Original Article

Effectiveness of Feeding Pump Method of Intermittent Enteral Feeding in Critically Ill Patients: A Randomized Control Trial

Anandika, MSc Critical Care Nursing
Nursing Officer, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India

Manju Dhandapani, PhD
Lecturer, National Institute of Nursing Education, Post Graduate Institute Of Medical Education and Research, Chandigarh, India

Lakshmi Narayana Yaddanapudi Ln
Professor, Department of Anesthesia and Intensive Care, Post Graduate Institute of Medical Education and Research, Chandigarh, India

Correspondence: Manju Dhandapani, PhD, Lecturer, National Institute Of Nursing Education, Post Graduate Institute Of Medical Education And Research, Chandigarh, India. Email: manjuseban@gmail.com

Abstract

Background: There is no conclusive evidence on the best method of feeding because of complications associated with different methods.
Aim: To compare the effectiveness of bolus v/s feeding pump method of intermittent enteral feeding on the occurrence of diarrhea, abdominal distension, the volume of increased gastric aspirate, vomiting, and aspiration pneumonia in Intensive Care Unit patients of a tertiary care hospital.
Methods: A randomized control trial was conducted on eighty adult patients admitted in the Intensive Care Unit. They were initiated with enteral feeding and were randomized into bolus and feeding pump method of intermittent enteral feeding (40 in each group). Data were collected through a checklist, clinical records, and observation. Patients were followed up daily from initiation of enteral feeding until seven days and on the fourteenth day. Ethical clearance was obtained from the Institute Ethics Committee and the trial was registered in Clinical Trial Registry-India. Written informed consent was obtained from caregivers/ patients.
Results: Interrupted feeding was found in 33% of the patients in the bolus group and 22% in the feeding pump group. An increased volume of gastric aspirate was the most common reason for feeding interruption among both the groups. An increased volume of gastric aspirate was found in 57% of the patients in the bolus group and 26% in the feeding pump group. There was no significant difference in the prevalence of diarrhea, vomiting, abdominal distension, and aspiration pneumonia in both groups.
Conclusion: Interruption of feeding and increased volume of gastric aspirate was developed more in patients who received bolus feeding as compared to the feeding pump method. An association of feeding interruption and increased volume of gastric aspirate suggests that the use of a feeding pump for enteral feeding may reduce feeding interruption in critically ill patients admitted in intensive care units.

Keywords: Enteral feeding; Feeding method; Intensive care unit; Bolus feeding; intermittent feeding, continuous feeding

Introduction

All patients admitted to intensive care units (ICU) have increased catabolic state and may require additional nutritional support. Inadequate nutritional intake and poor nutritional status are associated with pressure ulcers, poor outcomes, and higher mortality (Hoffer & Bistrian 2016). Nutrition can be provided through parenteral or enteral routes, but choosing the best mode of providing nutrition to a critically ill patient is challenging (Singer et al., 2009). Enteral feeding is the best means of providing nutrition in the absence of absolute contraindications and it is initiated when an individual can't eat any or enough food orally due to various problems such

as neurological impairment, anorexia, dysphagia, intubation or surgery. It can be provided through various routes (nasogastric, orogastric, nasoenteral, gastrostomy or jejunostomy) and methods (Bolus, intermittent or continuous) in ICU, but the evidence on the best method of enteral feeding remains controversial.

Research question: Is there any difference between bolus and feeding pump method of intermittent enteral feeding on the occurrence of diarrhea, abdominal distension, the volume of increased gastric aspirate, vomiting, and aspiration pneumonia in Intensive Care Unit patients of a tertiary care hospital?

Hypothesis: H_1 There is significant difference between bolus and feeding pump method of intermittent enteral feeding on the occurrence of diarrhea, abdominal distension, the volume of increased gastric aspirate, vomiting, and aspiration pneumonia in Intensive Care Unit patients of a tertiary care hospital.

H_0 There is no difference between bolus and feeding pump method of intermittent enteral feeding on the occurrence of diarrhea, abdominal distension, the volume of increased gastric aspirate, vomiting, and aspiration pneumonia in Intensive Care Unit patients of a tertiary care hospital.

