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ORIGINAL RESEARCH / *ÖZGÜN ARAŞTIRMA*

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Effects of Different Gastric Residual Volume Thresholds on Morbidity and Mortality in Patients Receiving Intensive Care

Yoğun Bakım Hastalarında Farklı Gastrik Rezidüel Volüm Eşiklerinin Morbidite ve Mortalite Üzerine Etkileri

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Abstract *Objective:* Enteral feeding is often limited by gastrointestinal intolerance. However, there is no consensus on the threshold value of gastric residual volume (GRV) on adjusting the enteral feeding rate. This study aimed to determine the effects of GRV thresholds of 150 mL and 250 mL on reaching calorie and protein targets and to determine gastric intolerance in patients receiving intensive care and enteral feeding.
Materials and Methods: In this retrospective study, patients who were treated and followed in the intensive care unit of our clinic between 2008 and 2017 were examined for 14 days after hospitalisation. Caloric values, protein values, presence of gastric intolerance, morbidity, and mortality factors of the patients, who were divided into two groups with 150-ml (group 1) and 250-ml (group 2) GRV thresholds, were examined.
Results: The amounts of calories and proteins provided after 14 days were significantly higher in group 2 ($p < 0.001$), and the cumulative calorie and protein deficits were significantly less in group 2 ($p < 0.001$). As regards morbidity and mortality, no significant difference was observed in aspiration pneumonia, anaemia, disseminated intravascular coagulation, septic shock, reintubation, intensive care mortality, 28th day mortality, and number of mechanical ventilation-free days between the two groups. The incidence of nosocomial infection ($p = 0.002$) and ventilator-associated pneumonia ($p < 0.001$) was significantly higher and the duration of mechanical ventilation ($p < 0.001$) and length of stay in the intensive care unit ($p < 0.001$) was significantly longer in group 2 than in group 1. No statistically significant difference was observed between the two groups in terms of the development of gastrointestinal intolerance during follow-up ($p = 0.896$).
Conclusion: Target nutritional values were reached in both groups. No pathological side effects of excessive intervention were observed in the group with lower tolerance. Similarly, no valuable morbidity or mortality result was obtained for the 250-ml threshold.
Keywords: Calories, enteral nutrition, gastric residual volume, intensive care, protein

ÖZ *Amaç:* Enteral beslenme sıklıkla gastrointestinal intolerans nedeniyle kısıtlanır. Enteral beslenme hızının gastrik rezidüel volüm (GRV)'e göre ayarlanmasının eşik değeri konusunda fikir birliği yoktur. Bu çalışmanın amacı; enteral beslenme uygulanmakta olan yoğun bakım hastalarında, 150 mL ve 250 mL GRV eşiklerinin hedef kalori ve proteine ulaşma miktarını, morbidite ve mortaliteye etkilerinin saptanmasıdır.
Gereç ve Yöntem: Çalışma klinik retrospektif olarak planlandı ve 2008–2017 tarihleri arasındaki dönemde kliniğimiz yoğun bakım ünitesinde takip ve tedavisi yapılan hastalar yatış anından itibaren 14 gün süreyle incelendi. GRV eşiğine göre 150 ml (Grup 1) ve 250 ml (Grup 2) olacak şekilde 2 gruba ayrılan hastaların kalori değerleri, protein değerleri, gastrik intolerans oluşumu, morbidite ve mortalite faktörleri incelendi.
Bulgular: On dört gün sonunda verilebilen kalori-protein oranları Grup 2'de anlamlı olarak daha yüksekti ($p<0,001$) ve kümülatif kalori ve protein açığı anlamlı olarak grup 2'de daha azdı ($p<0,001$). Morbidite ve mortalite karşılaştırıldığında; aspirasyon pnömonisi, anemi, dissemine intravasküler koagülasyon, septik şok, reentubasyon, yoğun bakım mortalitesi, 28. gün mortalitesi ve mekanik ventilatör bağımsız gün sayısı açısından anlamlı fark gözlenmemiştir. Grup 2'de anlamlı olarak nozokomiyal enfeksiyon yüksek ($p=0,002$), ventilatör ilişkili pnömoni yüksek ($p<0,001$), mekanik ventilatörde kalış süresi ($p<0,001$) ve yoğun bakım ünitesinde yatış süresi ($p<0,001$) daha uzun

tespit edildi. Takip süresince gastrointestinal intolerans gelişimi açısından iki grup arasında istatistiksel olarak anlamlı fark gözlenmedi (p=0,896).
Sonuç: Her iki grupta da hedef beslenme değerlerine ulaşılmıştır, daha düşük tolerans grubunda aşırı müdahalede bulunmanın herhangi bir patolojik yan etkisiyle karşılaşılmamıştır, benzer şekilde 250 ml için de avantajlı bir morbidite ya da mortalite sonucuna ulaşılamamıştır.
Anahtar Kelimeler: Enteral beslenme, gastrik rezidüel volüm, kalori, protein, yoğun bakım

