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Nutrition and Obesity (C Newberry, Section Editor)

A Review of Complications, Outcomes, and Technical Considerations of Endoscopically Placed Feeding Tubes in Obesity

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Abstract

Purpose of Review As the prevalence of obesity continues to rise, so does the need for enteral access for nutrition in patients who are overweight or obese. While gastrostomy tube placement is considered a safe procedure with a low complication rate in nonobese populations, there is limited literature regarding the outcomes and technical considerations of tube placement and nutritional feed selection in patients who are overweight or obese. In this review, we aim to discuss the outcomes of tube placement, technical considerations to optimize success, and selection of enteral feeds in patients who are overweight or obese and require the placement of a percutaneous endoscopic gastrostomy/jejunostomy tube (PEG/PEJ).

Recent Findings Technical success rates remain high for PEG placement in the obese population and comparable to the nonobese population. While complication rates are slightly higher in the obese population compared to the nonobese population, the difference is not significant. This contrasts with PEJ placement, which has lower technical success rate

in obese versus non obese patients. Once enteral access is achieved, patients with obesity benefit from starting nutritional rehabilitation with a high protein, low-calorie feed.
Summary Patients with obesity present a unique challenge as factors such as body habitus create challenges in transillumination, finger indentation, and needle puncture; BMI should not be a contraindication to PEG placement.

Introduction

Obesity is a growing worldwide epidemic and is associated with significant morbidity and mortality. The World Health Organization (WHO) estimated nearly 2 billion adults or 39% of adults were overweight, and over 650 million were obese [1]. Prevalence of obesity in the USA has increased over the past 3 decades and is projected to reach over 50% in 2030 [2]. Coinciding with the rising prevalence of obesity is the need for safe and effective specialized enteral nutritional support in this population.

Traditionally, common indications for a gastrostomy tube include dysphagia or dysfunctional swallowing, which is often caused by neurological disorders, such as cerebral vascular accidents (CVA), amyotrophic lateral sclerosis (ALS), dementia, severe facial trauma, malignancies (esophageal, head, neck cancers), malnutrition, and upper gastrointestinal tract motility impairments. The past decade has seen increasing rates of patients with obesity presenting with these conditions. This trend has been exemplified in the intensive care unit, with one multi-center nutritional study of critically ill patients reporting a mean BMI of 29 kg/m.^{2}. This suggests that just under 50% of their ICU population is obese with a majority requiring short-term enteral nutrition. [3]

Gastrostomy tubes are the preferred method for enteral nutrition and administration of medications in patients with a functional gastrointestinal tract but impaired swallowing regardless of weight status. Another option for enteral nutrition is jejunostomy tubes, which are appropriate in patients unable to tolerate gastric feeding (i.e., recurrent vomiting, tube-related aspiration, pancreatitis, severe gastroesophageal reflux, gastroparesis, gastric outlet obstruction, or altered gastric anatomy including total or partial gastrectomy). There exists a paucity of literature in understanding outcomes and technical considerations of tube placement and enteral tube feed selection in obesity. The aim of this review paper is to discuss (i) outcomes of tube placement, (ii) technical considerations, and (iii) selection of enteral feeds in patients who are overweight or obese requiring the placement of a percutaneous endoscopic gastrostomy tube (PEG).

Complications

Post-procedure complication rate in patients with a BMI ≥ 30 kg/m^2 has been reported in most of the literature to be between 0 and 3%. Wiggins et al., however, describe a higher rate of 44.1% describing most of these adverse effects as being minor. These events included pain at tube insertion site (8.5%, *n* = 5, stomal cellulitis (8.5%, *n* = 5), inadvertent J tube removal from PEG/J system (6.8%, *n* = 4), peristomal leak (6.8%, *n* = 4), post procedure nausea and vomiting (3.4%, *n* = 2), tube dislodgement (1.7%, *n* = 1), minor bleeding (1.7%, *n* = 1), pneumoperitoneum (1.7%, *n* = 1), tooth extraction, and tube clogging (1.7%, *n* = 1). The authors reported two major complications including intraperitoneal hemorrhage from a liver laceration and omental hematoma (3.4%,

$n=2$). On the multivariable logistic regression analysis, there was no effect of BMI on complication rate; however, after evaluation of data on a continuum, weight ≥ 250 lbs (≥ 113 kg) predicted increased likelihood of complications (odds ratio 3.86, 95% confidence, 1.02–14.57) [4].