Background

Enteral feeding through the nasogastric tube is reported as the first choice as compared to the parenteral feeding in critically ill patients with the preserved digestive function (Rubinsky & Kapoor 2012). However, orogastric feeding is found to reduce the complications most commonly associated with nasogastric and other invasive methods of feeding (Asfaw, Miles & Caplan 2000). The continuous and intermittent method of enteral feeding is administered using an infusion set with or without the help of a feeding pump. The feeding pump allows a set amount of feed to be delivered over a predetermined time. The continuous feed may be delivered throughout the day, while the intermittent feed is delivered in a cyclical pattern. The bolus method may be administered using a feeding syringe of 50 ml volume or bowl where the feed flows down by gravity or by using the plunger where feed is plunged down the tube at a slow rate. While the bolus method of feeding is more physiological as it mimics normal eating patterns and provide greater mobility to the patient, the continuous method may have better gastrointestinal tolerance and glycemic control due to its slow delivery rate (Ichimaru & Amagai 2014). Choosing the appropriate method of feeding with better tolerance and less feeding interruption is vital for achieving attainment of total enteral feeding at the earliest in patients admitted in critical care units. Though various routes and methods of enteral feeding strategies are adopted in critical care settings, they are associated with their adverse effects. These can be related to the tube insertion or gastric intolerance. The common adverse effects include sore mouth, thirst, swallowing difficulties, hoarseness, inhalational problems, and various gastrointestinal problems (Stroud, Duncan & Nightingale 2003). Higher incidence of gastrointestinal complications such as delayed gastric emptying, gastroesophageal reflux, vomiting, diarrhea, and abdominal bloating/cramps are reported in critically ill patients. (Montejo 1999). Roughly 20% of patients getting enteral tube feedings experience nausea and vomiting (Jones et al., 1983). Though multifactorial, the most widely recognized cause of vomiting is considered as delayed gastric emptying resulting in increased gastric residual volume. Diarrhea is common in tube-fed patients and can also lead to serious problems such as nutrient deficiency, fluid, and electrolyte imbalances, biochemical changes and infections from bedsores (Stroud Duncan & Nightingale 2003; Dhandapani et al., 2015). Various studies have done to compare continuous, intermittent, or bolus methods of feeding in critically ill patients**.** But conclusive evidence could not be generated due to controversial findings. Various studies have reported that continuous methods are the most opted method for feeding patients who are critically ill, being intubated for respiratory failure, exhibiting poor glycemic control, being fed on jejunostomy, or intolerant to the intermittent method (Kocan & Hickisch 1986; Mazaherpur et al., 2016; Steevens et, al 2002). When compared the continuous and bolus method of feeding, it was found that feeding intolerance and elevated gastric volume occurred significantly more often in bolus than in continuous feeding groups (Rhoney et al., 2002; Chowdhury 2016). Noncompliance and impatience in the continuous method can be the reasons for the higher use of large bolus infusions that can result in abdominal discomfort (Shang et al., 2004). However, the intermittent method of feeding is more physiological. It affords great patient mobility as compared to the continuous method, but also account for some complications.

Whereas others have reported no significant difference in diarrhea, gastric residual volume, pneumonia and mortality among patients in different feeding methods (Lee & Auyeung 2003; Lee et al., 2010) and are practically effective for the administration of the diet with frequently registered abnormalities (Serpa et al., 2003). It is reported that the intermittent method of feeding helps to reach the goal of caloric attainment earlier than the continuous method (Fayazi et al., 2016). A higher caloric supplement is required for overcoming the metabolic cascade and tissue repair. Timely nutritional support is associated with enhanced long-term outcome of critically ill patients (Ramprasad & Kapoor 2012; Dhandapani et al. 2015; Kapoor et al. 2018). Therefore, achieving early total enteral feeding and adequate caloric supplementation is a challenge for critical care providers. Both intermittent and bolus methods of feeding are having similar outcomes. Both can be used as a standard method of feeding (Nasiri et al., 2017). A review of the nursing care of enteral feeding tubes in critically ill adults has shown that further research by nurses in the management of patients with enteral tubes should be done (Williams & Leslie 2004). So, there is debate over the enteral tube feeding method that provides the maximum advantage to the patient for outcomes such as nutritional benefit and speedy recovery. Hence, there is a need to ascertain the optimal timing, dose, and mode of delivery (continuous, intermittent, and bolus method), route of delivery, and formula of enteral tube feeding. Though the use of the feeding pump in the continuous method is reported, its use in intermittent feeding and its related outcome is not evident. Considering the reported benefits of providing enteral tube feeding with the help of a feeding pump, the same may be used in intermittent feeding as well. Hence we have compared intermittent feeding using a feeding pump with the routine practice of bolus (siphon) method of enteral feeding on gastrointestinal intolerance and aspiration pneumonia in critically ill patients.