Introduction

It is accepted that nutritional support given to patients in intensive care units is as important as the drug therapies prescribed (1). Nutrition is considered to be one of the most important controllable factors affecting morbidity and mortality (2,3).

It has been shown that wounds heal faster and the immune system is strengthened in patients with sufficient feeding, and morbidity and mortality increases in patients suffering from malnutrition (2,4,5). 40% of malnutrition observed in intensive care patients was associated with morbidity and mortality (6).

It is essential to calculate the energy and protein needs of patients to ensure sufficient nutritional support and to determine how this support will be provided. It can be given enterally and/or parenterally depending on the clinical condition of the patient (2,7). It has been shown that enteral feeding is a less costly and more physiologically appropriate feeding method, but its application is often limited by gastrointestinal intolerance (high gastric residual volume [GRV], regurgitation, vomiting, diarrhea, constipation, or abdominal distension). In healthy adults, 10 - 100 mL of secretion (8) in the gastrointestinal tract remains in the stomach, but the amount of secretion remaining in the stomach increases in intensive care patients, where motility slows down (9). Complications such as vomiting, aspiration and ventilator-associated pneumonia can be observed in patients with delayed gastric emptying. In order to reduce these risks, current guidelines suggest that GRV should be checked at regular intervals and enteral feeding should be adjusted according to GRV (10); however, there are different opinions regarding GRV thresholds.

New protocols are being created with current studies. By allowing high gastric residual volumes without signs of gastric distension, an increase in the target calories was observed as well as shortened lengths of hospital stays without increasing the risk of aspiration in the patients. However, gastrointestinal intolerance may go unnoticed with longer follow-up intervals (11).

This study aims to determine the effects of GRV thresholds of 150 mL and 250 mL on reaching calorie and protein targets and to determine gastric intolerance in intensive care patients receiving enteral feeding.

Materials And Methods

This retrospective study was organized in accordance with the STROBE guidelines. After approval by the Clinical Trials Ethics Committee of the University (2017/189), the patients who were followed up and treated in our Anesthesiology and Reanimation Intensive Care Unit between 2008 and 2017 were examined clinically and retrospectively.

The patients' demographic data, laboratory values, vital signs, development of ventilator-associated pneumonia (VAP) (12), presence of nosocomial infection (non-VAP) (13), development of aspiration pneumonia (14), anemia (15,16), disseminated intravascular coagulation (DIC) (17), presence of septic shock (18), length of stay in the intensive care unit, length of stay on a mechanical ventilator, development of reintubation, intensive care unit mortality, values of APACHE II (Acute Pysiology and Chronic Health Evaluation), SOFA (The Sequential Organ Failure Assessment), GCS (Glasgow Coma Scale), PaO2/FiO2 ratio (Horowitz Index), protein and energy values attained, daily observations of gastrointestinal intolerance symptoms (vomiting/regurgitation, diarrhea, constipation), and prokinetic drug use were analyzed retrospectively over the first 14 days of admission into the intensive care unit, and the relationship between nutritional status and the clinical results of gastric residual volume limits were examined.

Patients under 18 years of age, pregnant patients, patients with malignancies, intoxicated patients, those with less than 3 days of hospitalization, burned patients, cases of renal failure and liver failure, those with a GCS value of 3, resuscitated patients, and patients with severe malnutrition and conditions limiting the enteral feeding during the ICU admision were excluded from the study.

At the beginning of the study, it had been calculated that a minimum of 154 patients should be included in the study for

each group at 80% strength. The Groups were determined as Group 1 (150 ml GRV) and Group 2 (250 ml GRV). During their follow-up, GRV was measured by aspiration with 50 mL syringe every 6 hours and if feeding was not interrupted, the aspirate was given back. Groups (150 mL and 250 mL) were formed according to the amount of GRV.

