Original Article

Effects of Continuous Versus Bolus Enteral Feeding in Trauma Patients: A Randomized Clinical Trial

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Abstract

Background and Objectives: Enteral alimentation is the preferred modality of support in critical patients who have acceptable digestive function and are unable to eat orally, but the advantages of continuous versus bolus administration are surrounded by controversy. This study aimed to examine the effect of tube feeding using the bolus method and continuous infusion on the clinical indicators of trauma patients in intensive care units (ICUs). **Materials and Methods:** A randomized clinical trial of the triple blind was conducted on 74 trauma patients admitted to special care units of a university hospital in 2022. The patients were randomly assigned to two equal groups (n = 36). Feeding in the continuous group was carried out through an infusion pump while feeding in the bolus group was carried out by the usual bolus method. In addition, clinical indicators (intestinal excretion, gavage's residual volume, vomiting, and pulmonary aspiration) were monitored for a period of 7 days in the patients. Data were analyzed using descriptive statistics, t-tests, Chi-square, and Fisher's exact test by the SPSS software version 16. **Results:** Results of the study showed that the number of times the gavage's residual volume was greater in the bolus group than in the continuous group (P = 0.02). Other results showed no statistical significant difference between the two groups regarding vomiting, intestinal excretion, and respiratory aspiration (P < 0.05). **Conclusion:** The gavage's residual volume did not increase during continuous infusion enteral feeding; therefore, this method is suitable for use in the ICU as a supportive feeding method.

Keywords: Enteral nutrition, intensive care units, malnutrition, nursing, patient, trauma

Introduction

Providing proper nutrition and nutritional support is crucial to patient care and treatment, particularly when trauma patients are hospitalized in critical care units.[1] A trauma patient in an intensive care unit (ICU) requires nutritional support as one of the protective processes.[2] Several studies conducted in ICU have demonstrated that nutritional support can improve patient outcomes when provided appropriately.[3,4] As a result of studies, 10%–60% of hospitalized patients are malnourished,[5,6] which can result in complications such as prolonged hospitalization, prolonged recovery time, infections, and even death.[7] As a result, paying attention to this issue is vital to help patients recover, particularly those in ICU.

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Studies have shown that malnutrition is more prevalent among patients hospitalized in the ICU.[8] If enough calories and protein are not provided to provide metabolism on time, catabolism will increase, fat reserves will decrease, and muscle mass will decrease.[9]

Trauma patients in the ICU cannot provide for their nutritional needs on their own, so artificial feeding methods are necessary, and one of these methods is tube feeding.[10] The effectiveness and efficiency of various tube feeding methods have been evaluated in multiple studies to determine which method is more efficient and effective and, simultaneously, has fewer side effects.[3,10,11] Following their protocols and the situation, nutritional support is provided to the patient through tube feeding and intravenous nutrition. Due to their disease conditions, patients in special care units accounted for 33%–92% of the cases of tube feeding and compared with other forms of feeding, venous has fewer adverse effects, such as reduced infection rates and reduced atrophy of the digestive system.[12-14] In addition, the clinical outcomes of the patients improve, the length of stay in ICU and hospitals decreases, and the risk of malnutrition during hospitalization is reduced.[15]

There are four feeding methods through a gastric tube: continuous, periodic, intermittent, and bolus infusion.[1] Studies have examined the advantages and disadvantages of each method, but the patient's particular condition determines the use of each method. In Iran, the bolus method is frequently used in ICUs, while some studies have shown that continuous methods are more effective.[9] Several studies have shown no significant difference between the two methods regarding the impact on the patient's clinical outcome.[16] Another study in the ICU examined the effects of continuous and bolus feeding on stool frequency and consistency. It was found that there was a significant difference between the two groups in terms of stool frequency and consistency, while the rate of aspiration and caloric intake did not differ. As a result of the study, researchers concluded that continuous feeding to the stomach should never be allowed to rest or be inactive at any time and that this continuous activity may lead to diarrhea.[17] According to Marino, bolus gavage is more similar to the natural process of eating food, but it is more likely to result in aspiration or diarrhea, whereas continuous infusion is more tolerated, and it results in weight gains and nitrogen balance.[18,19] The appropriate feeding method should be based on considerations such as digestive function, metabolism, and understanding of each protective feeding method's potential risks and benefits. According to the different theories regarding tube feeding, there is no preferred method as it has not been introduced, and further research in this area is required. A criterion is the clinical index, which includes aspiration, nausea, vomiting, abdominal distention, constipation, diarrhea, and residual stomach volume.[20] An important indicator determines the degree of tolerance to tube feeding and adequate gastric emptying in patients using tube feeding. The conclusions of the aforementioned studies are mixed and confusing for clinicians regarding whom enteral nutrition strategy is better and more suitable for adult patients with a critical illness. As determined as a research hypothesis, continuous enteral nutrition is more effective at improving clinical indicators in trauma patients in critical care units than bolus enteral feeding.

