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Gastric residual volume management in a neurosurgery intensive care unit: A randomized controlled trial

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Abstract
Aim: This randomized controlled trial aimed to analyze the impact of discarding or returning the aspirated gastric residual volume (GRV) on biochemical values in adult patients.
Material and Methods: The sample of the study consisted of three groups who have just begun to be fed enterally via a nasogastric tube. The first, second and control groups each included 30 patients. In the first group, GRV aspirated from the patients was given back to the patients, while in the second group, GRV was discarded. The third group was the control group, GRV was not checked.
Results: Between the three groups there was no statistically significant difference in GRV, the blood levels of aspartate amino transferase (AST), alanine amino transferase (ALT), C-reactive protein (CRP), prealbumin, transferrin, cholesterol, hemoglobin, hematocrit, urea, creatinine, electrolyte and glucose ($p>.05$), but the levels of triglycerides and phosphorus varied significantly among the three groups ($p<.05$).
Discussion: There is no difference was found between the groups of returning, discarding the aspirated GRV and control group, in terms of patients' AST, ALT, CRP, hemoglobin, hematocrit, transferrin, prealbumin, total cholesterol, urea, creatinine, sodium, potassium, chlorine, calcium, magnesium and glucose values, but differences were found between the groups in triglyceride and phosphorus values.

Keywords
Gastric Residual Volume, Intensive Care Units, Nursing, Neurosurgery

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Introduction

Enteral nutrition is being increasingly used with the development of technology, enteral feeding formulas and ingredients [1-3]. However, lung aspiration, tube blockage, intolerance, regurgitation, vomiting, diarrhea and esophagitis are frequently seen complications [4]. In order to reduce to a minimum, the possible complications of enteral nutrition and to evaluate gastrointestinal function, nurses perform gastric residual volume (GRV) checking [5,6,7].

In clinical practice, after the GRV is measured, some nurses discard the gastric contents, while others return it partially or completely to the patient [8,9].

Advantages and disadvantages of GRV management

There are studies, which support the return of the GRV aspirated from the patient because it contributes to the maintenance of the gastric content and the liquid electrolyte balance [10,11]. However, other studies recommend that the GRV aspirated from the patients be discarded in order to avoid complications such as tube contamination, the risk of infection and blockage, and to prevent the accumulation of volume related to gastric emptying [12,13]. There is no consensus in the literature as the frequency of GRV monitoring, minimum and maximum GRV [4,9,10,11], what constitutes a high GRV with values ranging from 50 ml to 500ml, whether to return the aspirated GRV to the patient or to discard it, and the effect on biochemical values [14,15].

The present study was conducted to analyze the impact of discarding or returning the aspirated GRV on biochemical values in adult patients.

Material and Methods

Design and Sample

This prospective, randomized controlled trial was conducted on 90 patients who were admitted to the Neurosurgery Intensive Care Unit (ICU) of a University Faculty of Medicine in western Turkey.

The data collection was performed between October 2013-July 2014. The sample of the study consisted of three groups. The first and second groups provided basic data, while the control group formed a necessary step in the randomized controlled study. The groups included 30 patients each, who had just begun enteral feeding via a nasogastric tube, who had a planned stay in the ICU of at least seven days, who had achieved hemodynamic stabilization, and who conformed to the inclusion criteria of the research. The inclusion criteria of the research were patients aged 18 or over, fed enterally via a nasogastric tube, no head trauma, no diarrhea, no mechanical intestinal obstruction, no paralytic ileus, no generalized peritonitis, no acute pancreatitis, no inflammatory bowel disease, no gastrointestinal bleeding, no short intestine syndrome, no morbid obesity, no diabetes mellitus, not having undergone abdominal surgery, not having undergone abdominal radiotherapy within the previous six weeks and voluntary participation in the study.