Normal calorie requirements were calculated using the Harris-Benedict formula and taking into account the stress factors (19–21)

The protein requirement was determined as 1-2 gr/kg of protein per day in metabolically stressed patients, as recommended by the current SCCM/ASPEN clinical practice guidelines, as it was based on nutritional status, level of stress and ability to metabolize proteins physiologically (22).

On the 1st, 3rd, 7th, 10th and 14th days after admission into the intensive care unit, APACHE II scores, SOFA scores and GCS of the patients were recorded.

Statistical Analysis

The data was analyzed using IBM SPSS V23. The suitability of the data for normal distribution was analyzed by the Shapiro Wilk test. The independent samples t-test was used to compare the data suitable for normal distribution, and the Mann Whitney U test was used to compare the data which was unsuitable for normal distribution. A comparison of categorical data according to group and mortality was performed with the chi-square test. Quantitative data was presented as arithmetic mean ± deviation, median (min-max), while qualitative data was expressed as frequency (percent). The significance level was taken as $p < 0.05$.

Results

Among 2324 patients followed up in the Department of Anesthesiology and Reanimation Intensive Care Unit of our Clinic, 312 patients who met the criteria were included in the study and the patients were divided into two groups (Group 1 [150 mL] and Group 2 [250 mL]) according to their gastric residual volume limits. Patients under the age of 18 (n=127), pregnant patients (n=42), patients with malignancies (n=288), intoxicated patients (n=184), those with less than 3 days of stay (n=348), those suffering from burns (n=67), chronic kidney failure (CKF) (n=206), and liver failure (n=59), patients with GCS equal to 3 (n=225), resuscitated patients (n=192), and patients with severe malnutrition (n=92) and other conditions preventing enteral feeding (n=182) during the hospitalization were excluded from the study, and when the number of patients meeting the criteria was reached, screening was terminated (Figure 1). The patients' gender, body weight, biochemical parameters at the time of hospitalization, vital signs, initial GCS values, Horowitz Index, blood glucose level, prokinetic drug use, and the presence of diarrhea, constipation and vomiting/regurgitation did not indicate a statistically significant difference between the two groups. The median age values of the patients differed between the groups (p=0.005). While the median value was 48 years in group 1, it was 55.5 years in group 2. The median BMI values during the admissions to the intensive care unit differed between the groups (p=0.011). While the median value was 28 kg m-2 in group 1, it was 27 kg m-2 in group 2. The median values of the APACHE II score and the SOFA score on the first day differed between the groups (p=0.042; p=0.028, respectively) (Table 1).

The most common cause for admission of the patients to the intensive care unit was trauma in both groups and was observed to be 42.3% in group 1 and 43.6% in group 2. Other causes of admission were determined to be postoperative period representing 28.8% and 16% in group 1 and group 2, respectively; hospitalization due to respiratory causes representing 16% and 30.8% in group 1 and group 2; neurological conditions representing 8.3% and 6.4% in group 1 and group 2; sepsis representing 3.2% and 1.9% in group 1 and group 2; and cardiac causes representing 1.3% in both groups, with a statistically significant difference (p=0.016, Table 2).

