

THE EFFECT OF GASTRIC GAS EMPTYING ON THE RESIDUAL GASTRIC VOLUME IN MECHANICALLY-VENTILATED INTENSIVE CARE UNIT PATIENTS FED THROUGH NASOGASTRIC TUBES: A RANDOMIZED, SINGLE-BLIND, CLINICAL TRIAL

ALI MOHAMMADPOUR¹, MOUSA SAJJADI², SOMAYYEH MAGHAMI³, HOSSEIN SOLTANI⁴

¹Associate Professor, PhD in Nursing Education, School of Nursing, Gonabad University of Medical Sciences, Gonabad, Iran.

²Assistant Professor, PhD in Nursing Education, School of Nursing, Gonabad University of Medical Sciences, Gonabad, Iran. ³MSc in Statistics, Department of Statistics and Information Technology, Department of Social Welfare, Khorasan Razavi Province, Mashhad, Iran. ⁴MSc Student of Intensive Care Nursing, School of Nursing, Gonabad University of Medical Sciences, Gonabad, Iran.
Email: kouroshmaghami@gmail.com

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ABSTRACT

Objective: Increased gastric residual volume is a complication of enteral nutrition intolerance that leads to gastrointestinal complications such as nausea, vomiting, and aspiration pneumonia. The present study was conducted to determine the effect of gastric gas emptying on the residual gastric volume in mechanically-ventilated patients fed through nasogastric tubes.

Methods: This randomized, single-blind, clinical trial was conducted on two groups of patients in the intensive care unit (ICU) of Kamyab Hospital of Mashhad. A total of 64 patients were randomly divided into a case and a control group. In the case group, the gastric gases accumulated through the nasogastric tube were emptied by applying palm pressure on the epigastric region. The control group did not undergo this intervention but received the routine care provided in the ward. Data were collected using a demographic questionnaire and a form containing records of the patients' residual gastric volume and disease-related information. The residual gastric volume was measured and compared in the two groups before and after the intervention. Data were analyzed in SPSS-19 using the Chi-square test, the independent t-test, and the repeated measures ANOVA at the significance level of 5%.

Results: The residual gastric volume did not differ significantly between the two groups before the intervention ($p=0.14$); after the intervention; however, a significant reduction was observed in the case group compared to the controls ($p=0.007$).

Conclusion: Gastric gas emptying helps reduce the residual gastric volume in mechanically-ventilated patients fed through nasogastric tubes. Further studies are recommended to further ensure the benefits of this method.

Keywords: Gastric gas emptying, Residual gastric volume, Mechanical ventilation, Tube feeding.

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INTRODUCTION

More than 50% of intensive care unit (ICU) patients experience malnutrition on their admission to this ward, and 38% are prone to malnutrition on discharge; the consequences of malnutrition for them include reduced immune function, increased risk of nosocomial infection, respiratory dysfunction, and a higher risk of death [1,2]. Malnutrition entails undesirable consequences, especially in mechanically-ventilated ICU patients, and clinical studies on this subject are particularly important [3]. Delayed gastric emptying and bowel movement dysfunction are the most common problems in critically-ill patients under mechanical ventilation [4] that leads to enteral nutrition intolerance [5]. Enteral nutrition intolerance entails several complications such as increased residual gastric volume, diarrhea, constipation, vomiting, and abdominal distension [1,4,6-10]. Abdominal distension is one of the causes of enteral nutrition intolerance [6] that is mainly caused by the accumulation of gastric gases. The accumulation of gas is one of the most common problems of the digestive system that consists of a sensation of abdominal pulling and distension together with excessive gas and an upward pushing of the diaphragm and a consequent reduction of lung expansion, which makes breathing difficult [11]. Gastric gases accumulate due to swallowing air and the production of gas by digestive and bacterial processes. These gases are often expelled by belching or through the rectum. Immobility, reduced gastrointestinal movement, swallowing air, the nutritional composition of the diet, and certain gastrointestinal disorders can cause changes in the amount of gastric gas and its symptoms. Swallowing air can be

obviated by eating slowly, chewing less gum, and avoiding drinking with a straw. Standing, mild exercise, or abdominal massaging can help increase the movement of gas in the digestive tract [12].