Ethical Considerations

In order to conduct the study, written approval was obtained from the Clinical Research Ethics Committee of the University Faculty of Medicine (reference date and number: 11.04.2012; 12-3/4), the Scientific Research Projects Commission of the University Faculty of Medicine Dean's Office (Reference date and number: 16.05.2013; 42490658-417-7902), a Neurosurgery Department of the University Faculty of Medicine (Reference date and number: 26.06.2013; 47700900-700), the Project and Special Services Coordination Centre of the Dean's Office of the University Medicine Faculty (Reference date and number: 08.10.2013; 589-14758), and from the patients in a Department of Neurosurgery ICU, in the case of conscious patients from the patients themselves and in the case of unconscious patients from their close relatives.

Randomization Procedure

A stratified randomization technique was used in this study. Patients were stratified and matched based on age and gender. Randomization occurred anytime from ICU admission, after assessment by the anesthesiologist, the ICU physician and the clinical nurse specialists that the patient was likely to receive enteral nutrition for seven or more days.

Four hundred fifty-one patients were assessed for eligibility and 283 patients were randomized. The trial ended when the sample size (30 patients for each group) was reached. The CONSORT (Consolidated Standards of Reporting Trials) flow diagram records the reasons for withdrawals. One hundred ninety-three patients were dropped out of the trial, because they were hospitalized less than seven days or they were exitus (Figure 1). Data Collection Instruments

A patient monitoring form developed by the researchers based on the literature was used as a data collection instrument [2,4,6,9,10,15,16,17]. The form recorded the patients' age, gender, diagnosis, Glasgow Coma Scale (GCS), descriptive characteristics such as weight and height, Nutritional Risk Screening 2002 (NRS 2002) and Simplified Acute Physiology Score II (SAPS II) scores, calories to be taken daily, the use of medications, basic vital signs, the amount of nutrients taken, daily fluid balance, amount of GRV aspirated, amount of GRV returned or discarded, complications of the gastrointestinal system, and the results of biochemical blood analysis, of aspartate aminotransferase (AST), alanine aminotransferase (ALT), C-reactive protein (CRP), prealbumin, total cholesterol, transferrin, triglyceride, hemoglobin, hematocrit, urea, creatinine, potassium, calcium, magnesium, chlorine, phosphorus and glucose.

Data Collection

After the randomization procedure, evaluations were performed, and the total daily calories to be taken by patients were determined using the Schofield Formula.

In terms of nutrients, a nutritionally complete, fiber-enriched and ready-to-use enteral tube feeding mixture was used, which provided full and balanced nutrition. These mixtures were given in a regular manner to the patients using enteral feeding sets with calibrated feeding pumps and 14 Fr polyurethane nasogastric feeding tubes.

Feeding was started for patients in the first, second and control groups at 20mL/h, and nutrients given were steadily increased until the targeted number of calories was reached. When this target was reached, checking of the GRV was started in the patients of first and second groups. For the control group patients, the enteral feeding protocol of the ICU where the study was conducted was taken as a base, and GRV checking

was not performed.

The GRV checking was performed at 12:00, 18:00, 00:00 and 06:00 in accordance with the steps of the GRV checking operation. Before and after each GRV check of patients in groups one and two, and in patients in the control group after an interval of five minutes, vital signs were recorded. Since gastric residual volume was not checked in the control group, vital signs were measured five minutes after the measurement to obtain the comparison data.

To make it easier to aspirate the gastric contents of patients in groups one and two, 30 mL of air was put into the stomach. After this, a 60 mL syringe was used to check the GRV. When no more gastric content could be taken, the stomach was regarded as empty. During the check of GRV, no position change was performed [2,10]. After the GRV check in groups one and two, and after an interval of six hours in the control group, 30 mL of tap water was given to prevent the nasogastric tube from blocking [17].

In checking the GRV of patients in the first group, it was planned to give back at most 500 mL of the aspirated contents [16]. All aspirated contents of patients in the second group were discarded, and the GRV of patients in the control group was not checked. The venous blood samples were taken from patients on the first, fourth and seventh day of the study at 06:00 to evaluate the values of biochemical testing (Table 1).

Data Analysis

Data obtained from study participants were analyzed using the Statistical Package for the Social Sciences (SPSS) for Windows 20.0 (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.). Patient and cohort characteristics were described using mean and standard deviation (SD) or median and interquartile range (IR), as appropriate. Age, gender, diagnosis, calories received, vital signs, scores of NRS 2002 and SAPS II, prokinetic agent used and biochemical blood analysis were compared between the first, second and control groups.