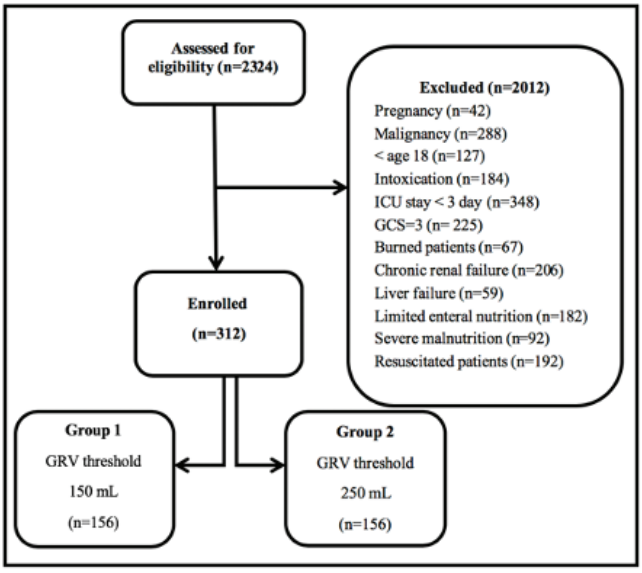

Figure 1. Flow chart of study population selection

Table 1. The Comparison of Demographic Data and Initial Values

	Group 1 (150 mL)	Group 2 (250 mL)	p value
Gender (n (%))			
Female	48 (30,8)	51 (32,7)	
Male	108 (69,2)	105 (67,3)	0,715
Weight (kg)	83 (58- 112)	82 (56- 108)	0,106
Height (year)	48 (19- 90)	55,5 (18- 89)	0,005
BMI (kg m^{-2})	28 (22- 37)	27 (19- 35)	0,011
Creatinin (mg dl^{-1})	1 (0- 5)	1 (0- 6)	0,642
Platelet (mcL^{-1})	166500 (151- 806000)	175500 (23000- 649000)	0,171
Total bilirubin (mg dl^{-1})	1 (0 -77)	1 (0- 8)	0,890
Fever (°C)	37 (35- 397)	37 (35- 39)	0,170
WBC (u mcL^{-1})	11150 (4- 89000)	10800 (4- 96000)	0,137
Albumin (g dL^{-1})	3 (2 - 5)	3 (2 - 5)	0,754
INR	1 (1 - 3)	1 (1 - 5)	0,274
ALT (IU L^{-1})	22 (1 - 550)	28,5 (1 - 950)	0,175
APACHE II	14 (2 - 31)	14 (2 - 27)	0,042
SOFA	6 (0 - 16)	5 (0 - 12)	0,028
GCS	10 (3 - 15)	10 (4 - 15)	0,416

BMI: Body Mass Index, WBC: White Blood Cell, INR: International Normalized Ratio, ALT: Alanine Aminotransferase, APACHE II: Acute Pysiology And Chronic Health Evaluation, SOFA: The Sequential Organ Failure Assessment, GCS: Glasgow Coma Scale

Concomitant diseases differed significantly between the groups (p = 0.018). The number of patients without any concomitant disease was 89 (57%) in group 1 and 85 (55%) in group 2. Considering the existing concomitant diseases, the most common concomitant diseases in group 1 were of neurological origin (29.9%), while in group 2, the percentage of diseases with neurological origin was 24.7%. The most common concomitant disease in group 2 was chronic obstructive pulmonary disease (COPD) (27.1%), while in group 1, the percentage with COPD was 9%. The percentage of patients with hypertension was 10.5% and 8.2% in group 1 and group 2, respectively; those with concomitant cardiac disease was 10.5% and 9.4% in group 1 and group 2; and the rate of patients with diabetes mellitus (DM) known to compromise gastrointestinal motility was 3% and 7.1% in group 1 and group 2, respectively. Only group 1 included patients with hematological disorders with a rate of 7.5% (Table 2).

Table 2. The Comparison of Reason for admission and Comorbid Diseases

	Group 1 (150 mL) n (%)	Group 2 (250 mL) n (%)	p value
Reason for admission			
Cardiac	2 (1,3)	2 (1,3)	
Neurological	13 (8,3)	10 (6,4)	
Respiratory	25 (16)	48 (30,8)	
Sepsis	5 (3,2)	3 (1,9)	0,016
Trauma	66 (42,3)	68 (43,6)	
Postoperative	45 (28,8)	25 (16)	
Comorbid disease			
Hypertension	7 (10,4)	7 (8,2)	
CAD	5 (7,5)	3 (3,5)	
CHF	2 (3)	5 (5,9)	
Diabetes Mellitus	2 (3)	6 (7,1)	
COPD	6 (9)	23 (27,1)	0,018
Neurological	20 (29,9)	21 (24,7)	
Haematological	5 (7,5)	0 (0)	
Others	20 (29,9)	20 (23,5)	

CAD: Coronary Artery Disease, CHF: Congestive Heart Failure, COPD: Chronic Obstructive Pulmonary Disease

The two groups were compared in terms of calorie and protein intake. The amount of calories and proteins provided after fourteen days was significantly higher in Group 2 (p<0.001). The cumulative calorie and protein deficit after fourteen days was significantly less in group 2 (p <0.001) (Table 3).

When the two groups were compared in terms of morbidity and mortality, no significant difference was observed in terms of aspiration pneumonia, anemia, DIC, septic shock, reintubation, intensive care mortality, 28th day mortality and number of mechanical ventilation free days. In Group 2, nosocomial infection (p=0.002) and ventilator-associated pneumonia (p<0.001) were significantly higher, duration of stay in the mechanical ventilator (p<0.001) and length of stay in the intensive care unit (p<0.001) were significantly longer (Table 4).

