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The relationship of gastrointestinal complications and ventilator related status with gastric residual volume in intensive care patients

Yoğun Bakım Hastalarında İki Farklı Gastrik Rezidüel Volümün Gastrointestinal Komplikasyon ve Ventilatör İlişkili Durum İle İlişkisi

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ABSTRACT

Aim: Our study aimed primarily to determine whether there was a relationship between total gastric residual volume (GRV) amounts and two different GRV thresholds and the development of gastrointestinal intolerance in patients on mechanical ventilation in the intensive care unit (ICU) and secondarily, to determine the effects of different GRV quantities on ventilator-related conditions (VAC).
Methods: Seventy patients above the age of 18 who were scheduled to be fed with enteral nutrition (EN) for at least three days, were divided into two groups including 35 patients according to GRV threshold values of 250 ml and 500 ml. The total amounts of GRV of the patients who did not exceed any of the two GRV thresholds during the follow-up period of 72 hours were recorded and calculated. For all patients, necessary data was recorded and high gastric residual volume rates (HGRV), times to reach target calories, mean GRV amounts, abdominal distension, vomiting, diarrhea, VAC and infection-related ventilator-related complications (IVAC) were all observed.
Results: Although there were statistically significant differences between the groups in terms of the HGRV rates and the HGRV rates exceeding the determined threshold values [p <0.05], there was no significant difference between the groups in terms of abdominal distension, vomiting, diarrhea, VAC and IVAC (p> 0.05).
Conclusion: The results of this study suggest that measuring the amount of GRV in intensive care patients fed by EN via the nasogastric tube in order to decide on gastrointestinal motility function and to reduce the complication rate, is not necessary.

Key Words: Enteral nutrition, complications, critical care

ÖZ

Amaç: Çalışmamızın amacı, yoğun bakım ünitesinde solunumu mekanik ventilasyon ile sağlanan hastalarda, toplam gastrik kalıntı hacim miktarları ve iki farklı gastrik kalıntı hacmi eşiği ile gastrointestinal komplikasyon gelişimi arasında ilişki olup olmadığının tespiti, ikinci hedefimiz ise farklı gastrik kalıntı hacimlerinin, ventilatör ilişkili durumlar üzerindeki etkilerini belirlemektir.
Metod: Çalışmaya en az 3 gün enteral beslenme planlanan, 18 yaşın üzerindeki 70 adet yetişkin hasta dahil edildi. Birinci gruptaki 35 hastada gastrik kalıntı hacmi eşiği 250 ml, ikinci grupta ise 500 ml olarak belirlendi. İzlem süresi boyunca, belirlenen her iki gastrik kalıntı hacmi eşiğinden herhangi birini aşmamış olan hastaların, 72 saat boyunca kaydedilen gastrik kalıntı hacimlerinin toplam miktarı hesaplandı. Tüm hastaların yüksek gastrik kalıntı hacim oranları, hedef kaloriye ulaşma süreleri, ortalama mide kalıntı hacim miktarları, abdominal distansiyon, kusma, diyare, ventilatör ilişkili durum ve enfeksiyona bağlı ventilatör ilişkili komplikasyon oranları gözlendi.
Bulgular: Çalışmamızın sonunda, iki grup arasında yüksek gastrik kalıntı hacim oranları, belirlenen eşik değerini aşan yüksek gastrik kalıntı hacim oranları arasına, anlamlı bir fark oluşmasına rağmen (p<0.05), her iki grup arasında abdominal distansiyon, kusma, diyare, ventilatör ilişkili durum ve enfeksiyona bağlı ventilatör ilişkili komplikasyon açısından anlamlı bir fark yoktu. (p >0.05)
Sonuç: Bu sonuçlar, enteral yolla beslenen yoğun bakım hastalarında, gastrointestinal motiliteyi ölçmek ve komplikasyon oranını azaltmak için gastrik kalıntı hacim miktarlarının ölçülmesinin gerekli olmadığı düşündürmektedir.

