomy (PEG) in the intensive care unit (ICU) and subgroup comparisons (survivors vs. non-survivors; patients with vs. without PEG-related complications)

Parameters	Total (n=42)	Survivors (n=25)	Non-Survivors (n=17)	p	Complication (+) (n=11)	Complication (-) (n=31)	p
Demographic Parameters							
Age* (years)	76.5 [58-84.25]	75 [57.5-82]	81 [67-86]	0.104	78 [39.5-86]	76 [59.5-84.5]	0.608
Male, n (%)	24 (57.1)	16 (64)	8 (47.1)	0.276	4 (36.4)	20 (64.5)	0.139
Acute Illness Severity, Organ Failure, and Nutritional Risk Assessment Scores							
APACHE II*	20 [16-25.25]	19 [16-22]	22 [16-29]	0.237	20 [13.5-24]	20 [17-25.5]	0.397
SOFA*	6 [5-8.25]	6 [5-7]	6 [4-10]	0.698	6 [2-10.5]	6 [5-8]	0.786
GCS*	11.5 [8-13]	12 [9-14]	11 [8-13]	0.518	10 [8.5-14.5]	12 [8-13]	0.810
mNUTRIC*	5 [4-7]	5 [4-6]	5 [4.5-7.5]	0.498	5 [2.5-6.5]	5 [4-7]	0.414
Comorbidities, n (%)							
Hypertension	25 (59.5)	16 (64)	9 (52.9)	0.474	5 (45.5)	20 (64.5)	1.0
Neurological disease	23 (54.8)	12 (48)	11 (64.7)	0.632	5 (45.5)	18 (58.1)	0.752
CAD/CHF	14 (33.3)	7 (28)	7 (41.2)	0.374	3 (27.3)	11 (35.5)	1.0
Diabetes mellitus	10 (23.8)	6 (24)	4 (23.5)	1.0	4 (36.4)	6 (19.4)	0.181
Cancer (solid and/or hematologic)	9 (21.4)	6 (24)	3 (17.6)	0.782	1 (9.1)	8 (25.8)	0.561
COPD/Asthma	8 (19)	7 (28)	1 (5.9)	0.114	4 (36.4)	4 (12.9)	0.083
ICU Admission Reason, n (%)							
Acute respiratory failure	35 (83.3)	21 (84)	14 (82.4)	1.0	7 (63.6)	28 (90.3)	0.631
Sepsis/septic shock	25 (59.5)	12 (48)	13 (76.5)	0.065	5 (45.5)	20 (64.5)	0.446
Disturbance in general condition	8 (19)	5 (20)	3 (17.6)	0.810	2 (18.2)	6 (19.4)	0.856
Post-resuscitation care	2 (4.8)	1 (4)	1 (5.9)	0.825	1 (9.1)	1 (3.2)	0.625
ICU Admission Source, n (%)							
Emergency department	14 (33.3)	8 (32)	6 (35.3)	0.824	3 (27.3)	11 (35.5)	1.0
Other ICUs	13 (31)	9 (36)	4 (23.5)	0.391	3 (27.3)	10 (32.3)	1.0
Wards (internal medicine or others)	13 (31)	7 (28)	6 (35.3)	0.867	2 (18.2)	11 (35.5)	0.785
Other hospitals	2 (4.8)	1 (4)	1 (5.9)	1.0	1 (9.1)	1 (3.2)	0.485
Time to ICU from hospitalization (days)*	6 [2-14.75]	4 [2-15.5]	6 [1.5-15.5]	0.918	8 [1-23.5]	6 [2-10]	0.928
ICU stay duration (days)*	52 [35-78.25]	48 [36.5-80.5]	55 [34.5-77.5]	0.858	82 [47-272]	47 [35-75.5]	**0.025**
Hospital stay duration (days)*	72.5 [49.75-114]	66 [46-110.5]	83 [59.5-120.5]	0.465	109 [78-298.5]	65 [46-102.5]	**0.011**
Invasive mechanical ventilation, n (%)	40 (95.2)	23 (92)	17 (100)	0.506	9 (81.8)	31 (100)	1.0
Duration of invasive mechanical ventilation (days)*	54.5 [36.5-77.25]	47 [36.5-79.5]	55 [35.5-77.5]	0.990	82 [48.5-158.5]	47 [35-70]	**0.023**
Patients who developed nosocomial infections in the ICU, n (%)	41 (97.6)	24 (96)	17 (100)	1.0	10 (90.1)	31 (100)	1.0
Type of nosocomial infections in the ICU, n (%)							
Ventilator-associated pneumonia	39 (92.9)	24 (96)	15 (88.2)	0.556	9 (81.8)	30 (96.7)	1.0
Bloodstream or catheter-related bloodstream infection	28 (66.7)	16 (64)	12 (70.6)	0.657	7 (63.6)	21 (67.7)	0.692
Catheter-associated urinary tract infection	26 (61.9)	15 (60)	11 (64.7)	0.758	7 (63.6)	19 (61.3)	0.825
Wound infection	9 (21.4)	7 (28)	2 (11.8)	0.271	2 (18.2)	7 (22.6)	1.0
Nutritional support prior to PEG placement, n (%)							
Enteral nutrition	42 (100)	25 (100)	17 (100)	1.0	11 (100)	31 (100)	1.0
Supplementary parenteral nutrition	9 (21.4)	5 (20)	4 (23.5)	1.0	4 (36.4)	5 (16.1)	0.101
Patients who underwent tracheostomy in the ICU, n (%)	36 (85.7)	23 (92)	13 (76.5)	0.202	9 (81.8)	27 (87.1)	1.0