No statistically significant difference was observed between the two groups in terms of the development of gastrointestinal intolerance during follow-up (p=0.896) (Table 5).

Table 3. The Comparison of Protein and Calorie Parameters			
	Group 1 (150 mL)	Group 2 (250 mL)	p value
EN (day)	1 (1 - 14)	3 (1 - 65)	<0,001
PN (day)	2 (0 - 14)	3 (0 - 14)	0,038
Oral Feeding (day)	0 (0 - 9)	0 (0 - 12)	0,946
Mean Protein Quantity (g kg^{-1} day^{-1})*	1,30±0,21	1,51±0,22	0,001
Percentage of Protein that can be given**	77 (55 - 90)	86 (55 - 99)	<0,001
14-day Total Protein Deficit (g)	407,5 (157 - 590)	238 (14 - 490)	<0,001
Mean Calorie Quantity (kcal kg^{-1} day^{-1})*	28,21±4,30	29,10±5,40	0,041
Percentage of Calorie that can be given**	80 (74- 96)	90 (76- 105)	<0,001
14-day Total Calorie Deficit (kcal)	7494 (1666- 11070)	3291 (0 - 10389)	<0,001

*Mean±SD, other values are shown as median (min-max), **In the First 14 Days of Admission to Intensive Care
EN: Enteral Nutrition, PN: Parenteral Nutrition
Mean Protein Quantity (g kg^{-1} day^{-1}): The mean protein intake in a day.
Percentage of Protein that can be given: The mean 'protein intake percentages of the patients' for 14 days were compared.
14-day Total Protein Deficit (g): The 14-day total protein deficits of the patients were compared.
Mean Calorie Quantity (kcal kg^{-1} day^{-1}): The mean calorie intake in a day.
Percentage of Calorie that can be given: The mean 'calorie intake percentages of the patients' for 14 days were compared.
14-day Total Calorie Deficit (kcal): The 14-day total calorie deficits of the patients were compared.

Discussion

Enteral feeding is defined as the continuous or intermittent administration of nutrients through nasogastric, nasojejunal, gastrostomy or jejunostomy routes in patients with normal gastrointestinal tract function who are suffering from malnutrition or expected to develop malnutrition (22). It is a safe and cost-efficient method that is suitable for human physiology (2,23). The most important cause of failure of enteral feeding is gastrointestinal motility disorder. As a result of this, GRV increases, and distention, vomiting, regurgitation, aspiration and diarrhea occurs. For this reason, GRV measurements are used in routine patient follow-ups to avoid complications. Increased GRV was identified as a cause of interruption to feeding, and 70% was found to be preventable (24,25).

Monitoring GRV at regular intervals in patients receiving enteral feeding is recommended (6,26). Although there is a clear consensus on the necessity of enteral feeding in intensive care patients, the method of application of this procedure, which has been adopted for 50 years, varies in the literature (6,27,28). There are studies indicating that GRV limits may be in the range of 50-500 mL in the follow-up of patients receiving enteral feeding (26,29). However, there are new studies showing that measuring GRV causes interruptions to enteral feeding, prolongs the time to reach target calories, and causes malnutrition; thus there is no need to measure GRV unless there are signs of gastric intolerance (26). In parallel with these studies, in the current study it was found that feeding in group 2 was interrupted less often; therefore EN could be given for statistically significantly longer periods (median values are 0 (0-14) in group 150 and 3 (0-14) in group 250, p= 0).

Based on the studies, the energy requirement should be 20-25 kcal/kg/day in the acute period and 25-30 kcal/kg/day in the recovery period (30). When the patients followed up in our ICU were analyzed retrospectively, it was found that group 2 were fed significantly more in terms of protein percentages and calorie requirements that were met during the first 14 days of their hospitalization (Table 4). When total protein and calorie deficits were analyzed in the same period, cumulative protein and calorie deficits were found to be significantly less in group 2, in which the patients could be fed enterally for a longer period of time (Table 4).

In our study, the median values of albumin at the 10th day in group 2 were found to be significantly higher in accordance with the protein and calorie percentages that were given to the patients during the 14-day follow-up (1-3-7-10-14 days) of the two groups (2 in group 1 (2-4), 3 (2-4) in group 2, p = 0.009). The median albumin value at the end of 14 days was 2.5 (1-4) in group 1 and 3 (1-4) in group 2 (p=0.126).