Anahtar Kelimeler: Enteral beslenme, komplikasyonlar, yoğun bakım

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INTRODUCTION

Nutrition is one of the important factors playing a role in decreasing morbidity and mortality rates, treating immunodeficiency and speeding up wound healing processes in intensive care patients [1]. In the instances where there are no contraindication, the physiological route of nutrition is enteral nutrition. However, gastrointestinal intolerance or dysfunction [vomiting, gastric distension, high gastric residual volume and diarrhea that may occur during enteral nutrition, may limit the practice of enteral nutrition [2]. Gastric residual volume (GRV) is defined as the volume of gastric juice pulled back by a syringe connected to the feeding tube, when aspirating the gastric contents [3]. The GRV measurement, which is one of the important markers of gastrointestinal function, is one of the standard procedures in care protocols of the patients receiving enteral nutrition and is still frequently used for the diagnosis of food intolerance [4]. The measurement of GRV for the evaluation of gastrointestinal dysfunction may also help the determination of intolerance to EN, during the onset and progression of EN [5].

In cases of high GRV resulting from delayed gastric emptying during enteral nutrition, foods accumulated in the stomach may accidentally pass into the trachea and pneumonia may occur as an result of this. Enteral nutrition is accepted as one of the risk factors for the development of ventilator-associated pneumonia (VAP), as well as respiratory failure, coma and depressed state of consciousness [6]. Because of these limitations, clinicians keep recommending the use of GRV measurements in the care of patients receiving enteral nutrition [7]. There is no ideal amount standardized by evidence-based medical practice for gastric residual volume to be used, for the measurement of gastric function during the nutrition of intensive care patients. However, volumes between 150 and 500 ml are generally used in practice and residual volumes are generally measured every six hours for the measurements of gastric residual volume, that are used as a marker of gastrointestinal intolerance [8].

Our study aimed to determine whether there was a relationship between total GRV amounts calculated based on the period of time to reach total calories in patients on mechanical ventilation in an intensive care unit, and gastrointestinal intolerance occurrence among patients with two different GRV thresholds. We also aimed to determine the results of this change on the incidence of ventilator-associated condition and different variables.

MATERIAL AND METHOD

With the approval of Clinical Research Ethical Committee of Erciyes University Faculty of Medicine (2019/42), eighty patients over the age of 18 who were admitted to the intensive care unit due to pulmonary diseases, cerebrovascular diseases and large joint fractures, who were determined as patients requiring mechanical ventilation due to respiratory failure, coma, unconsciousness and hemodynamic stabilization, and who were scheduled to receive enteral feeding for at least three days, were included in the study. The entire study was carried out according to the principles of the Declaration of Helsinki. Our study plan was explained in detail to all the patients or patients' relatives and their informed consents for voluntary participation were obtained. The target calories for EN were not reached in 10 out of the 80 patients. Since the enteral nutrition was considered unsuccessful in these patients, additional feeding methods were used.

Those who stayed in intensive care unit for less than 3 days, those under the age of 18, those whose nutrition would stop for more than two hours for any reason, those with a gastrostomy or jejunostomy feeding tube, those who had non-functional bowel (ischemia, obstruction or anatomic conditions), those who had signs of generalized peritonitis and paralytic ileus, those who had severe diarrhea (>1000ml/day), those who were diagnosed with upper gastrointestinal bleeding and those who had morbid obesity (body mass index (BMI) >40 kg/m2), were all excluded from the study.

Group I (n = 35): measurements were carried out every 6 hours in the patient group whose GRV threshold was determined to be 250 ml and the amount of increase in the enteral feeding mixture after every six hours was 10 ml. The total amount of gastric residual volumes recorded for 72 hours in the patients whose GRV was under the threshold

value were calculated. Patients whose total GRV amount was up to 500 ml were also included in this group.

Group II (n = 35): measurements were carried out every 6 hours in the patient group whose GRV threshold was determined as 500 ml and the amount of increase in the enteral feeding mixture after every six hours was 10 ml. The total amount of gastric residual volumes recorded for 72 hours in the patients whose GRV was under the threshold value was calculated. Patients whose total GRV amount was more than 500 ml were also included in this group.

Patients' demographic data, comorbid diseases, sedative or inotropic drugs given, Acute Physiology and Chronic Health Evaluation II (APACHE II) scores and total days spent in intensive care unit, were recorded. A 12 fr size of nasogastric feeding tube was placed in all the patients and the position of nasogastric tube was confirmed with chest radiography and the method of auscultation through gastric insufflation of 15 ml of air with a syringe. The tubes were kept in the stomach during the feeding and measurement processes.