Methods

A randomized control trial was conducted to assess the effect of the bolus and feeding pump method of intermittent enteral feeding on diarrhea, vomiting, increased volume of gastric aspirate, aspiration pneumonia and abdominal distension among 80 patients admitted in ICU of a tertiary care hospital from July 2018 to January 2019. The trial was approved by our Institute Ethics Committee and was registered under The Clinical Trials Registry- India (CTRI). The sample size was calculated considering the incidence of diarrhea as 55.5% in the intermittent method and 22.2% in the continuous method of enteral feeding (Steevens et al., 2002). An online calculator (Kane 2018) for a two-arm, randomized, parallel-group trial with confidence interval 95% and a power of 0.80 was used to calculate the sample size. The calculated sample size was 64 (32 in each group) but enrolled 80 patients, 40 in each group considering approximately 20% dropout. The total enumeration technique was used to enroll the patients who met the inclusion criteria. All patients admitted in ICU and were on nasogastric/ orogastric tube feeding with normal gastric function and aged between 18 to 75 years were enrolled in our study. A patient information sheet was given and written informed consent was taken from the patient or their legal representative before enrolment. Known patients of the short gut, gastric intolerance, acute pancreatitis, post intestinal surgery, ileostomy, intestinal failure, and high/triple ionotropic support were excluded. The patients who died or got discharged before 48 hours of initiation of feeding were also excluded. A computer-generated random number table was used to allocate the patients in the control (siphon method) and experimental (feeding pump method) group. Allocation concealment, with the help of a sealed envelope technique, was used to avoid the enrollment bias. Sealed envelopes were prepared by primary investigator and were kept over Nurses station. Due to time constraints, stratification or blocking could not be done. The protocol was developed to standardize both the methods. In the bolus method, the feed was introduced via nasogastric or orogastric tube under the flow of gravity with the help of the siphoning technique. In the bolus method of feeding, 5ml of feed was initially instilled using a syringe through nasogastric or orogastric Ryle's tube and the Ryle's tube was then dipped into the bowl with feed (250-300 ml) to introduce feed under gravity over 5-10 min. While in the feeding pump method, the feed (250-300ml) was introduced via nasogastric or orogastric Ryle's tube with the help of a volumetric infusion pump (B/Braun Melsungen AG infusomat® P) at 10 ml/minute over 30-40 minutes. To maintain uniformity and standards of the procedure, the Nursing Officers working in our study settings (ICU) were given a demonstration of both the methods. Their skill in administering feed using both the methods was evaluated with the checklist

while performing the task. Patients in the control group received enteral feeding via the bolus (siphon) method and the patients in the experiment group via the intermittent feeding pump method.

The baseline sociodemographic and clinical data of patients in both the group were collected on the day of enrollment of the patients. After initiation of feed, the patients were followed up daily twice at an interval of 12 hours (9 am and 9 pm) for the first seven days or till the discharge or death within seven days of initiation of enteral feed and on the 14th day (Fig 1). The data was collected from the clinical records and observation of the patients.Statistical analysis was done using Microsoft Excel 2013, IBM SPSS Statistical Package for Social Sciences) version 23.0. and Openepi. Com (Dean et al., 2013). Data were checked for normal distribution using the Shapiro-Wilk test. Normally distributed data were expressed as mean, standard deviation, and compared using independent t-test. Skewed data were expressed as median, interquartile range, and compared using the Mann-Whitney U test. Categorical variables were expressed in terms of numbers and percentages and were analyzed using the Chi-square test and Fisher exact test. A two-sided p-value $\leq$ 0.05 was considered as statistically significant.

Source of support: Post Graduate Institute of Medical Education and Research, Chandigarh, India have been using volumetric infusion pump (B/Braun Melsungen AG infusomat® P) which were used for giving enteral feed to the patients while conducting research study.