Numeric and percentage distributions of the data were examined. Conformity with the numeric data to a normal distribution was evaluated with the Shapiro-Wilk Test. The One-Way Anova Test and the Bonferroni Test were applied to numeric data with a normal distribution. The Kruskal-Wallis Test, the Wilcoxon-Rank Test and the Mann-Whitney Test were applied to numeric data that did not show normal distribution. The Chi-Square Test was applied to non-numeric data. Statistical significance was taken as 95%, and the confidence interval as $p<.05$.

Results

General Characteristics of Patients

Male patients accounted for 50% of all groups. The mean age of the first group patients was 44.47±18.36 (Min: 18, Max: 83) years, in the second group- 43.77±16.99 (Min: 18, Max: 78) years, and in the control group- 40.77±16.44 (Min:21, Max:77) years. The majority of the patients included in this study had brain tumors. It was determined that all patients were using H2 receptor antagonists and that 66.7% of them were using prokinetic agent.

No statistically significant difference was found between patients' age, gender, diagnosis, GCS, SAPS II, NRS 2002 mean scores, amount of calories received, and use of H2 receptor antagonists or prokinetic agent (Table 2).

Results of Gastric Residual volume, Vital Signs, and Biochemical Blood Values

Median values of GRV of patients on days when biochemical blood tests were performed as follows: 1st day, first group: 19.00-11.50 (Min:5, Max:58) and second group: 20.75-19.31 (Min:3, Max:49) (U=393.50, p=.40), 4th day, first group: 90.50-98.75 (Min:26, Max:259) and second group: 97.50-113.00 (Min:17-Max:291) (U=416.00, p=.615), 7th day, first group: 53.00-62.25 (Min:9, Max:205) and second group: 42.50-63.25 (Min:9, Max:190) (U=396.00, p=.42). No statistically significant difference was found between the groups in amounts of GRV when biochemical tests were performed (Table 3).

Statistically no significant difference was found between the groups in systolic blood pressure and pulse rate before, after the GRV checking and control group ($p>.05$). A statistically