Patients were continuously fed by the same polymeric formula in which 1 cc was 1 calorie by using the kangaroo feeding pump Set (Abbot, Illinois, USA) which was regularly calibrated. Energy requirements of the patients were calculated by the Schofield formula. During nutrition and GRV measurements, the head of the bed was elevated 30–45º and Ramsay sedation score was kept at 3-6 by ensuring its compatibility with mechanical ventilator of the patients. Midazolam (Dormicum 15 mg/3ml Roche) 0.1 mg / kg / hour was administered for sedation. Opioids were not used. In cases where the sedation score was adequate, no additional sedation was given, whereas when it was inadequate, Midazolam was used to provide intravenous sedation, according to the clinical state of the patient, though the protocol of the sedation was not standardized. Gastrointestinal intolerance findings (vomiting, regurgitation abdominal distension and diarrhea) were monitored in the patients.

Nutrition was initiated at a rate of 20 ml/hour in both groups. In case of gastrointestinal intolerance, no EN was administered as long as the findings were still observed in the patients during nutrition intervals, until the next controls. If gastrointestinal intolerance was not found, planned increases were prepared in case GRV was under the threshold value. When GRV exceeded the threshold value, the nutrition continued at the last determined rate without any increase. When the patients whose nutrition was intermitted due to gastrointestinal intolerance were re-evaluated, the nutrition was initiated again at a rate of 20 ml/h if there was no finding of gastrointestinal intolerance, and the decisions on EN were made. According to the criteria used in the determination of gastrointestinal intolerance, clinical symptoms of gastrointestinal intolerance were as follows: abdominal distension: abdominal swelling felt by palpation and no bowel sounds; vomiting: orally ejected enteral formula; regurgitation: enteral formula in oral or nasal cavity; and diarrhea: watery stool for five times or more during 24-hour period or approximate stool volume equal to 2.000 ml/day or more.

All the patients were screened for ventilator-associated conditions and infection-related ventilator-associated complications. VAC was defined as the need for increase in daily minimum FiO2 at a rate of ≥20% or increase lasting two or more days in daily minimum PEEP (positive and expiratory pressure) at a rate of ≥3 cm H2O after a stability lasting for two or more days or followed by a decrease to daily minimum PEEP or daily minimum FiO2, in a patient who was connected to the mechanical ventilator. Infection-related ventilator-associated complications include possible infection markers at the same time with the onset of VAC in addition to positive radiographic findings. Infection-related ventilator-associated complications are defined as abnormal body temperature (>38 0C or 36 0C) or abnormal leukocyte count (4.000/mm3 or less or 12.000/mm3 or more) with the use of one or more than one antibiotic, which was initiated four or more days before and still used [9].

GRV measurements of the patients included in the study were recorded by group coordinators every six hours in both Group I and Group II, by evaluating the last states of the patients. Before the study started all the nurse practitioners were trained on infection control for the patients receiving enteral

nutrition, as the other factors were excluded and infection control had a vital importance.

Gastric residual volumes were measured in ml through nasogastric tube aspiration by a 50 ml syringe. The volume obtained from the patient was not returned but emptied. Required period of time to reach target EN rate, interval periods and their causes were noted. All the patients received EN for at least 72 hours. Patients who were discharged from intensive care unit before the 72 hour-length of stay were excluded from the study. According to the power analysis based on the study by Pinilla et al. [10], 34 patients were required in each group at 95% confidence interval and 80% statistical power with a mean ± standard deviation of 22±22 (mean ± SD) in the first implementation (GRV:200 ml) and 12±8 (mean ± SD) in the second implementation, in order to determine the difference between the durations of both implementations to reach the target calories.

Statistical analysis

Statistical analysis was carried out using the SPSS 22.0 Statistics Package of Social Sciences Software (IBM SPSS Statistics, Armonk, NY, USA). Continuous data was given as mean and standard deviation while categorical data was given as counts and percentiles. Differences between the groups in terms of independent variables were statistically evaluated. The results with p value under 0.05 were accepted as statistically significant. The Mann-Whitney U test was used in the evaluation of nonparametric data and the Chi-square and Fisher's exact tests were used in the evaluation of the difference between the groups.

RESULTS

The study was initiated with 80 consecutive patients expected to remain in the intensive care unit for more than 3 days with mechanical ventilation support at the Niğde Education and Research Hospital.

Four of the patients were transferred to the ward before their follow-up period ended. Enteral nutrition was stopped and parenteral nutrition was initiated in one of the patients. In another patient, enteral nutrition was stopped as the result of a suspected cholecystitis and 4 of the patients were exitus. Out of 80 patients, 10 were excluded from the study due the reasons stated above and therefore the data of 70 patients were evaluated. There was no difference between the groups in terms of age, gender, causes of admission to the ICU, need for sedation, use of inotropes, APACHE 2 score and having a co-morbid disease (Table 1).