Materials and Methods

This randomized, controlled, triple-blind, two-arm clinical trial was conducted on trauma patients in ICUs in an educational hospital in Iran. The sampling was conducted between June 2022 and October 2022. The nurses, patients, and statistical analysts were blind in this study. Patients are selected through continuous sampling and then randomly assigned to continuous feeding and bolus feeding groups through online randomization software in six blocks. We randomly assigned patients in a 1:1 ratio following block randomization procedures to two groups: the bolus feeding group and the continuous feeding group. It was the author responsible for the article which created the randomization sequence using the software, and the first author was responsible for sampling and assigning them to the groups. The allocation sequence was concealed from researchers who enrolled patients using sequentially numbered patient cards.

The sample size of 68 was calculated regarding the mean of the residual volume in the stomach in the intervention (39.78 ± 4.94) and control (43.98 ± 7.18) groups.[3] as well as the α and β values of 0.05 and 0.2, respectively. Regarding a dropout probability of 10%, the number of patients enrolling will be approximately 72.

The inclusion criteria included the age range of 18–65 years, willingness of the patient family or legal guardian to participate in the study, hospitalization in the critical care unit, the inability to swallow food through the mouth, the possibility of administering bolus nutrition or continuous infusion, lack of suffering from fistula, necrosis, obstruction, and surgeries of the digestive system, peritonitis, diabetes or intolerance to glucose and having the same indication for both methods. Exclusion criteria included discharge or death before 7 days and worsening of the clinical condition, being unable to maintain adequate nutrition during the study, nutrition interruption for more than 24 h, unwillingness to cooperate in the study, and undergoing surgery during the study.

Demographic and clinical characteristics of the patients were recorded using a researcher-made checklist (including age, sex, weight, and duration of hospital admission) at the beginning of the study by an ICU nursing staff (the second researcher assistant). The study will collect demographic and baseline characteristics from medical records and electronic medical records, including age and sex, as well as clinical information, including disease diagnosis, hospitalization duration, length of ICU stay, duration of intubation, whether the patient has undergone surgery, the type of surgery, the number of antibiotics administered, the amount of serum received within 24 h, and underlying conditions.

After ensuring that the gastric tube has been appropriately placed, gastric feeding will begin for both groups. According

to the instructions, ensure powder should be mixed with 90 mL of boiled water and cooled with two cups of powder. An expert nutritionist calculates the volume needed daily in the form of a uniform solution. According to the patient's condition and calculating the stress coefficient, the ideal weight is multiplied by 25–30 kcal.[21] The prepared food was administered through a stomach tube to both groups as 1 kcal/mL. Following the patient's condition, the nutritionist determined the calories and volume needed using the Harris–Benedict formula. For the patient, an enteral feeding bolus (300 ml every 3 h) was administered for 10–20 min based on gravity using a 50 cc syringe, and the tube was washed with 20 mL of plain water at the end.[3] With a syringe pump, liquid nutrition was delivered at a constant rate infusion, and the volume was confirmed and recorded every 4 h. This method begins with a volume of 50 mL/h and then adds 50 mL every 6 h to determine the volume and calories. A continuous infusion of gavage fluid was provided to the patient 24 h a day.[3]

The ICU nurses were trained to perform the same intervention on patients before the intervention began. Furthermore, a checklist and explanations concerning how to establish and increase the volume level were written separately for each patient based on his or her condition, nutrition method, and calorie intake. The researcher provided the necessary explanations by phone or in person due to the change in nurse work shifts. Every morning, he reviewed the existing cases to prevent errors from occurring. The intervention was performed in seven consecutive days by three ICU nurses with similar expertise and experience in each shift, which were unaware of the study details and aims. Furthermore, all the patients were blind to the course of the intervention.