Clinical Trial Registration Number : It was also registered under CTRI (CTRI/2018/06/014427).

Institute Ethics Committee: The trial was approved by the Institute Ethics Committee (INT/IEC/2018/000550).

Results

We enrolled 40 patients in each control and experiment group but, five patients in each group have been excluded from the analysis of outcome variables because they met the exclusion criteria. The mean age of the patients was 42.2 ± 17.8 years (range 18-75 years) in bolus and 39.2±16.8 (range 18-75 years) in the feeding pump group. Approximately half of the patients in the bolus (57%) and feeding pump (52%) group were females (p=0.65) (Table 1). As shown in table 1, the mean BMI of patients in the bolus group and feeding pump groups were 23.7±4.4 kg/m^2 and 23.4±5.1 kg/m^2 (p=0.81), respectively. The mean Acute Physiology and Chronic Health Evaluation II score of the patients on admission was 16±7.6 and 18.2±6.7 in bolus and the feeding pump group, respectively. The mean Glasgow Coma Scale score among patients on admission was 10.1 ±2.4 (range 3-15) in the bolus group and 8.8 ±2.9 (range 3-15) in the feeding pump group. Ninety-seven percent of patients in the bolus group, and all patients i.e. 100% in the feeding pump group, were on mechanical ventilation.

As shown in table 1, patients in both the groups were comparable in terms of enteral feeding related characteristics, i.e. enteral feeding was initiated before 24 hours of admission in ICU in 95% and 98% of the patients in the bolus group and feeding pump group respectively (p=1.00). The majority of patients in the bolus group (85%) and feeding pump (88%) group were given enteral feed through the orogastric route (p= 0.75). The majority of the patients in both groups were fed through 14 FG Ryle's tube (p=0.75). As shown in table 2. 14% to 83% of patients were underfed (<80% of prescribed calorie (kcal) intake) in both the groups during the study period. During our observation, feeding was interrupted in both groups due to various reasons. As shown in table 3, the most common reason for the interruption of feeding in both the groups was increased volume of gastric aspirate (gastric aspirate >10% of the feed given in the last 24 hours) and withdrawal of feed for therapeutic procedures such as planned tracheostomy, tracheostomy tube change, endotracheal tube change, etc. Other reasons for feeding interruption were vomiting, diarrhea, and diagnostic procedures such as radiological studies. Association of the increased volume of gastric aspirate and feeding interruption in the bolus group, as well as the feeding pump group, is shown in table 4. It was observed on day three that significantly more patients i.e. 20% of the patients in the bolus group, had feeding interruption due to increased volume of gastric aspirate as compared to none of the patients in the feeding pump group (p=0.03).A comparison of outcome parameters assessed in our study is shown in table 5. Significantly more patients, i.e., 57% of patients in the bolus group, were found to have increased volume of gastric aspirate as compared to 26% of the patients in the feeding pump group (p=0.02). There was no significant difference found between the two groups in terms of the occurrence of diarrhea, abdominal distension, and vomiting. Approximately half of the patients in the bolus group (51%) and feeding pump group (40%) were

having diarrhea (p=0.47). Abdominal distension was found in 6% of the patients in the bolus group and 9% of the patients in the feeding pump group (p=1.00). The occurrence of vomiting has been reported among 20% of the patients in the bolus and 11% of the patients in the feeding pump group (p=0.51). Though statistically not significant, aspiration pneumonia developed in 31% of the patient in the bolus group as compared to 23% of the patients in the feeding pump group (p=0.59). Binomial logistic regression was performed to ascertain the effects of those variables which were significant in univariate analysis, on the likelihood of patients developing more increased volume of gastric aspirate. The odds of patients with the occurrence of the increased volume of gastric aspirate were significantly higher in the bolus method of feeding as compared to the feeding pump method (OR=3.704, 95% CI= 1.343-10.212).The duration of the ICU stay of the patients was similar in both bolus [24 days (40days)] and feeding pump [27 days (15days)] groups. There was no significant difference in mortality among patients during the study period within 14 days of ICU stay in the bolus group (23%) and feeding pump group (38%) as shown in table 1.