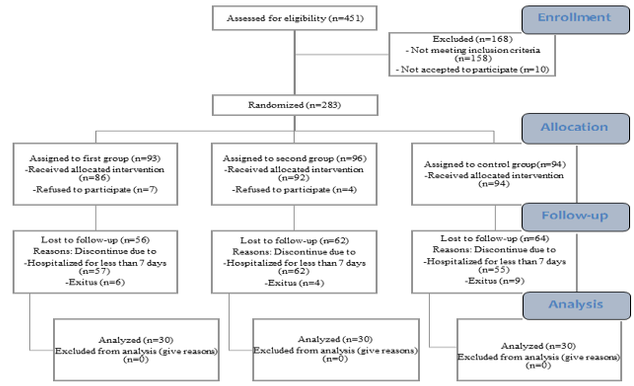

Figure 1. CONSORT flow diagram

Figure 2. Biochemical blood values of 1 st and 7 th days

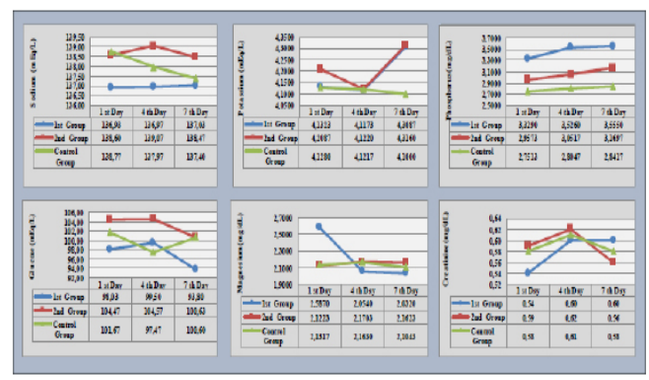

Figure 3. Biochemical blood values of 1 st, 4 th and 7 th days

Table 1. Schedule of data collection

Patients conforming to the research criteria		
Obtaining approval from patients or first-degree relatives		
Randomization of patients (First group, Second group and Control group)		
Assessment of NRS 2002 and SAPS II scores		
Determination of patients' daily calorie intake using the Schofield formula		
Start of feeding at 20 ml/h, reaching the targeted number of calories		
1st, 4th and 7th days		
First group	Second group	Control group
* Vital signs were taken	* Vital signs were taken	* Vital signs taken at 12:00, 18:00, 00:00 and 06:00
* GRV was checked	* GRV was checked	* Five minutes after taking vital signs again.
* At most 250 ml of aspirated GRV was returned	* Vital signs were taken again	* At 06:00 venous blood sample for biochemical testing was taken
* Vital signs were taken again	* If the GRV exceeded 500 ml, feeding was stopped until the next GRV check	
* If the GRV exceeded 500 ml, feeding was stopped until the next GRV check.	* Repeat at 12:00, 18:00, 00:00 and 06:00	
* Repeat at 12:00, 18:00, 00:00 and 06:00	* At 06:00 venous blood sample for biochemical testing was taken	
* At 06:00 venous blood sample for biochemical testing was taken		

Table 2. General characteristics of patients (n=90)

Characteristics	Groups			p value
	First group	Second group	Control group	
Mean age (SD)	44.47(18.36)	43.77(16.99)	40.77(16.44)	.68
Males (%)	50%	50%	50%	
Diagnosis n (%)				
Number of patients with tumor	8 (26.7)	6 (20.0)	7 (23.3)	
Aneurism	3 (10.0)	3 (10.0)	5 (16.7)	
Epidural hematoma	3 (10.0)	4 (13.3)	3 (10.0)	
Hydrocephalus	3 (10.0)	4 (13.3)	3 (10.0)	
Subarachnoid bleeding	3 (10.0)	3 (10.0)	3 (10.0)	1.00
Intracerebral hematoma	4 (13.3)	3 (10.0)	2 (6.7)	
Subdural hematoma	2 (6.7)	3 (10.0)	3 (10.0)	
Intraventricular hematoma	2 (6.7)	3 (10.0)	3 (10.0)	
Arteriovenous malformation	2 (6.7)	1 (3.3)	1 (3.3)	
Mean SAPS II (SD)	23.70 (7.96)	27.07 (6.99)	29.00 (7.87)	.06
Mean NRS 2002 (SD)	3.77 (0.93)	4.07 (1.01)	4.50 (1.22)	.05
Median calories received (IR)	2005 (62)	2032 (54)	2044 (51)	.91
H2 receptor antagonist used n(%)	30 (100.0)	30 (100.0)	30 (100.0)	-
Prokinetic agent used n(%)	6 (20.0)	9 (30.0)	5 (16.7)	.43

N; Number, %; Percentage, SD; Standart Deviation, IR; Interquartile Range *p<.05

Table 3. Values of GRV of patients on days when biochemical blood tests were performed

Gastric residual volume	Groups			p value*
	First group	Second group	Control group	
1st day M-IR (ml) (Min-Max)	19.00-11.50 (5-58)	20.75-19.31 (3-49)	--	.40
4th day M-IR (ml) (Min-Max)	90.50-98.75 (26-259)	97.50-113.00 (17-291)	--	.61
7th day M-IR (ml) (Min-Max)	53.00-62.25 (9-205)	42.50-63.25 (9-190)	--	.42

M; Median, IR; Interquartile Range, Min; Minimum, Max; Maximum *p<.05

significant difference was found between the groups in diastolic blood pressure, and body temperature evaluation before, after the GRV checking and control group (p<.05).

As seen in Figures 2 and 3, there was no difference between the groups of patients in the study in terms of hemoglobin, hematocrit, transferrin, prealbumin, total cholesterol, urea, creatinine, sodium, potassium, chlorine, calcium, magnesium and glucose values (p>.05), but a difference was found between the groups in triglyceride and phosphorus values (p<.05). On the other hand, no statistically significant difference was found between the groups in gastrointestinal system complications such as vomiting, diarrhea, abdominal distension or constipation (p>.05).