Data collection of this study was performed in the morning, afternoon, and night shifts in 7 consecutive days using the checklist. To evaluate the enteral feeding intolerance of the patients, a researcher-made checklist including data on constipation, diarrhea, vomiting, abdominal distension, and gavage residual volume (GRV) was used. In bolus feeding, GRV was assessed by gastric aspiration every 3 h after feeding. If the aspirated volume was more than 200 cc, then 100 cc of the aspirated content was replaced along with the rest of the feeding amount and aspiration was rechecked after 3 h. In intermittent feeding, GRV was assessed every 4 h after stopping the feeding pump for half an hour and aspiration of gastric contents. If aspirated volume was more than 200cc, then 100cc of the aspirated content were replaced, feeding was continued at the same rate for the next 4 h and aspiration was rechecked. If aspiration was still more than 200 cc, a sign of intolerance was confirmed.

Data were analyzed using descriptive statistics, *t*-tests, Chi-square, and Fisher's exact test by SPSS software v. 16 (SPSS Inc., Chicago, IL, USA). The Kolmogorov–Smirnov test checked the normality of the data. A significance level of 5% will be used for all statistical tests.

Results

From a total of 85 patients assessed for eligibility in the study, 13 did not meet the inclusion criteria, and 72 patients were randomly allocated to two equal groups. The bolus group had nine patients excluded (3 due to death and 6 due to emergency surgery) and the continuous group had five patients excluded (3 due to death and 2 due to emergency surgery) [Figure 1].

There were 64.5% (n = 20) males in the continuous feeding group and 52% (n = 13) in the bolus feeding group. The mean age of the samples in the continuous feeding and bolus feeding groups were 60.16 ± 23.61 and 69.16 ± 19.57 years, respectively. In the continuous group, the mean hospital stay in the ICU was 6.32 ± 6.46 days, while in the bolus group, it was 6.28 ± 7.77 days. The mean duration of intubation was 6.54 ± 6.72 days in the continuous and 8.64 ± 12.45 days in the bolus groups. No significant difference was found between the two groups regarding age, sex, surgery, Glasgow Coma Scale (GCS), hospitalization, intubation, and hospitalization in ICU [$P > 0.05$; Table 1].

There were no vomiting cases in 74.2% (n = 23) and 76% (n = 19) of the samples in the bolus and continuous groups, respectively. Furthermore, 8% (n = 2) and 18.4% (n = 6) of the participants in the bolus and continuous groups had residual volumes exceeding three times, respectively. The results of the Chi-square test showed a significant difference between the two groups (P = 0.02). The Chi-square test results showed no statistically significant difference between the frequency of vomiting, intestinal excretion, stomach bleeding, and weaning ($P > 0.05$). Furthermore, the results showed that none of the participants had diarrhea during the intervention in the two groups [Table 2].

Discussion

As a result of the present study, there was a statistically significant difference in residual volume between the two groups during the intervention, such that the residual volume frequency was higher in the bolus-feeding group than in the continuous-feeding group. The results of Shahriari and Rezaei's study also showed that the amount of residual volume in the blous feeding method is higher than in the continuous method.[3] The results of other studies also confirm this finding, which is in line with the present results.[11,22]

The study's results also demonstrated no statistically significant difference between the two groups regarding the number of times they vomited. In Nasiri *et al*.'s study, no statistically significant difference was found between the two groups regarding vomiting.[23] According to Table 2, however, there are significant clinical differences between the two groups. Consequently, the number of people experiencing vomiting during the intervention period was higher in the bolus group than in the continuous group. The results of another study showed that there is no statistically significant difference between the two groups of continuous and intermittent