Discussion

The present study aimed to compare the effectiveness of bolus and feeding pump method of intermittent enteral feeding on the prevalence of diarrhea, vomiting, increased volume of gastric aspirate, abdominal distension and aspiration pneumonia among patients admitted in ICU. Most of the updated guidelines for nutritional support in critical care setting suggests for initiation of enteral nutrition within 24 to 48 hours after admission to maintain the integrity of the gut, control stress and immune function and decrease the severity of disease (Taylor et al., 2016; Alpers 2002). Similarly, in the present study, the enteral feeding in the majority of patients, 95% in bolus and 98% in feeding pump method of enteral feeding have been initiated within 24 hours of admission in ICU. Interference of feeding or fasting causes disturbance of intestinal integrity through atrophy and a decrease in the size of microvilli in catabolic conditions such as in intensive care units (Alpers 2002; Heyland 2012). In the present study, the patients in both the groups were found to have interruption of feeding due to increased volume of gastric aspirate, therapeutic procedures, diagnostic procedures, vomiting, etc. And, the most common cause of feeding interruption during the first seven days was increased gastric aspirate. Previous literature has also reported that frequent feeding interruptions are brought about by diagnostic tests, surgical procedures, GI intolerance, feeding tube problems, and routine nursing procedures (Kim et al., 2013). Though the rate of feeding interruption was similar in both groups, the same due to the increased volume of gastric aspirate was significantly higher in patients of the bolus group as compared to the patients in the feeding pump group (p=0.03). In patients who are enterally tube fed, it is recommended to withhold the feed if the gastric aspirate is more than 20% of the previous feed (Kaur et al., 2013). This explains the reason for feeding interruption in a greater number of patients in the bolus group of feeding. A feeding pump can be used in a continuous or intermittent method to regulate the flow rate of feed delivery (White, H., & King, L. 2014). The feeding pump method may involve a greater cost, may not only be of procuring, but also support of biomedical technicians is mandatory in maintaining and calibrating the feeding pumps (Schijndel et al., 2007). Hence, the use of a feeding pump for tube feeding for the patients in an ICU may be less feasible and questionable. The continuous method of enteral feeding in comparison with bolus or intermittent feeding may be associated with better tolerance, improved glycemic control, reduced risk of aspiration (Chowdhury et al., 2016; Rhoney et al., 2002). Still, some studies have reported reverse or no difference (Macleod et al. 2007; Serpa et al., 2003; Mazaherpur et al., 2016). The intermittent method is better tolerated than the bolus method and is reported to enhance the quality of life (Ichimaru & Amagai 2014). As compared to continuous, it requires no feeding interruption for the administration of medications (Stroud, Duncan & Nightingale 2003). The bolus method decreases feeding time and hence provides more mobility (Jones, Payne & Silk 1980). In the present study, underfeeding was reported in both the intermittent feeding pump method and the bolus siphon method. Still, statistically, there was no difference in the number of underfeeding events among both groups and mortality. Some practices related to enteral nutrition therapy may contribute to underfeeding in critically ill patients (Marshall & West 2006).