Swallowing air is higher in patients under positive pressure ventilation and therefore causes distension and esophageal reflux [13,14]. In addition, certain conditions in patients, especially ICU patients, increase the amount of air swallowed, such as swallowing the excess salivary and postnasal discharge, attempting to increase lip and tongue movement to produce more saliva and overcome the dry mouth caused by an open mouth, tracheal intubation or the anticholinergic side effects of some medications. These instances are associated with the excessive swallowing of air and cause gastric gas accumulation and distension. Swallowing air may also occur under stress [15,16]. There are various methods for reducing gastric gases and distension. The routine procedure in abdominal surgeries is that nasogastric tube is inserted to reduce the gastric distension caused by the accumulation of air or to empty the excretions [16]. To reduce gastric distension, the tube is ideally placed after the pyloric sphincter to reduce the risk of distension and reflux [17]. Pharmacological remedies are also available for reducing distension, such as the administration of non-absorbable antibiotics [18,19], abdominal exercise and physical activity, the administration of laxatives to reduce constipation [20,21] and help reduce bloating, and the use of anti-gas medications [22]. Gastric gas emptying is one of the recommended methods for reducing abdominal distension and the residual gastric volume and is performed in different ways. The accumulation of gas and its subsequent digestive

complications are commonplace in mechanically-ventilated ICU patients fed through nasogastric tubes, and one of the methods proposed for gastric gas emptying and reducing digestive complications in these patients is to keep the end of the nasogastric tube open for short periods and to help reduce the gastric volume (where the gas accumulates) by applying a gentle pressure on the abdomen. Nonetheless, the level and mechanism of effect of this intervention for gastric gas emptying and reducing the residual volume following enteral feeding is not yet clearly understood [23-29]. Given the importance of the subject, its role in professional nursing and the absence of research in this area, the present study was conducted to determine the effect of gastric gas emptying on the residual gastric volume in mechanically-ventilated ICU patients fed through nasogastric tubes.

MATERIALS AND METHODS

The present randomized, single-blind, clinical trial was conducted, in 2015, on two groups of mechanically-ventilated patients in the Continuous Positive Airway Pressure (CPAP) mode fed through nasogastric tubes in the ICU of Kamyab Hospital of Mashhad University of Medical Sciences. The subjects were selected through convenience sampling, and the sample size was determined as 26 per group based on the data obtained from a similar study [6] with a confidence interval (CI) of 95% and a test power of 80%; to take account of a potential withdrawal of 20%, the sample size was increased to 32 per group, making for a total of 64 subjects. The subjects were randomly divided into a case and control group. The study inclusion criteria consisted of being under mechanical ventilation with tracheal intubation in the CPAP mode for trauma, age 18–60, a Glasgow coma scale (GCS) score ≤ 9 , a nasogastric tube No. 14–16, gavage with a standard solution prepared in the hospital, the lapse of 5 days since the beginning of force-feeding, no history of surgery or disorders such as pancreatitis, peptic ulcer or lesions, gastric bleeding or malignancies, and liver or kidney failure, having no obvious abdominal wounds, scars or infection, not being pregnant, having no limb or head traumas, no pneumocephalus, no ruptures of the diaphragm, no compressive hemothorax and pneumothorax, no floating chest and neck or spinal trauma, and having no signs of increased intracranial pressure. The exclusion criteria were the patient's death, the termination of gavage due to the patient's conditions and a prohibition against the semi-upright position. Data were collected using a demographic and clinical questionnaire and the patients' medical records.

Both groups received the routine treatments prescribed by the physician. All the patients were gavaged with a standard solution prepared in the hospital. In the case group, a nasogastric tube connected to a 60-cc pistonless syringe was kept open after gavage 40 cm above the head for 1 min on three occasions with 1-h intervals, and a 2-cm area of the epigastric region was gently pressed using the palm of the hand so as to empty the accumulated gastric gases. In this method, any of the gastric content entering the syringe returns to the stomach by gravity. This intervention was performed on two consecutive occasions after gavage. The residual gastric volume was measured and recorded before beginning the gavage. The intervention began half an hour after the gavage. The residual gastric volume was measured and recorded again before the next gavage. The intervention was repeated after the second gavage, and the residual gastric volume was again measured before the third gavage. The control group received only the routine medical treatments provided to all patients, and the residual gastric volume was measured and recorded as in the case group.

These included: (1) Approval of the Regional Research Ethics Committee of Gonabad University of Medical Sciences (Code: IR.GMU.REC.1394.27); (2) necessary arrangements with study setting; (3) participants' informed consents; (4) assuring participants about confidentiality of personal data, photos, and results; (5) withdrawal at any stage; and (6) registration of study at Iran's Clinical Trials Registration Center (Code: IRCT2015072223291N1).