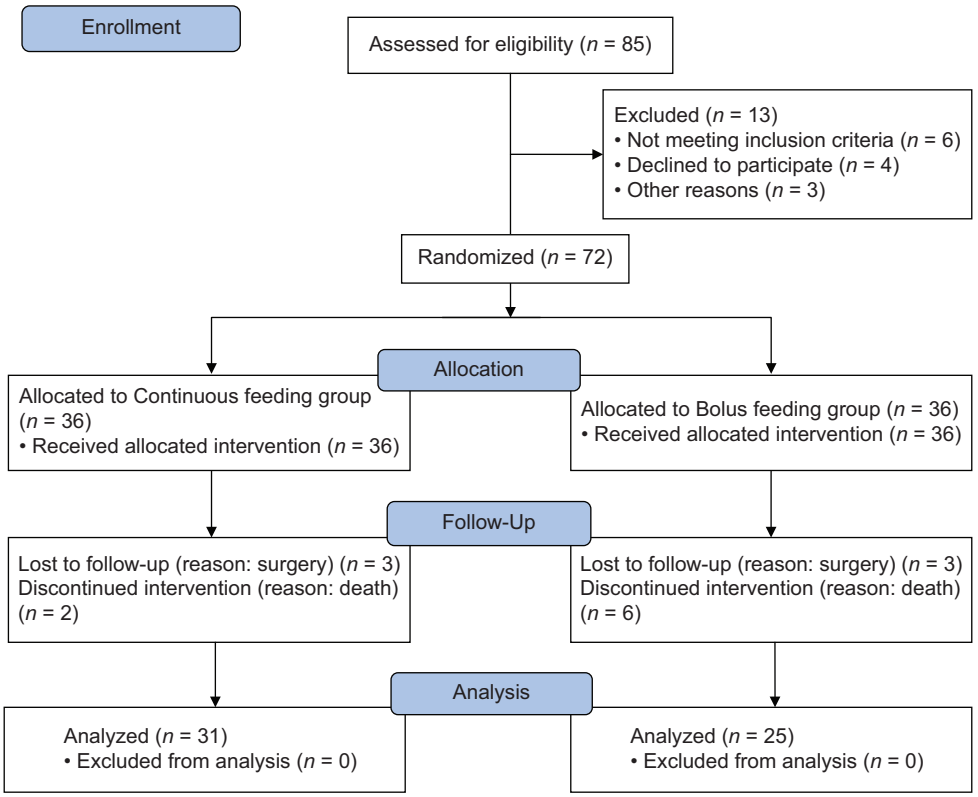

Figure 1: Diagram of enrollment and allocation of samples in groups

feeding.[11] Some studies have shown that the continuous method in comparison with the bolus or intermittent feeding, is associated with better tolerance due to the lower feeding rate.[24-26] As a result of this finding, we can state that the exit of stomach contents in the form of vomiting depends on the pressure created in the fundus of the stomach, which was probably not sufficient in the trauma patients studied to cause significant complications.[27]

In the present study, no incidence of diarrhea was reported in any of the two groups, which is similar to the results of Shahriari and Rezaei's study.[3] According to Serpa *et al*., no difference was observed between the two groups regarding diarrhea incidence.[16] The results of other studies are also in line with the present study.[23,25,28] Unlike the group that considers tube feeding to be the leading cause of diarrhea, wise states that, this kind of feeding reduces the incidence of diarrhea due to maintaining the tissue integrity of the digestive tract and the efficiency of its supporting tissue.[29]

The results of the present study showed no statistically significant difference in the incidence of pulmonary aspiration between the two groups. The results of Ahangari *et al*.'s study showed that there was no statistically significant difference in the amount of aspiration in the three groups regarding bolus, intermittent, and regular feeding methods.[30] The results of the study conducted by Musazadeh *et al*. also report the incidence of pulmonary aspiration in trauma patients in ICUs under bolus nutrition as 5.6%, which is in line with the results of the present study.[10] Despite the lack of statistical difference between the two groups in the present study, three people in the bolus-feeding group suffered from pulmonary aspiration, which is clinically significant. According to Hasanzadeh *et al*., tube feeding using the bolus method results in a higher rate of a respiratory aspiration than intermittent feeding.[31] In expressing this finding, it can be said that the presence of high speed and pressure during bolus feeding and the opening of the sphincter at the end of the esophagus due to the presence of a stomach tube may result in regurgitation of the solution into the mouth and leakage from around the cuff of the tracheal tube into the lungs during bolus feeding. While in continuous feeding, the speed and pressure of entering the food solution is uniform and as a result, it has fewer side effects. In addition, researchers state that gradually introducing food solutions and gradually increasing the speed of the process can help reduce pulmonary aspiration in patients.[31] A meta-analysis study showed that the incidence of high gastric volume and aspiration were both higher in bolus-feeding group, indicating that the increased risk of high gastric volume might be an important cause for aspiration.[11]