Table 1: Patient characteristics

	Group I	Group II	P
Number of patients	35	35	
Age	70 ± 18.8	75 ± 11.9	0.312
Gender			0.473
Male	15 (42.8%)	18 (51.4%)	
Female	20 (57.1%)	17 (48.5%)	
Weight	73 ± 11.4	76 ± 7.7	0.069
Comorbid disease			0.780
SVH	28.6%	20.0%	
Heart lung disease	42.9%	48.6%	
Skeletal system disease	11.4%	8.6%	
Other	17.1%	22.9%	
APACHE II	25.1 ± 4.6	26.4 ± 2.3	0.131
Inotropic need	45.7%	57.1%	0.339
Sedation requirement	48.6%	45.7%	0.811
Additional disease	65.6%	68.7%	0.799

Values are expressed as n. Values for p <0.05 were considered as being statistically significant.

In our study, mean total GRV was measured as 317.14 ± 127.39 ml in Group I while it was 598.86 ± 86.09 in Group II during the follow-up period of 3 days and a statistically significant difference was found between the two groups (p<0.001). While a high gastric residual volume was measured in 6 patients in Group I, no high GRV was monitored in Group II. No statistically significant difference was found between the groups in terms of the period of time to reach target calories, target calorie values and the length of stay in intensive care unit (Table 2). No statistically significant difference was found between Group I and Group II in terms of the abdominal distension, diarrhea, vomiting, rate of IVAC and rate of VAC (Table 3).

Table2: Obtained values

	Group I	Group II	p
Patients with HGRV	17.1%	0.0%	0.012
Time until reaching target calories	48.4 ± 19.3	53.4 ± 19.3	0.152
Medium GRV	317.1 ± 127.3	598.8 ± 86.0	0.001
Target calories	1673.1 ± 246.2	1708.2 ± 159.2	0.481
Duration of stay	19.6 ± 13.0	15.8 ± 10.2	0.205

GRV: gastric residual volume, HGRV: high gastric residual volume. Values are expressed as n. Values for p <0.05 were considered as statistically significant results.

Table 3: Rates of gastrointestinal complications

	Group I	Group II	p
Patients with gastrointestinal complications	45.5%	54.5%	0.607
Patients with abdominal distension	38.5%	61.5%	0.356
Patients with diarrhea	42.9%	52.1%	0.766
Patients with vomiting	37.5%	62.5%	0.710
Patients with VAC	45.5%	54.5%	0.743
Patients with IVAC	33.3%	66.6%	1.00

VAC: ventilator-associated condition. IVAC: infection-related ventilator-related complications. Values are expressed as n. Values for p <0.05 were considered as statistically significant results

DISCUSSION

There exists some views asserting that gastrointestinal functions must be regularly measured when the evidence associated with negative results caused by the occurrence of gastrointestinal intolerance are considered in critical patients [11]. Using GRV in the determination of gastric intolerance in the patients receiving enteral nutrition is a method accepted as clinically routine and it has been included in the nutrition support algorithms in several intensive care units [12]. Currently, GRV is used for the measurement of gastrointestinal function in our own intensive care unit.

Targeted calories in enteral nutrition may generally be reached in 3 days, however, in some studies, periods between 3 days and 6 weeks have been observed [10, 13]. For the patients in our study group, the targeted period of time to reach the daily calorie intake was 3 days and no statistically significant difference was found between the groups, in terms of the period of time to reach target calories. These results were similar to those in the studies by Flesher et al. [14] and Pinilla et al. [10].

Montejo et al. suggested that a GRV value between 200 and 500 ml is a normal value since a threshold value of 500 ml during enteral nutrition implementation was not associated with gastrointestinal complications or adverse effects in the result variables. In this study, the threshold values of 200 ml and 500 ml were compared, and it was found that increasing the GRV threshold value in patients with mechanical ventilator was not associated with gastrointestinal complications [15]. The reason why we chose a threshold value of 500 ml in the second group of our study was that this value was determined as a clinical endpoint in literature. In our study, groups with GRV threshold value of 250 and 500 ml were compared. We could not find a statistically significant difference between the groups in terms of the period of time to reach target calories, regurgitation, aspiration, gastric distension and rate of VAC. These results were consistent with those in the study by Montejo et al [16].