When previous studies were examined, 150 and 250 mL GRV threshold values were compared in terms of vomiting frequency and no difference was found between the two groups (11). In a recent study, 200 mL and 400 mL GRV

Table 4. Cross-Group Comparison			
	Group 1 (150 mL) n (%)	Group 2 (250 mL) n (%)	p value
Nosocomial infection (non-VAP)			
No	94 (60,3)	67 (42,9)	**0,002**
Yes	62 (39,7)	89 (57,1)	
VAP			
No	136 (87,2)	104 (66,7)	**<0,001**
Yes	20 (12,8)	52 (33,3)	
Aspiration pneumonia			
No	125 (80,1)	135 (86,5)	0,129
Yes	31 (19,9)	21 (13,5)	
Anemia			
No	128 (82,1)	130 (83,3)	0,765
Yes	28 (17,9)	26 (16,7)	
DIC			
No	115 (73,7)	127 (81,4)	0,103
Yes	41 (26,3)	29 (18,6)	
Septic shock			
No	120 (76,9)	111 (71,2)	0,245
Yes	36 (23,1)	45 (28,8)	
Reintubation			
No	144 (92,3)	143 (91,7)	0,835
Yes	12 (7,7)	13 (8,3)	
ICU mortality			
No	111 (71,2)	104 (66,7)	0,392
Yes	45 (28,8)	52 (33,3)	
28th day mortality			
No	113 (72,4)	121 (77,6)	0,296
Yes	43 (27,6)	35 (22,4)	
MV free day	2 (0-20)	2.50 (0-40)	0.165
Duration of stay in MV*	4 (0 - 37)	9,5 (0 - 45)	**<0,001**
Length of stay in ICU*	7 (3 - 37)	13 (3 - 70)	**<0,001**

*Median (min-max)
VAP: Ventilator Associated Pneumonia, DIC: Disseminated Intravascular Coagulopathy, ICU: Intensive Care Unit, MV: Mechanical Ventilator

threshold values were compared in terms of aspiration and regurgitation, and it was asserted that high GRV values did not increase the risk (27). Vomiting frequencies in patients with GRV>300 mL and GRV<300 mL were compared and it was reported that no significant difference was observed (8). No significant difference was found in a study examining

Table 5. The Comparison of Total Gastric Intolerance Presences of Each Patient for 14 Days		
	Median (min-max)	p value
Group 1 (150 mL)	0 (0 - 14)	0,896
Group 2 (250 mL)	0,5 (0 - 12)	

the development of aspiration and pneumonia with high GRV values (31). Another study compared the 200 mL and 500 mL limits and reported that the high GRV limit was not associated with gastrointestinal complications in patients connected to the mechanical ventilator (29). A group without GRV measurements (with interruptions to feeding only when gastrointestinal intolerance occurred) and two groups with a 250 mL limit were compared, and it was found that the group without GRV measurements reached the target calories faster; and ventilator-associated pneumonia, aspiration, diarrhea, and length of stay in the intensive care unit were found to be similar in both groups (26). There was no difference in terms of vomiting or feeding intolerance in groups with and without GRV measurements (32). In onestudy, 100 mL and 200 mL GRV were compared and it was found that GIS complications were less in the 100 mL group (33). In another study, diarrhea was observed at a rate of 29.5%. No significant difference was found between the two groups compared to the current study in terms of diarrhea, constipation, vomiting/regurgitation, aspiration and aspiration pneumonia (p=0.896) (11).

There are studies that have asserted that prokinetic drugs which accelerate gastric motility, such as metoclopramide and erythromycin, may be beneficial (34). On the other hand, in another study, the effects of prokinetic drug use on GRV were compared and it was determined that there was no significant difference between the groups (11). In the current study, it was found that the use of prokinetic drugs did not differ significantly in GRV (p=0.285). Reviews of the literature revealed that the number of studies on the drug-gastric motility relationship, or on the drugs that should be administrated by interrupting feeding, are limited (35,36). Steroid and insulin, which may affect gastric motility, were examined in the current study and no significant difference was found when the two groups were compared.

Scoring systems such as APACHE II, SAPS (Simplified Acute Physiology Score), PSI (Physiology Stability Index), SOFA and TISS (Therapeutic Intervention Scoring System) are used to determine disease severity of intensive care patients (37,38). In the current study, the APACHE II and SOFA scores were considered and similar results were

obtained for the two groups. Similarly, in a study that undertook calorie and protein monitoring, no correlation was found between APACHE II scores and gastric intolerance symptoms (39).