*Median [1st-3rd quartiles], n (%): Number (percentage). Bolded p-values indicate statistical significance (p<0.05).

Abbreviations: ICU: Intensive care unit; PEG: Percutaneous endoscopic gastrostomy; APACHE: Acute Physiology and Chronic Health Evaluation; SOFA: Sequential Organ Failure Assessment; GCS: Glasgow Coma Scale; mNUTRIC: Modified Nutrition Risk in the Critically Ill; CAD: Coronary artery disease; CHF: Congestive heart failure; COPD: Chronic obstructive pulmonary disease.

Table 2. Procedural characteristics of patients who underwent percutaneous endoscopic gastrostomy (PEG) in the intensive care unit (ICU) and subgroup comparisons (survivors vs. non-survivors; patients with vs. without PEG-related complications)

Parameters	Total (n=42)	Survivors (n=25)	Non-Survivors (n=17)	p	Complication (+) (n=11)	Complication (-) (n=31)	p
ICU day of PEG placement (median)*	27 [11.75-40]	28 [11.5-41.5]	26 [13.5-39]	0.939	30 [13.5-39.5]	27 [11.5-40.5]	0.952
Swallowing assessment performed prior to the procedure, n (%)	4 (9.5)	3 (12)	1 (5.9)	0.635	1 (9.1)	3 (9.7)	1.0
Personnel performing the procedure, n (%)							
General surgeons	6 (14.3)	6 (24)	0 (0)	0.066	2 (18.2)	4 (12.9)	0.958
Gastroenterologists	36 (85.7)	19 (76)	17 (100)		9 (81.8)	27 (87.1)	
COVID-19 screening prior to PEG, n (%)	28 (66.7)	19 (76)	9 (52.9)	0.184	6 (54.5)	22 (71)	1.0
ASA physical status classification, n (%)							
ASA Class III	6 (14.3)	5 (20)	1 (5.9)	0.374	1 (14.3)	5 (14.3)	1.0
ASA Class IV	36 (85.7)	20 (80)	16 (94.1)		8 (72.7)	28 (90.3)	
Time to initiation of feeding after PEG (hours, median)*	8 [6-21]	8 [6-18]	8 [6-24]	0.864	8 [7-24]	8 [6-16]	0.236
Nutritional products administered immediately after the PEG procedure, n (%)							
Dextrose-based solution	4 (9.5)	2 (8)	2 (11.8)	1.0	0 (0)	4 (12.9)	1.0
Standard enteral nutritional formula	38 (90.5)	23 (92)	15 (88.2)	0.635	11 (100)	27 (87.1)	0.561
Antibiotic administration related to PEG, n (%)							
Prophylactic use	1 (2.4)	1 (4)	0 (0)	1.0	0 (0)	1 (3.2)	1.0