Data were analyzed in SPSS-19 using descriptive and inferential statistics. The results were described using statistical indices and

frequency distribution tables. The normal distribution of the data was confirmed using the Kolmogorov-Smirnov test and the case and control groups were then compared in terms of age, height, weight, systolic and diastolic blood pressure, GCS and BMI using the independent t-test, and in terms of disease history, gender, history of surgeries, level of education, marital status, occupation, and the use of sedatives and pro-kinetic medications using the Chi-square test. The intra- and inter-group comparison of the residual gastric volume was carried out before and after the intervention using the independent t-test and the repeated measures ANOVA. The level of statistical significance was set at $p < 0.05$ for all the tests.

RESULTS

The present study was conducted on 64 mechanically-ventilated patients fed through nasogastric tubes; 73.5% of the subjects were male, and 26.5% were female. The patients had an age range of 19–65 and a mean age of 43.92 ± 13.32 years. Each group had 32 subjects. The independent t-test showed no significant differences between these two groups in terms of age, height, weight, systolic and diastolic blood pressure, and GCS or BMI, and the groups were, therefore, matching in these characteristics. The Chi-square test also showed no significant differences between the groups in terms of disease history, gender, history of surgeries, level of education, marital status, occupation and use of sedatives or pro-kinetic medications (with a CI of 95%). No significant differences were observed between the two groups in terms of the mean \pm standard deviation residual gastric volume before and after the first and second measurements, but after the second intervention (i.e., the third measurement), this means volume reached 3.43 ± 10.65 ml in the case group and 22.18 ± 35.69 ml in the control group, suggesting a statistically significant difference between the two groups ($p = 0.007$; Table 1). The repeated measures ANOVA was used to assess the effect of time on the measured variable (i.e., for the intragroup comparison). According to Mauchly's test, the sphericity assumption was met ($p = 0.47$). The repeated measures ANOVA showed a difference between the two groups. According to Figure 1, the intervention performed in the case group had a significant effect on the residual gastric volume in this group ($p < 0.05$; Figure 1). The difference was assessed with a two-by-two comparison of the mean values, and significant differences were observed in the case group between the first and second measurement occasions and the third measurement and a significant reduction was thus noted ($p < 0.05$). No significant differences were observed in the mean residual gastric volume between the three measurement occasions in the control group, suggesting the lack of a significant reduction in the residual gastric volume in this group ($p > 0.05$; Table 2). The mean residual gastric volumes calculated in the two groups suggest that the intervention had a positive effect on this variable in the case group and reduced it over time. In the control group, however, the mean residual gastric volume initially increased and then reduced, but the reduction was not significant in relation to the values obtained in the first and second measurements (Fig. 1).

DISCUSSION AND CONCLUSION

The present study was conducted to assess the effect of gastric gas emptying on the residual gastric volume in mechanically-ventilated patients fed through nasogastric tubes. The results showed a lower residual gastric volume in the patients who had undergone the gastric gas emptying intervention; these patients also better tolerated their gavage.

Previous studies have shown that abdominal massage in patients fed through nasogastric tubes prevents a large residual volume and abdominal distension and stimulates the digestive system and intestinal movements [6,30]. The intervention performed in this study created a stimulation and a slight pressure on the epigastric region and thus encouraged movements of the digestive system and led to gastric gas emptying and thus prevented vomiting and distension in the patients and helped empty their stomach and reduce their residual gastric volume.

Table 1: A comparison of the two groups in terms of the mean and SD of the residual gastric volume

Residual gastric volume measurement occasion	Mean±SD		Independent t-test results	Mean difference (CI=95%)	Significance level (p-value)
	Case	Control			
First	23.96±29.95	13.28±27.22	1.49	(-3.61, 24.99)	0.14
Second	17.75±25.08	30.42±51.84	-1.24	(-33.07, 7.63)	0.21
Third	3.43±10.65	22.18±35.69	-2.84	(-32.09, -5.4)	0.007

SD: Standard deviation, CI: Confidence interval

Table 2: The two-by-two comparison of the mean difference in residual gastric volume in each of the two groups

Case group		Mean difference	Significance level	95% CI for the mean differences	
Measurement occasion					Upper bound
I	J	I-J	P		
First	Second	6.21	0.51	-5.01	17.45
First	Third	20.53	0.001	7.92	33.14
Second	Third	14.31	0.005	3.85	24.77
Control group					
First	Second	-17.18	0.11	-37.23	2.86
First	Third	-8.90	0.36	-23.02	5.21
Second	Third	8.28	0.62	-7.99	24.55