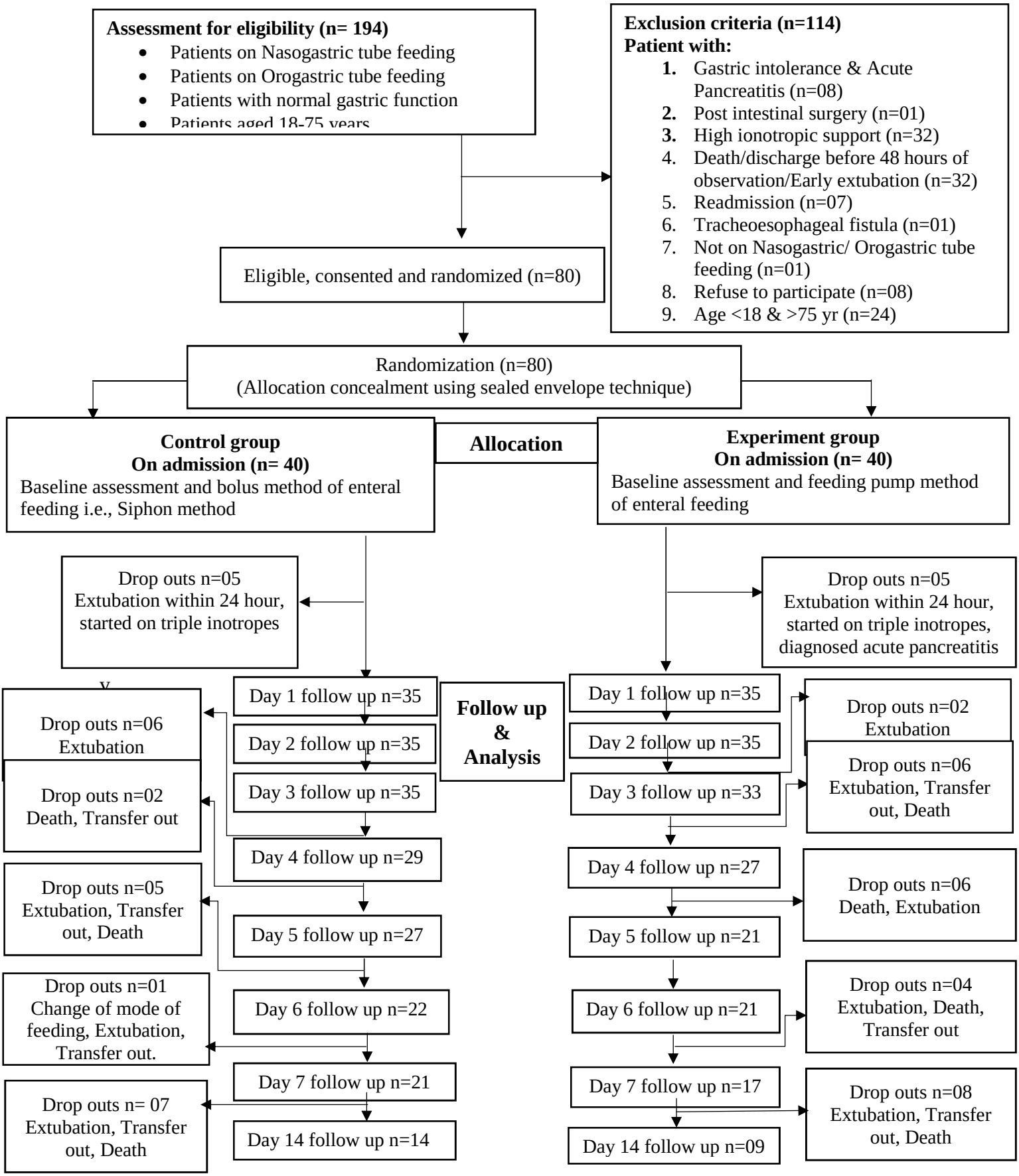

Fig 1: CONSORT flow diagram

Table 1: Comparison of socio-demographic and clinical variables of bolus group v/s feeding pump group

Sociodemographic variables of patients	**Bolus group $n_1 = 40$ f (%)**	**Feeding pump group $n_2 = 40$ f (%)**	**p value**
Age (Years) ŧ Mean ± SD	42.2 ± 17.8	39.2±16.8	0.43
Gender Male Female	 17 (43) 23 (57)	 19 (48) 21 (52)	 0.65
BMI (kg/m^2) ŧ Mean ± S.D. (Range)	23.7±4.4 (12.3-33.5)	23.4±5.1 (6.8-35.4)	0.81
GCS on admission Mean ± S.D. (Range)	10.1 ± 2.4 (3-15)	8.8 ± 2.9 (3-15)	0.03
APACHE II on admission Mean ± S.D. (Range)	16 ± 7.6 (2-34)	18.2 ± 6.7 (7-32)	0.18
Patients on Mechanical Ventilation ¥	39 (97)	40(100)	1.00
Patients on neuromuscular block agent ¥	03 (09)	04 (11)	1.00
Length of stay in ICU (days) ▲	24 (40)	27 (15)	0.20
Mortality during study period ¥ ≤ 14 days	 09 (23)	 15 (38)	 0.19
Initiation of enteral feeding ¥ Before 24 hours After 24 hours	 38 (95) 02 (05)	 39 (98) 01 (02)	 1.00
Route of enteral feeding Nasogastric Orogastric	 06 (15) 34 (85)	 05 (12) 35 (88)	 0.75
Size of Ryle's tube ¥ 14 FG 16 FG 18 FG	 33 (83) 04 (10) 03 (07)	 35 (88) 04 (10) 01 (02)	 0.72