Already administered for systemic infections	35 (83.3)	20 (80)	15 (88.2)	0.681	8 (72.7)	27 (87.1)	0.532
Not administered	6 (14.3)	4 (16)	2 (11.8)	1.0	3 (27.3)	3 (9.7)	0.214
Pre-procedure laboratory parameters							
Albumin (g/dL)*	2.5 [2.3-2.7]	2.5 [2.3-2.7]	2.5 [2.26-2.7]	0.979	2.6 [2.45-2.9]	2.4 [2.25-2.65]	0.075
White blood cell count (/mm^3)*	8910 [6900-12395]	8100 [6900-11600]	10090 [6945-14500]	0.522	6700 [5440-11110]	9780 [7180-12790]	0.081
INR*	1.2 [1.08-1.29]	1.16 [1.08-1.27]	1.25 [1.11-1.33]	0.081	1.16 [1.05-1.27]	1.2 [1.11-1.29]	0.333
Platelet count (/mm^3)*	274000 [198000-351750]	245000 [193500-331500]	285000 [225000-359000]	0.427	272000 [179000-386500]	276000 [198000-355000]	0.952
BUN (mg/dL)*	27 [18-39.5]	25 [19.36-38.21]	29 [14.05-60]	1.0	35 [20.6-44.7]	25 [17.4-38]	0.507
Creatinine (mg/dL)*	0.58 [0.43-0.97]	0.57 [0.41-0.92]	0.69 [0.43-1.06]	0.599	0.71 [0.41-1.7]	0.57 [0.43-0.97]	0.333
Number of PEG procedures during the same ICU stay, n (%)							
Single PEG Procedure	40 (95.2)	24 (96)	16 (94.1)	1.0	9 (81.8)	31 (100)	1.0
Repeat PEG Procedure	2 (4.8)	1 (4)	1 (5.9)	1.0	2 (18.2)	0 (0)	0.058
Early complications following PEG placement (within 48 hours), n (%)							
Peristomal bleeding	1 (2.4)	1 (4)	0 (0)	1.0	1 (9.1)	-	-
Peristomal leakage	1 (2.4)	1 (4)	0 (0)	1.0	1 (9.1)	-	-
Late complications following PEG placement (one week or later), n (%)							
Gastrostomy tube dislodgement	2 (4.8)	2 (8)	0 (0)	0.506	2 (18.2)	-	-
Peristomal leakage	1 (2.4)	1 (4)	0 (0)	1.0	1 (9.1)	-	-
Peristomal infection	5 (11.9)	3 (12)	2 (11.8)	1.0	5 (45.5)	-	-
Feeding intolerance	1 (2.4)	1 (4)	0 (0)	1.0	1 (9.1)	-	-
Major complications following PEG placement, n (%)	0 (0.0)	0 (0)	0 (0)	-	0 (0)	-	-

Table 2. Procedural characteristics of patients who underwent percutaneous endoscopic gastrostomy (PEG) in the intensive care unit (ICU) and subgroup comparisons (survivors vs. non-survivors; patients with vs. without PEG-related complications) (Cont.)