In a study comparing VAP or new infection development, the length of ICU and hospital stay, organ failure scores, mortality rates in patients undergoing mechanical ventilation, similar results were found in patients with and without GRV follow-up (26). The development of sepsis and gastric intolerance (high GRV, diarrhea) was examined and a correlation was found between them ($p<0.001$) (40). In the current study, the rate of nosocomial infection (non-VAP) and VAP development were found to be higher in group 2. When the number of patients' MV free days was examined, it was observed that no difference was seen between the two groups and that initial APACHE II and SOFA scores were similar, which suggested that the difference in VAP development may have been caused by regurgitation that went unnoticed. Having considered the causes of admission to ICU, it was thought that the higher age average in Group 2, the significantly higher respiratory hospitalization rate, as well as the high rate of COPD as a concomitant disease, may have affected the length of hospital stay. In addition, the presence of significantly more postoperative patients in Group 1 may have also affected the length of hospital stay. The causes of longer hospitals and MV stays in Group 2 were attributed to the fact that the patients may be more susceptible to infections and late recovery despite their higher protein intake due to respiratory factors and age differences. In addition, as the number of postoperative patients in Group 1 was higher, patients could be discharged earlier. Although the length of stay in MV differed, no significant difference was found in terms of ventilation when PaO2/FiO2 values were compared. It should also be remembered that there may be many causes that affect the length of ICU and MV stays. The fact that the target protein values were achieved in both groups, that more VAP cases were seen, and longer ICU and MV stays were observed in Group 2 suggests that the 150 mL limit might actually be sufficient.

As for the length of stay in the intensive care unit, a group of patients with a GRV threshold of 250 mL and without any GRV measurements had been compare previously; however, there was no difference in terms of their length of stay in ICU and MV (26). In another study, 200 ml and 500 ml GRV threshold values were compared and no difference was observed (29).

In one study, no difference was detected between the two groups with a GRV threshold value of 250 ml and without GRV monitoring in terms of duration of use of the mechanical ventilator (26). In a further study in which enteral feeding was evaluated in two groups, no significant difference was found in the duration of mechanical ventilation of patients (41).

Nutritional practices have a great effect on morbidity and mortality. On the other hand, enteral feeding is preferred as it strengthens the immune functions and is very beneficial in terms of reducing costs in developing countries like Turkey (3,42). In the current study, no significant difference was found between the groups in terms of ICU mortality and 28th day mortality ($p=0.392$, $p=0.296$). After examining all patients in this study, it was found that the increase in the number of days on which PN was given was associated with increased mortality ($p=0.004$), and the increase in the number of days of oral feeding was associated with decreased mortality ($p=0$).

Further studies on the evaluation of gastrointestinal intolerance in enteral feeding are ongoing. It is argued that the application of protocols allowing high GRV without any gastric distension symptoms will help increase target protein and calorie levels, and will shorten the length of hospital stay and the duration of mechanical ventilation, without causing an increased risk of aspiration.

Study Limitations

Since our study was retrospective, higher GRV values or patients with no measured GRV values were not examined. In addition, energy and protein requirements were met according to the then current weights of the patients. For a more detailed evaluation, it is recommended that new studies should be conducted and compared based on the ideal weight of patients. After the study was completed, patients with higher GRV values began to be followed up in ICU. The difference between the BMI values measured during hospitalization yielded similar results in total protein and calorie amounts; however, when an evaluation was made in terms of the percentage of requirements met, based on the current weight, significant results were obtained.

Conclusion

Target nutritional values were reached in both groups. No pathological side effects of excessive intervention were observed in the lower tolerance group. Similarly, no

advantageous morbidity or mortality result was obtained for the 250 ml threshold. The results of this study have led to a belief that the current guidelines should be questioned and prospective randomized controlled studies should be conducted involving more patients.

Ethics

Ethics Committee Approval: The present study was approved by the Ethics Committee of Karadeniz Technical University (2017/189).

Informed Consent: It is a retrospective study. No need for consent.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: E.Ç., Concept: E.Ç., H.U., Design: E.Ç., S.Ç., H.U., Data Collection or Processing: E.Ç., Analysis or Interpretation: E.Ç., S.Ç., A.O.K., H.U., Literature Search: E.Ç., A.O.K., Writing: E.Ç.

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