ŧ Independent t test, ¥ Fisher exact test, ▲ Median (IQR); Man-Whitney U test
GCS Glasgow Coma Scale, APACHE II The Acute Physiology and Chronic Health Evaluation II

Table 2: Comparison of the adequacy of calorie intake (%Kilocalorie) in bolus group v/s feeding pump group

Groups		**Day 1 n_1=35**	**Day 2 n_1=35**	**Day 3 n_1=35**	**Day 4 n_1=29**	**Day 5 n_1=27**	**Day 6 n_1=22**	**Day 7 n_1=21**	**Day 14 n_1=14**
Bolus group f (%)	Adequate calorie intake	06(17)	17(49)	18(51)	17 (59)	16(59)	15(68)	12(57)	10(72)
	Underfeeding	29(83)	15(43)	17(49)	12(41)	10(37)	06(27)	08(38)	02(14)
	Overfeeding	-	03(08)	-	-	01(04)	01(05)	01(05)	02(14)
Feeding pump group f (%)		**n_2=35**	**n_2=35**	**n_2=33**	**n_2=27**	**n_2=21**	**n_2=21**	**n_2=17**	**n_2=09**
	Adequate calorie intake	06(17)	23(66)	07(47)	14(52)	08(38)	13(62)	12(70)	05(56)
	Underfeeding	29(83)	10(29)	07(47)	12(44)	12(57)	08(38)	04(24)	03(33)
	Overfeeding	-	02(05)	01(06)	01(04)	01(05)	-	01(06)	01(11)
p-value (95% CI)		0.00[€]	0.32	0.45	0.70	0.38	0.64	0.74	0.70

[€]Chi square value

Table 3: Reasons for feeding interruption in bolus group v/s feeding pump group

Reasons for feeding interruption	Bolus group f (%)	Feeding pump group f (%)
Day 1	**n_1=35**	**n_2=35**
Increased volume of gastric aspirate	04 (11)	01 (03)
Therapeutic Procedure	02 (06)	01 (03)
Day 2	**n_1=35**	**n_2=35**
Increased volume of gastric aspirate	05 (14)	01 (03)
Therapeutic Procedure	04 (11)	07 (20)
Bleeding	02 (06)	-
Vomiting	01 (03)	-
Vomiting + Increased volume of gastric aspirate	01 (03)	-
Others	-	02 (06)
Diagnostic procedure	-	01 (03)
Day 3	**n_1=35**	**n_2=33**
Increased volume of gastric aspirate	07 (20)	-
Therapeutic Procedure	07 (20)	11 (33)
Vomiting+ Increased volume of gastric aspirate+ Diarrhea	02 (06)	01 (03)
Vomiting	01 (02)	01 (03)
Diagnostic Procedure	01 (02)	-
Day 4	**n_1=29**	**n_2=27**
Therapeutic Procedure	06 (21)	05 (19)
Increased volume of gastric aspirate	03 (10)	02 (07)
Diagnostic Procedure	01 (03)	01 (04)
Vomiting + Increased volume of gastric aspirate	01 (03)	-
Day 5	**n_1=27**	**n_2=21**
Increased volume of gastric aspirate	06 (22)	-
Therapeutic Procedure	02 (07)	04 (19)
Diagnostic Procedure	02 (07)	-
Day 6	**n_1=22**	**n_2=21**
Vomiting	04 (17)	01 (05)

Increased volume of gastric aspirate	01 (04)	-
Therapeutic Procedure	-	03 (14)
Increased volume of gastric aspirate + Therapeutic procedure	-	01(05)
Day 7	**n_1=21**	**n_2=17**
Increased volume of gastric aspirate	04 (18)	-
Therapeutic Procedure	03 (14)	03 (18)
Increased volume of gastric aspirate + Therapeutic procedure	02 (10)	-
Diarrhea	01 (04)	-
Diagnostic Procedure	01 (04)	-
Day 14	**n_1=14**	**n_2=09**
Increased volume of gastric aspirate	03 (23)	-
Therapeutic Procedure	-	01 (11)

Table 4: Feeding interruption due to increased volume of gastric aspirate in bolus v/s feeding pump group