Discussion

Monitoring GRV is one of the most traditional, widely accepted and common practices in assessing the tolerance of a patient to enteral nutrition and preventing pulmonary aspiration in nursing practices in the ICUs' [13,18]. A national survey among the American Association of Critical Care Nurses (AACN) indicated that more than 97% of nurses reported measuring GRV [11]. However, in recent guidelines and studies, it is not recommended as a routine care [15,16,19].

Studies have shown different results in GRV measurements with enteral feeding tubes of different diameters; with wide diameter feeding tubes, there was a greater development of reflux, while with narrow diameter tubes, blockage occurred more frequently [6, 20, 21,22].

In a study in which gastric volume measurements were performed 890 times on 137 patients, it was reported that there was no difference between the GRV amounts measured with 14 Fr and 18 Fr nasogastric tubes, but that the GRV measured with a 10 Fr nasogastric tube was approximately half of that of other tubes [6]. In a study performed with 40 enteral feeding patients in an ICU, the mean GRV of patients in whom a 10 Fr nasogastric tube was used was found to be 108±35 mL, while when a 16 Fr tube was used it was 137±20 mL [9]. The GRV amount specified in the study is quite high compared to the present study. All patients included in the study were fed enterally with 14 Fr polyurethane nasogastric

tubes, and aspiration of the GRV was performed using 60 mL syringes. Patients' head height was maintained at 30-45°. Care of the nasogastric tubes was conducted in accordance with the literature [6,20,21]. In this way, standardization was provided for all patients, and the effects of the use of different sizes of nasogastric tubes and aspiration syringes and different head angles were reduced to a minimum.

In the studies of gastric residue and complications in ICU patients who were being fed enterally with standard products with or without fibers, it was found that throughout the days of monitoring, the amounts of GRV in the groups were similar [23,24]. In our study, patients were fed enterally with fiber products, and no difference was found between the amounts of the GRV in the first and second groups.

According to the studies, there was no statistically significant difference in vital signs and oxygen saturation before and after procedure in the 1st and 7th days [10,23]. In the present study, it was found that gastric residual volume measurement had no effect on vital signs. Our findings were similar to other studies. Randomized controlled trials have indicated that the return of gastric residues provided more benefits for fluid and electrolyte balance, but did not increase gastric intolerance [4,10,23,24]. Although there is no consensus on how much gastric residual volume should be returned [16,25], there are studies indicating that up to 250 ml can be returned [10,23].

In the other studies, no difference was found in the development of complications when GRV was returned or discarded [4,24], except that an increase was seen in sodium and chlorine values and a decline in potassium values [4].

In Juvé-Udina et al's [2009] study on the impact of returning or discarding aspirated GRV on patients' liquid electrolyte levels, patients were monitored for at least 48 hours, and no difference was reported between the groups in terms of sodium, potassium and protein values, but blood sugar values were higher in the group in which GRV was returned [10].

In some studies, returning and discarding gastric residual volume in patients fed enterally, according to the days, it was reported that there was no difference in the values of prealbumin, glucose, cholesterol, AST, ALT, creatinine, sodium, potassium, chlorine, magnesium or calcium [10,23,24]. The biochemical values in our study were similar with the literature. However, triglyceride values in both groups were lower on the 1st day than on the 7th day, and phosphorus values were higher than on the 1st day.

Conclusion

In conclusion of the present study, no difference was found between the groups in terms of patients' AST, ALT, CRP, hemoglobin, hematocrit, transferrin, prealbumin, total cholesterol, urea, creatinine, sodium, potassium, chlorine, calcium, magnesium and glucose values, but differences were found between the groups in triglyceride and phosphorus values.

Recommendations

In recent guidelines and studies of enteral feeding, routine measurement of GRV is not recommended. According to our study results, our recommendations regarding this situation are as follows:

• It is possible to remove routine GRV measurement from the standard nursing care in the ICU.

• If there is a requirement for measuring GRV, to reduce the incidence of gastric dysmotility complications such as regurgitation, vomiting, aspiration, and ventilator-associated pneumonia (VAP) in patients, discarding of GRV may be recommended.

• Attention should be paid to the amount of returning GRV.

• Returning GRV could lead to better optimization of enteral feeding to achieve caloric targets and biochemical values balance.

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Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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