Conclusion

The results of this study demonstrated that continuous feeding has a much lower residual volume than bolus feeding. Aspiration is considered one of the most serious side effects of enteral nutrition. We found that the aspiration rate was higher in bolus feeding compared with continuous feeding. It has been reported that large feeding volume, high gastric volume, and

Table 1: Comparison of demographic and clinical variables of the two groups

Variable	Continuous, *n* (%)	Bolus, *n* (%)	*P*
Sex			
Male	20 (64.5)	13 (52)	0.34*
Female	11 (35.5)	12 (48)	
Surgery			
Yes	24 (77.4)	19 (76)	0.90*
No	7 (22.6)	6 (24)	
Receive laxatives			
Yes	8 (25.8)	4 (16)	0.29**
No	23 (74.2)	21 (84)	
Anti-acide	31 (100)	25 (100)	-
Antibiotic			
Imipenem	31 (100)	25 (100)	0.44*
Tvanex	15 (48.4)	9 (36)	
Vancomycin	27 (87/1)	25 (100)	
Clindamycim	16 (15.6)	16 (64)	
Ciprofloxacin	11 (35.5)	11 (44)	
Cefipim	3 (9.7)	4 (16)	
Linazolid	4 (12.9)	1 (4)	
Variable	**Groups**	**Mean±SD**	***P******
Age (year)	Continuous	60.16±23.61	0.17
	Bolus	69.16±19.57	
Gelasco Coma Scale	Continuous	7.45±2.41	0.63
	Bolus	7.76±2.18	
Hospitalization (day)	Continuous	8.74±6.95	0.43
	Bolus	10.00±7.58	
Intubation (day)	Continuous	6.54±6.72	0.68
	Bolus	8.64±12.45	
Time in ICU (day)	Continuous	6.32±6.46	0.68
	Bolus	6.28±7.77	
Fluid output (CC)	Continuous	3219.8±3827.9	0.34
	Bolus	2464.7±926.3	
Fluid intake (CC)	Continuous	2418.8±731.6	0.67
	Bolus	2496.4±624.4	

*Chi-square, **Fisher's exact test, ****t*-test. ICU: Intensive care unit, SD: Standard deviation

Table 2: Comparison of the clinical indicators between the continuous and bolus feeding groups

P	Group		*P*
	Continuous, *n* (%)	Bolus, *n* (%)	
Vomiting			
No	26 (83.9)	14 (56)	0.12*
One	4 (12.9)	8 (32)	
Two	1 (3.2)	3 (12)	
GRV			
No	25 (80.7)	11 (44)	0.02*
1-2	3 (19.3)	10 (40)	
3 and more	0	4 (16)	
Intestinal excretion			
Normal	17 (54.8)	16 (64)	0.58**
Constipation	14 (45.2)	9 (36)	
Diarrhea	0	0	
Pulmonary aspiration			
Yes	0	3 (12)	0.08**
No	31 (100)	22 (88)	

*Chi-square, **Fisher's exact test. GRV: Gavage residual volume

vomiting are risk factors for aspiration. In bolus feeding, the large feeding volume causes acutely higher pressure on the wall of the gastrointestinal tract, which could subsequently lead to high intra-gastric pressure and aspiration. Therefore, nurses should use safer methods, such as continuous enteral feeding of trauma patients in ICUs. It is recommended that other studies be conducted to compare different methods of supportive nutrition in other wards with a larger sample size and follow-up period as well as to evaluate different clinical outcomes.

Limitations

Among the limitations of this study is the fact that it was conducted in only one treatment center, which may have reduced the generalizability of the results. Furthermore, this study used a standard nutritional solution for all patients, which may have affected the results in patients with different physical conditions.

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Conflicts of interest

There are no conflicts of interest.

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