While a lower BMI has been shown to be a predictive factor of increased 30-day mortality, a similar effect has not been shown in BMI ≥ 30 kg/m^2 [5]. When looking at post-procedure mortality, two studies report a procedure-related mortality to be 0% [4, 6]. Both studies reported post-procedure deaths unrelated to gastrostomy tube placement identified by autopsy. However, a study from the surgical literature of endoscopic gastrostomy placement reports early post-operative mortality to be 11%; however, this was not significantly different in obese patients compared to normal BMI group (11% vs 11.7%) [6]. This difference in mortality rate may be explained by patient selection by gastroenterology versus surgery.

When considering placement of direct percutaneous endoscopic jejunostomy (DPEJ/PEJ) in overweight and obese patients, the literature shows that adverse events both major and minor were not different between patients who were overweight compared to those normal or decreased BMI [4]. Major adverse events reported in the literature include sepsis of unknown cause ($n=1$), necrotizing fasciitis ($n=1$), and obstruction and volvulus ($n=3$) [7]. Although complication rate did not differ between patients who were normal/underweight and those who were overweight/obese, there were numerically more serious adverse events in patients with BMI > 25 that just missed statistical significance.

Technical Outcomes

In overweight and obese patients, PEG placement has a high reported technical success rate between 89.6 and 97% [4, 8, 9]. A retrospective study including 67 patients with obesity undergoing placement of PEG/J showed an overall success rate of 81.8% [4]. One study aiming to correlate BMI with technical success rate reviewed 134 overweight and obese patients with BMI ranging from 27 to 63 kg/m^2. Overall success rate was 97% with higher success rates in patients with BMI 30–35 kg/m^2 compared to that of patients with BMI > 35 kg/m^2 (93.3% vs 86.5%) although not statistically significant [9]. Similarly high success rate of 100% has been shown in patients with BMI ≥ 60 kg/m^2 in multiple case studies and case series [8, 10–12].

Successful DPEJ placement has been reported in 57.1–100% of overweight and obese patients; however, procedural success was less frequent in obese patients compared to patients with a normal or decreased BMI [4, 7, 13]. Procedure time was not an indicator for technical success as the procedure time was not different between obese and nonobese patients [7]. However, mean abdominal wall thickness greater than 3 cm identified on CT scan is an indicator of decreased success for DPEJ placement. Maple et al. demonstrate greater abdominal wall thickness in patients who underwent failed DPEJ compared with those that underwent successful procedures (27 mm vs 21 mm;

$P = 0.02$) with less than 39% of patients with abdominal wall thickness more than 3 cm undergoing successful DPEJ placement [14].

Other technical considerations discussed in the literature include clinical setting for tube placement, average length between bumpers, and time required for placement. One study found no difference in technical success in patients with BMI ≥ 27 kg/m^2 receiving PEG placement bedside in the ICU compared to those receiving tubes in the endoscopy suite [9]. The average total procedure time in obese patients was only 15.5 min (range, 5–60 min) compared to 13.3 ± 4.2 min in the nonobese population [6, 15]. Lastly, there is a direct association between average length of tubing from internal bumper and external bumper and BMI with no increase in complication based on increased length [4].

Technical Considerations

Patients with successful placement of enteral tubes were aided by transillumination with deep palpation and finger impression alone. It was noted that obese patients tend to have more redundant adipose tissue and thicker abdominal wall making it difficult to obtain optimal abdominal wall position for PEG and DPEJ. Unsuccessful placement was attributed to inadequate transillumination, lack of visualization of finger indentation, abnormal anatomy from prior bariatric surgery, suboptimal visualization of safe tract method and abnormal structural findings (i.e., duodenal edema and pharyngeal mass), and inadequate sedation [4, 9]. Inability to endoscopically identify extrinsic compression with manual pressure is an indicator of procedure failure [8].