Parameters	Total (n=42)	Survivors (n=25)	Non-Survivors (n=17)	p	Complication (+) (n=11)	Complication (-) (n=31)	p
Minor complications following PEG placement, n (%)	11 (26.2)	9 (36)	2 (11.8)	0.271	11 (100)	-	-
ICU outcomes following PEG, n (%)							
Died in the ICU	17 (40.5)	-	17 (100)	-	3 (27.3)	14 (45.2)	0.354
Discharged to home, nursing facility, or palliative care center	20 (47.6)	20 (80)	-	-	8 (72.7)	12 (38.7)	0.214
Transferred to other wards	5 (11.9)	5 (20)	-	-	0 (0)	5 (16.1)	0.762
ICU length of stay following PEG placement (days)*	26 [10-39]	27 [10-47.5]	21 [9-36.5]	0.555	42 [22-243]	24 [10-31.5]	**0.02**
Survival duration post-ICU discharge with PEG (months)* (n=24)	4 [3-8.75]	4 [3-8.75]	-	-	3 [2-10]	5 [3-8.5]	0.494

*Median [1st-3rd quartiles], n (%): Number (percentage). Bolded p-values indicate statistical significance (p<0.05).

Abbreviations: ICU: Intensive care unit; PEG: Percutaneous endoscopic gastrostomy; COVID-19: Coronavirus disease 2019; ASA: American Society of Anesthesiologists; INR: International Normalization Ratio; BUN: Blood urea nitrogen.

Outcomes

Following PEG placement, patients remained in the ICU for a median of 26 days [10-39]. Seventeen patients (40.5%) died in the ICU. Of the remaining patients, 20 (47.6%) were discharged to home, a nursing home, or a palliative care center, and five (11.9%) were transferred to hospital wards. None of the ICU deaths were related to the PEG procedure. Among the 25 patients who were discharged or transferred, only one remained alive as of June 2024, with a survival duration of 52 months. The remaining 24 patients died within a median of 4 months [3-8.75] after discharge (Table 2).

Comparative Analysis

No statistically significant differences in patient characteristics or PEG procedure parameters were observed between ICU survivors and non-survivors (Tables 1 and 2). However, when comparing patients who experienced PEG-related complications to those who did not, several significant differences emerged. While the timing of PEG placement from ICU admission was similar between groups (30 days [13.5-39.5] vs. 27 days [11.5-40.5]; p=0.952), patients with complications had significantly longer ICU stays (82 days [47-272] vs. 47 days [35-75.5]; p=0.025), hospital stays (109 days [78-298.5] vs. 65 days [46-102.5]; p=0.011), IMV durations (82 days [48.5-158.5] vs. 47 days [35-70]; p=0.023), and post-PEG ICU stays (42 days [22-243] vs. 24 days [10-31.5]; p=0.02). However, no significant differences were observed in ICU mortality rates or post-discharge survival between the two groups (Tables 1 and 2).

Discussion

Percutaneous endoscopic gastrostomy is a widely used method for providing long-term enteral nutrition, particularly in patients who are unable to feed orally, have inadequate oral intake, or are at high risk of aspiration. In some cases, PEG can be performed during an ICU stay. In this study, PEG was performed in 42 critically ill patients either to establish a long-term enteral feeding route during ICU admission or in preparation for discharge. The procedure was carried out at a median of 27 days after ICU admission, and patients remained in the ICU for a median of 26 days following the procedure. Most PEGs were performed by gastroenterologists in the endoscopy unit, under the supervision of an anesthesiologist and with the use of sedation and analgesia. Enteral feeding via PEG was initiated at a median of 8 hours after the procedure, typically using commercial enteral feeding products. Minor complications occurred in 11 patients (26.2%), with two classified as early and nine as late. Notably, no major complications were reported. Although these complications did not impact ICU mortality, they were associated with significantly longer ICU and hospital stays, as well as prolonged durations of invasive mechanical ventilation. Seventeen of the 42 patients (40.5%) died before hospital discharge due to causes unrelated to the PEG procedure. Among those discharged, 24 died within a median of 4 months post-discharge. Long-term survival was rare, with only one patient (2.4%) surviving for 52 months.