CI: Confidence interval

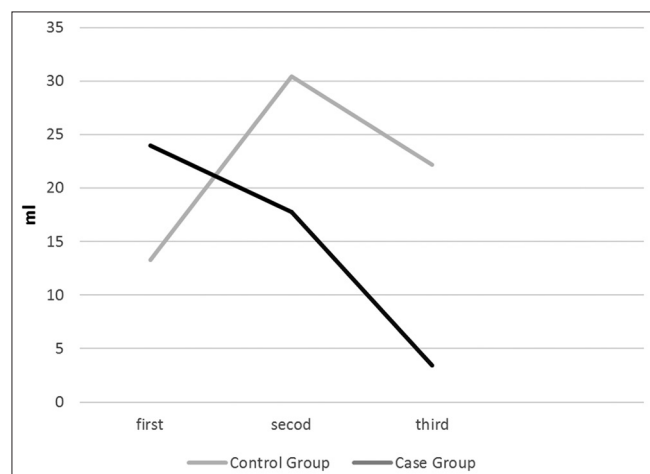


Fig. 1: The mean estimates of the residual gastric volume in the two groups

In a study conducted by Voort *et al.*, no differences were observed in the residual gastric volume between the patients in the supine and prone positions, but oxygenation was better in the prone position in the patients who were found to be hypoxic in the supine position, as secretions were better expelled in this position. The risk of reflux, vomiting, and pulmonary aspiration, however, remains to be further studied in the prone position [5]. In a case study by Berg *et al.*, removing pressure from the stomach by inserting a nasogastric tube dramatically increased the flowing volume and improved ventilation [14,31], which must have been due to the insertion of the tube after distension, causing gases, and liquids to be emptied and leading to a subsequent reduction in distension and an increased respiratory flow volume. In the present study; however, the gastric tube was in place before the intervention for the purpose of feeding and the patients were not experiencing distension at the beginning. A study conducted by Destrebecq *et al.* showed that, while a large volume of gastric air substantially increased the risk of ventilator-associated pneumonia, the residual gastric volume was not related to the chance of developing this condition [32], which could be because the cited study did not perform gastric gas emptying on the patients while the present study did perform this procedure and therefore managed to reduce the residual gastric volume. In a study conducted by Solomon *et al.* entitled "underwater-seal nasogastric

tube drainage to relieve gastric distension caused by air swallowing," abdominal distension was reduced and ventilation improved after several days, and enteral feeding was, therefore, more successful and led to fewer complications [27]. A meta-analysis conducted by Cheatham *et al.* showed an increased distension and vomiting in the absence of nasogastric tubes, but the routine use of this tube is not recommended for reducing gastric pressure in laparotomy [24,33]. In a study conducted by Razaghi, keeping the feeding tube open for 30 min after tube feeding and changing the child's position guided by CPAP prevented severe abdominal distension [28]. The present study showed a significant difference in the residual gastric volume between the case and control groups, and the two groups were matching in terms of age, gender, weight, GCS, blood pressure, and body temperature and there were no significant differences between them in terms of these variables.

According to the results obtained, gastric gas emptying reduced the residual gastric volume in mechanically-ventilated patients fed through nasogastric tubes and this procedure can, therefore, be recommended as a complementary method for increasing enteral feeding tolerance. This finding is particularly important for nursing care [7,34], since improving this index without the administration of medications is considered a main objective of health care that can alleviate the side effects of pharmacological interventions. Considering that the residual gastric volume is an important determinant of enteral feeding tolerance [6,35], gastric gas emptying in mechanically-ventilated ICU patients and their feeding through nasogastric tubes are recommended for increasing enteral feeding tolerance; however, further studies are required to reach a definite conclusion on this intervention.

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AUTHOR'S CONTRIBUTION

The conception and design of the study: Ali Mohammadpour.

Acquisition of data: Hossein Soltani.

Analysis and interpretation of data: Mousa Sajadi, Somayyeh Maghami.

Drafting the article or revising it critically for important intellectual content: Ali Mohammadpour, Mousa Sajadi, Somayyeh Maghami, and Hossein Soltani.

Final approval of the version to be submitted: Ali Mohammadpour, Mousa Sajadi, Somayyeh Maghami, and Hossein Soltani.

CONFLICTS OF INTEREST

The authors have no conflicts of interest.

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