To assure optimal finger indentation and transillumination, proceduralists can identify the area with the least amount of fat tissue density or the "B-zone," named after Dr. Bochicchio (Table 1) [8]. After the identification of the position, the "spot" finger impression is determined, and the lights are dimmed to attempt transillumination. Next, the abdominal wall is transilluminated with the endoscope light. This is visible externally as a

Table 1. Technical considerations of PEG placement in overweight/obese patients

Technical challenges	Solution
Suboptimal transillumination	1. Identify B Zone [8] 2. Dim light and increase the intensity of light from the endoscope 3. Gastric insufflation
Finger indentation	Substitute with fist
PEG/J needle puncture	1) Use 'safe tract' technique 2) Exert downwards pressure 3) Gastric insufflation 4) Fasten needle or syringe to the trocar 5) Use of a longer, thinner caliber needle

bright red or orange light on the abdominal wall. If necessary, the endoscope's light intensity can be increased from the base controls. However, if unsuccessful to identify transillumination or to establish a one-to-one relationship with a finger, a fist with increased transabdominal pressure can be utilized for transabdominal compression [8]. Furthermore, gastric insufflation is particularly important in this population with addition of 500 mL of CO2 before insertion is attempted to ensure adequate approximation of the gastric wall to the skin.

To ensure needle penetration into the gastric cavity, the "safe tract" technique, which utilizes a 22-gauge, 1.5-inch Seldinger needle attached to a 20-mL syringe should be performed. The barrel on the syringe is retracted as the needle is slowly advanced through the abdominal wall. Air return in the syringe with simultaneous endoscopic documentation of the needle within the gastric lumen ensures appropriate placement with avoidance of bowel. While endoscopists are concerned about trocar length given adipose tissue, it has not been shown routinely to be a limiting factor [9, 16–18]. However, fastening a syringe to the trocar can add control and precision [9]. Some case studies in the literature highlight the use of a longer 18-gauge spinal needle to facilitate passage in patients with severe class 3 obesity [10, 11, 19, 20]. Because of the significant amount of abdominal wall tissue density that needs to be penetrated before piercing the peritoneum, the operator must continue to place a moderate amount of pressure on the abdominal wall area with a hand around the site of needle penetration to compress tissue and allow for insertion into the gastric wall. McGarr et al. recommend appropriate angle of trocar toward the R shoulder and ensuring placement with a single thrust maneuver rather than a slow or gentle entry [9].

After achieving needle penetration and the guidewire is inserted and ensnared, the PEG is secured to the looped end of the guidewire using a square knot. The PEG is subsequently lubricated and pulled through the subcutaneous and adipose tissue. Occasionally, there may be increased resistance to pulling the tube through the adipose tissue. The literature describes one such case despite multiple attempts of pulling at various angles. The authors attribute this failure to pass to excessive abdominal wall fat. This case was aborted, clips were placed on the endoscopic side to close the gastric defect, and surgery was consulted for enteral access [20, 21]. In this situation, the surgeons can create a transverse abdominal incision with dissection to the rectus sheath.

Feeding Considerations

Nutrition Care Planning

Aside from the placement of the feeding tube, careful consideration must be given to the choice of enteral feeds utilized in obesity. This is done most effectively with a nutrition support team composed of a clinician, dietician, visiting nurse, and pharmacist. Intercollaborative communication between the team should be established prior to the placement of the feeding tube to establish nutritional goals and initiate EN. The first step in initiating EN in patients with obesity is to perform a nutritional assessment. In patients who are hospitalized, this assessment should be performed within 24 to 48 h after hospital admission with interval of reassessment performed daily in patients who are critically ill in the ICU [22].

While not validated in overweight and obese patients, nutritional assessment scoring systems can be used to identify patients at high-risk for malnutrition. Observational cohort studies suggest that scoring assessments with BMI-criterion can lead to under detection of malnutrition in this group [23]. Instead, scoring systems like subjective global assessment (SGA) should be used for patients in the hospital. Once high-risk patients are identified, further assessment should be obtained to understand patient's current nutrition and health status.

Indirect calorimetry (IC) is the gold standard for measuring resting energy expenditure (REE) [24]; however, given its limited availability and cost, predictive equations are routinely utilized to approximate REE. In all hospitalized patients regardless of their ICU status, the Penn State University (PSU) predictive equation and modified PSU most accurately predict resting energy expenditure in patients < 60 and ≥ 60 years, respectively, with an accuracy of approximately 70% ($\pm$ 10% of REE) [25] (Table 2). The Mifflin St. Jeor equation has been validated in the outpatient obese population [26] (Table 2).