Since its introduction in 1980 by Gauderer et al.[6] as an alternative to surgical gastrostomy, PEG has become the preferred method for long-term enteral nutrition. Its advantages include the avoidance of general anesthesia and operating room use, shorter procedure time, lower cost, and reduced complication rates.[6-8] PEG is commonly indicated in patients with permanent neurological disorders (e.g., stroke, dementia, Parkinson's disease, amyotrophic lateral sclerosis), congenital anomalies with severe mental-motor retardation, comatose states following trauma or cardiopulmonary resuscitation, cancers (particularly head and neck or upper gastrointestinal tumors), swallowing dysfunction with aspiration risk, and chronic catabolic conditions (e.g., cystic fibrosis, Human Immunodeficiency Virus /Acquired Immunodeficiency Syndrome (HIV/AIDS), Crohn's disease, and various cancers). Polytrauma and severe burns are also among the indications. Global and national studies report variable rates for PEG indications; however, neurological and neurodegenerative diseases consistently rank as the most common indication (ranging from 18.6% to 90%), followed by cancer.[11-15] Similarly, in our study, neurological diseases were the leading indication for PEG (54.8%), including cerebrovascular accidents (11 patients), Alzheimer's disease/dementia (seven patients), Parkinson's disease (four patients), and amyotrophic lateral sclerosis (one patient). Cancer was the second most common indication, accounting for 21.4% of cases.

Although PEG placement in our ICU is performed exclusively using the endoscopic technique, alternative approaches include surgical (open or laparoscopic) and radiological methods, such as those guided by ultrasound, computed tomography, or fluoroscopy. Comparative studies generally conclude that endoscopic PEG is more cost-effective and associated with lower morbidity and mortality. However, this technique may be unsuitable for patients with certain conditions, including massive ascites, morbid obesity, organomegaly, interposed organs, peritoneal carcinomatosis, previous abdominal surgery, or complete oropharyngeal/esophageal obstruction.[16-18]

There is currently no consensus on the optimal timing of PEG placement in ICU patients. Some sources recommend waiting at least two weeks in cases such as stroke or traumatic brain injury.[19] The decision should be individualized, taking into account factors such as hemodynamic stability, presence of infection, severity of the acute illness, and both short- and long-term prognosis. Nevertheless, early PEG placement may offer several benefits, including reducing complications associated with nasoenteric tubes, such as mucosal irritation, ulceration, bleeding, gastroesophageal reflux, and aspiration, and providing a more effective and comfortable route for enteral nutrition.[20,21] Several studies have reported PEG placement occurring between the 7th and 42nd days of ICU admission.[22–24] In our cohort, PEG was performed at a median of 27 days [11.75-40] following ICU admission.

The literature presents varying perspectives on the optimal timing for initiating enteral feeding after PEG placement. Although early feeding (within 4 hours) and delayed feeding (after 24 hours) have been shown to result in similar complication and mortality rates, early initiation may be associated with higher gastric residual volumes. However, this does not appear to translate into an increased risk of aspiration pneumonia.[7,25,26] Therefore, if the patient's clinical condition and vital signs are stable post-procedure and there are no acute complications related to PEG placement, early initiation of enteral feeding is considered safe. In our study cohort, enteral nutrition was initiated at a median of 8 hours[6-21] following PEG placement.

Although PEG is generally considered a safe procedure, various complications may occur both during and after placement. These are typically categorized as either minor, including peristomal infection, bleeding, hematoma, leakage, pneumoperitoneum, granulation tissue formation, tube displacement, or tube blockage, or major, such as aspiration pneumonia, peritonitis, perforation, gastrocolic fistula, buried bumper syndrome, necrotizing fasciitis, sepsis, and death. The reported incidence of PEG-related complications varies considerably, with minor complications occurring in up to 50% of cases, while major complications remain below 5%. Some studies further classify complications based on their timing, distinguishing between early (within the first month) and late (after one month) events.[27–30] In our study, complications occurred in 11 patients (26.2%), all of which were minor, with peristomal infection being the most common. Although there were no significant differences in baseline characteristics or ICU mortality between patients with and without complications, those who experienced complications had significantly longer ICU and hospital stays.