It was reported that sedation might affect gastric drainage and indirectly, GRV [17]. This is the reason the Ramsay score was monitored and kept between 3 and 6 in all the patients included in this study. No statistically significant difference was found between the two groups in terms of sedation score. In our study, no statistically significant difference was found between GRV values of the patients using or not using sedative medication for sedation. It is recommended that the volume should be 10-20 ml when the nutrition is initiated, that it should be carefully increased by monitoring gastrointestinal symptoms and that it should not exceed the maximum energy of 20 kcal/kg, which is recommended for acute phases within 3 days. Two methods are available for the standardization of GRV measurement. The first is withdrawing gastric juice with a syringe and the second is performing this action with the

help of a drainage bag placed at the level of the stomach, and by monitoring the ejected volume in between 15 and 120 minutes [18]. In our study, we initiated enteral nutrition at a rate of 20 ml/hour and aimed to reach the determined energy target with separate Schofield formulas for each patient. While measuring GRV, we used the aspiration method, using a 50 ml syringe. The reason why we did not use free drainage system for GRV measurement was to avoid the adverse effects of nutrition intermittences needed for drainage measurement.

Williams et al. [19] have suggested returning the gastric aspirate withdrawn by the syringe to the patient. Buyukcoban et al. [20] did not return the gastric aspirate to the patient in order to avoid the adverse effects of bolus injection. We chose not to return the gastric aspirates.

Mc Clave et al. [8] compared GRV threshold values of 200 ml and 400 ml in terms of aspiration and regurgitation and found that high GRV did not increase the risk. In 2007, Desachy et al. [21] compared the vomiting rates of the patients whose GRV were >300 ml and <300 ml in their study, in which GRV threshold value was determined as 300 ml, and they found no significant difference. In our study, no significant difference was found between the vomiting rates of the patients whose threshold values were 250 ml and 500 ml. This result brought us to consider that the GRV amount was not critical in the rate of vomiting.

Bankhead et al. [22] found no relationship between high GRV and the probability of aspiration and related pneumonia. In a study by Reinger et al. [23] in 2013, the group with 200 ml GRV and the group with no GRV were compared through intermitting the nutrition, in case of gastrointestinal intolerance. The group in which no GRV was measured reached the target calories faster, but complications such as ventilator-associated pneumonia, infection or aspiration and lengths of stay in intensive care, were similar. Fogg et al. reported that personnel training, proper usage procedures and developed enteral nutrition protocols, decreased the level and incidence of bacterial contamination in enteral tube feeding [24]. Infection-related ventilator-associated complications occurred in none of our patients and no significant difference was found between the two groups in terms of VAC. Before the study started, all the nurse practitioners were trained on infection control for the patients receiving enteral nutrition, since the other factors were excluded, and infection control had a vital importance and would have affected our results.

In the evaluation based on total GRV amounts in our study, total GRV amounts were measured until target calories were reached and no statistically significant difference was found between the two groups in terms of gastrointestinal intolerance.

Although Elke et al. [25] reported that necessity for GRV measurements in units where nutrition implementations were carried out by an experienced nurse team and where standardized nutrition protocols and other safety criteria were implemented became a controversial topic. GRV is recommended to be used in particular in surgical intensive care patients and patients with an extremely severe condition. In our study, we could not find a statistically significant difference between the groups in terms of the period of time to reach target calories, regurgitation, aspiration, gastric distension and rate of VAC. Our results of standardized enteral nutrition protocol, based on two different GRV values implemented in our intensive care unit by experienced intensive care nurses, were investigated and these results were consistent with the views of Elke et al. [25]

Limitations of the study: In our study, GRV amounts of the patients were only measured for the period of reaching the target calories, not throughout their entire stay in the ICU.

Conclusion: Although a statistically significant difference was found between Group I for which 250 ml of GRV was based and Group II for which 500 ml of GRV based in terms of total GRV in our study, there was no difference in terms of occurrence of vomiting, diarrhea, regurgitation, abdominal distension, infection-related ventilator-associated complications and ventilator-associated condition. These results make the necessity of GRV measurement used to measure gastrointestinal motility in patients receiving enteral nutrition via nasogastric tube controversial; they suggest that the usage of enteral nutrition protocols standardized in intensive care units to

prevent gastrointestinal intolerance is crucial.

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