Once the energy needs have been calculated, the American Society for Parenteral and Enteral Nutrition (ASPEN) recommends a high-protein, low-calorie feeding [22]. For all classes of obesity and levels of acuity, the goal of enteral nutrition should not exceed 65–70% of target energy requirements as this will promote steady weight loss. In addition to a low caloric diet, a high protein feeding may be started at 2 g/kg ideal body weight per day for patients with BMI 30–40 kg/m^2 and 2.5 g/kg ideal body weight per day for patients with BMI > 40 kg/m^2.

Patients must be monitored closely in the hospital and continued to follow up in the outpatient setting regularly to follow weight trends, laboratory work, nitrogen balance studies, and REE. These values will allow for frequent optimization of enteral feeds. Caution must be exercised in certain populations (i.e., elderly and renal failure). Given increased risk of

Table 2. Predictive REE equations

PSU	RMR (kcal/d) = MSJ(0.96) + Tmax(167) + VE(31) − 6216
Modified PSU	RMR (kcal/d) = MSJ(0.71) + Tmax(85) + VE(64) − 3085
MSJ	Men (kcal/day) = 5 + 10 × Weight (kg) + 6.25 × ht(cm) − 5 × Age(y) Women (kcal/day) = − 161 + 10 × Weight (kg) + 6.25 × ht(cm) − 5 × Age(y)

azotemia in elderly patients, current guidelines conclude that high protein is safe and efficacious but close monitoring of kidney function is required.

EN Formulations

Providers can initiate standard isotonic formulas with or without additional fiber based on clinical picture as these formulas' mimic macronutrient content of regular foods. Generally, first line formulas include Jevity 1 Cal or Osmolite 1 Cal, which provide 1.06 cal/mL and 0.044 g protein/mL. Unless there are other underlying issues, there is no role for elemental, semi-elemental, or specialized formulas to start.

Nutrition Outcomes

Although not determined in randomized control trials (RCTs) with adequate population size, current guidelines on EN formulations with higher levels of protein have been associated with positive patient outcomes in retrospective, prospective observational studies, and small RCTs. In a prospective cohort study including mechanically ventilated critically ill patients (mean BMI: 26 ± 6 kg/m^2), optimal nutritional therapy (guided by indirect calorimetry and 1.2 g/kg protein supplementation) was associated with a 50% decrease in 28-day mortality [27]. In a study including 1171 ICU patients (mean BMI 28 kg/m^2), increased protein intake was associated with a reduction in mortality risk [28]. Hypocaloric high-protein enteral nutrition is associated with a decrease in net protein catabolism in hospitalized and critically ill patients with obesity [29–33]. A retrospective study including 40 critically ill patients with obesity showed improved clinical outcomes, such as decreased LOS, duration of antibiotic therapy, days requiring mechanical ventilation, with hypocaloric, high-protein feeding compared to eucaloric feeding [33]. Positive clinical outcomes were also shown in 2 observational case series including surgical patients with obesity [32, 34]. However, other studies have shown no difference [30, 31]. A large RCT is needed to determine whether hypocaloric, high protein nutrition offers a significant therapeutic benefit and reduces complications compared to other methods of feeding formulations (e.g., eucaloric, hypercaloric) in hospitalized patients with obesity.

Conclusion

Early nutrition assessment and gastrostomy tube placement should be made in patients with obesity. Percutaneous enteral access device placement is obese patients is generally safe with a high technical success rate, low complication rate and low post-procedure mortality risk comparable with that of nonobese patients. When considering placement of gastrostomy tubes, BMI alone should not be considered a procedural contraindication. Various techniques exist to address and overcome technical issues that may occur during placement. Establishing enteral nutrition is crucial in a population with poor oral intake from various causes including acute illness and chronic debilitating diseases. Successful nutritional rehabilitation requires accurate calculation of their nutritional needs (via indirect calorimetry or various equations) and prompt initiation of a high-protein, low-calorie feed. Further studies into this vulnerable population are required to improve and optimize our current clinical practice and decision-making in this growing population.

Author Contribution

All authors worked in all 4 aspects of authorship as per ICMJE guidelines.

Declarations

Conflict of Interest
Ankoor H Patel declares that he has no conflict of interest. Keerthana Kesavarapu declares that he has no conflict of interest.

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