The literature presents mixed findings regarding the use of prophylactic antibiotics prior to PEG placement to prevent infectious complications. Intravenous admin-

istration of first-generation cephalosporins 1-2 hours before the procedure is commonly recommended.[31,32] However, a study from Sweden demonstrated that administering a trimethoprim-sulfamethoxazole solution directly through the gastrostomy tube immediately after placement was equally effective in preventing peristomal infections.[33] At our institution, routine prophylactic antibiotic administration before PEG placement is not standard practice. Nevertheless, 35 of the 42 patients in our study were already receiving broad-spectrum antibiotics due to systemic infections. Among the remaining seven patients, only one received antibiotic prophylaxis before the procedure; this patient had a pre-existing degenerative mitral valve condition.

Mortality rates among patients undergoing PEG vary widely across the literature. Reported procedure-related mortality ranges from 0% to 4%, 30-day mortality from 5.8% to 23.3%, ICU mortality from 25% to 62%, and one-year mortality from 32% to 90%.[34-38] These mortality rates, whether directly related to the PEG procedure or reflective of overall patient outcomes, are influenced by a variety of factors, including patient characteristics (e.g., age, comorbidities, nutritional status, frailty, immunosuppression), severity of acute illness, presence of organ failure, infection burden, and the infrastructure, experience, and quality of care provided in the ICU setting.[39,40] In our study, there were no PEG-related deaths, and the overall ICU mortality rate was 40.5%.

Studies evaluating long-term survival in patients with PEG report highly variable outcomes.[41-45] For instance, a study from Türkiye reported a median survival of 22 months, with outcomes varying based on the underlying diagnosis.[42] However, such studies rarely focus specifically on ICU populations. In our study, 25 patients were followed after ICU discharge. Of these, 20 were transferred to palliative care facilities or nursing homes, and five were discharged to their homes. Notably, 18 patients were readmitted to acute care hospitals within three months, and 24 within six months. Ultimately, all but one patient died within a median of 4 months [3-8.75 months] following ICU discharge. The only long-term survivor was a 68-year-old man who had been admitted to the ICU with aspiration pneumonia following a stroke and underwent PEG placement due to swallowing dysfunction. His gastrostomy tube was removed five months after ICU discharge, and he remained alive 52 months later (as of June 2024).

This study has several limitations. First, its retrospective design may have resulted in the omission of variables that could influence ICU mortality or PEG-related complications. Second, it was conducted in a single medical ICU, which may limit the generalizability of the findings to other settings. Third, although subgroup analyses were performed, the small sample size reduced the statistical power to detect specific associations. An additional methodological consideration is the deviation from standard definitions in classifying complications. In this study, we defined early complications as those occurring within 48 hours and late complications as those arising after one week. This classification reflects our ICU's practice of performing PEG procedures close to the time of discharge. However, in some cases, ICU stays were prolonged due to PEG-related complications, secondary infections, organ failure, or delays in discharge caused by family refusal to consent. Complications were further categorized as major or minor. As previously noted, no major complications or PEG-related mortality were observed in our cohort. Despite its limitations, this study provides valuable insights by offering long-term follow-up data on ICU patients discharged with PEG. The notably low long-term survival rate in this population highlights the need for careful evaluation of the indication for PEG placement in critically ill patients.

Conclusion

In conclusion, PEG is a reliable and effective method for providing long-term enteral nutrition in patients with neurological conditions, swallowing dysfunction, or cancer. However, in critically ill ICU patients, the decision to proceed with PEG placement should be made with caution, considering both short- and long-term prognoses. This study highlights the importance of individualized decision-making and underscores the need for further research to optimize patient selection and improve outcomes in this vulnerable population.

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