Days	Cause of feeding interruption	Bolus group f (%)		Feeding pump group f (%)		p-value¥
Day 1	Increased volume of gastric aspirate Other causes	**n_1 = 35**	4 (11) 02 (06)	**n_2 = 35**	01 (03) 01 (03)	0.39
Day 2	Increased volume of gastric aspirate Other causes	**n_1 = 35**	05 (14) 08 (23)	**n_2 = 35**	01 (03) 10 (29)	0.29
Day 3	Increased volume of gastric aspirate Other causes	**n_1 = 35**	07 (20) 11 (31)	**n_2 = 33**	- 13 (03)	0.03*
Day 4	Increased volume of gastric aspirate Other causes	**n_1 = 29**	03 (10) 08 (28	**n_2 = 27**	02 (07) 06 (22)	0.85
Day 5	Increased volume of gastric aspirate Other causes	**n_1 = 27**	06 (22) 04 (15)	**n_2 = 21**	- 05 (24)	0.07
Day 6	Increased volume of gastric aspirate Other causes	**n_1 = 22**	04 (18) 01 (05)	**n_2 = 21**	01 (05) 04 (19)	0.18
Day 7	Increased volume of gastric aspirate Other causes	**n_1 = 21**	04 (19) 07 (33)	**n_2 = 17**	- 03 (18)	0.07
Day 14	Increased volume of gastric aspirate Other causes	**n_1 = 14**	03 (21) -	**n_2 = 09**	- 01 (11)	0.15

¥ Fisher exact value

Table 5: Comparison of selected outcome parameters in bolus group v/s feeding pump group

Clinical Variables	Bolus group $n_1 = 35$ f (%)	Feeding pump group $n_2 = 35$ f (%)	OR (CI)[δ]	p value
Increased volume of gastric aspirate	20 (57)	09 (26)	0.270 (0.98-0.74)	0.02*
Abdominal distension[¥]	02 (06)	03 (09)	1.547 (0.24-9.88)	1.00
Diarrhea	18 (51)	14 (40)	0.630 (0.24-0.16)	0.47
Vomiting	07 (20)	04 (11)	0.516 (0.14-1.95)	0.51
Aspiration Pneumonia	11 (31)	08 (23)	0.646 (0.22-1.87)	0.59

[¥] Fisher exact value, [δ] Odds Ratio (Confidence Interval)

However, it is essential to identify the best possible method of enteral feeding to reduce feeding interruption, increased volume of gastric aspirate, and underfeeding. The intermittent feeding pump method can be considered as a superior method of feeding in terms of a lesser volume of gastric aspirate and a lesser number of feeding interruption as compared to the bolus method. So intermittent feeding pump method may be considered for the initiation of feeding as it would aid the feeding to be sustained or maintained with lesser interruption as compared to the bolus method. But, considering the fact that the bolus method is more physiological, and the practical difficulties associated with the intermittent feeding pump method, the patient may be gradually shifted from the intermittent method to the bolus method of tube feeding. As there is no difference in most of the outcome variables and based on many advantages reported in the literature, the bolus method is also used as a safe method of tube feeding practice in ICUs. Though the nursing time required in the bolus method is more than the intermittent method, it is still the most commonly adopted method (Ciocon et al, 1992, Jones 1986). Hence, intermittent feeding with a feeding pump can be initiated in critically ill ICU patients to avoid or decrease the feeding interruption and later may be gradually changed to a bolus method which is more physiological and cost-effective to the patients and many other advantages. Nurse-led feeding protocols can be prepared to initiate and gradually escalate to the total enteral feed attainment (Thakur et al, 2019). Advancement in ICU services contribute to enhanced recovery and long-term outcome.

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Conclusion

Patients fed using a feeding pump method are found to have less occurrence of the increased volume of gastric aspirate and feeding interruption as compared to the bolus method of feeding. Study findings show that the common

cause of feeding interruption was the increased volume of gastric aspirate. Hence, the feeding pump method of intermittent enteral feeding can be used as a method to initiate and early attainment of total enteral feeding with less interruption. Once total attainment of enteral feeding is achieved, the bolus method can be initiated as it is more physiological and practical. Further studies may be conducted on the use of a feeding pump for enteral tube feeding to create solid evidence.

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