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Gut access in critically ill and injured patients: Where have we gone thus far?

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Zugänge zur enteralen Ernährung beim kritisch Kranken und Schwerverletzten: Wo stehen wir jetzt?

Zusammenfassung. *Grundlagen:* Ernährung beim kritisch Kranken und Schwerverletzten ist essentiell und kann parenteral oder enteral erfolgen. Jede Methode hat ihre Vor-und Nachteile. Hier untersuchen wir den enteralen Zugang, vor allem die Zugangswege.

Methodik: Übersicht der Literatur.

Ergebnisse: Folgende Zugangswege für enterale Ernährungssonden stehen uns zur Verfügung: orogastrisch, nasogastrisch, nasojejunal. Die beliebtere Methode ist die permanente endoskopische Gastrostomie (PEG), aus ökonomischen und sicherheitstechnischen Überlegungen. Alternativ finden sich die offene Gastrostomie, laparoskopische oder laparoskopisch assistierte Gastrostomie und Jejunostomie.

Schlussfolgerungen: Wann immer ein enteraler Zugang möglich ist, sollte einer enteralen Ernährung der Vorzug gegeben werden, ob prä- oder post-pylorisch ist derzeit nicht eindeutig zu beantworten. PEG ist sicher und ökonomisch sinnvoll.

Schlüsselwörter: Ernährungssonde, perkutane endoskopische Gastrostomie (PEG), Nasojejunalsonde.

Summary. *Background:* Nutritional support in critically ill and injured patients is crucial. It can be provided via parenteral or enteral access, each of which has advantages and disadvantages. In this article, we review enteral support, particularly gut access.

Methods: We conducted a literature review.

Results: A number of techniques enable access to the gastrointestinal tract in critically ill and injured patients. A temporary orogastric (OG), nasogastric (NG), or nasojejunal (NJ) feeding tube can be placed. But the prevalent technique is the more permanent percutaneous endoscopic gastrostomy (PEG), which has economic as well as safety benefits. Other techniques include open operative gastrostomy, laparoscopic or laparoscopic-assisted gastrostomy, and jejunostomy.

Conclusions: Nutritional support should be provided enterally, via gut access whenever possible. The issue of pre- *versus* post-pyloric access remains controversial. PEG is safe and economical for long-term access.

Keywords: Feeding tube, percutaneous endoscopic gastrostomy, nasogastric tube, nasojejunostomy.

Introduction

Anyone who practices intensive care medicine would agree that providing daily nutritional support to critically ill and injured patients is not only necessary but also vital. The Society of Critical Care Medicine and the American Society for Parenteral and Enteral Nutrition have recently updated guidelines for providing and assessing nutritional support in critically ill adults [1]. In this literature review, we focus on the issue of enteral nutrition (EN), particularly gut access. We also incorporate our own perspective, drawing on our combined multiple years of experience of intensive care medicine practice, mostly in a trauma center's surgical intensive care unit (ICU) [2].

Inconclusive studies

According to the current consensus and to commonsense logic, "if gut is available, use it" [3, 4]. But the studies comparing the complications and benefits of EN and parenteral nutrition (PN) do not necessarily yield straightforward conclusions, given design weaknesses and heterogeneous patient populations. Several

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published studies have suggested that PN can lead to increased infectious complications, and that early EN support is a must in order to prevent infectious complications [5–9]. The concept of "early" (that is, within 24 to 36 hours after the onset of critical illness or after injury) EN is now universal. We have evenly applied early EN to our trauma patient population, even to the unique subgroup of "open abdomen" patients [10]. Plurad et al. and Rhee et al. [11, 12] recently demonstrated a trend of decreased PN use, over time, in their contemporary trauma ICU.

Noninvasive (temporary) gut access

Types of tubes

Numerous studies have compared nasogastric (NG) and nasojejunal (NJ) feeding tubes [13–25]. But, again, drawing firm conclusions is quite difficult because of small sample sizes, inconsistent and heterogeneous patient populations, and the lack of a scientific basis for associated complications (such as gastroesophageal reflux and pneumonia). In intubated patients with facial injuries OG tube is an acceptable method of providing nutrition support, until more permanent solution is obtained. For any enteral access, the goals are ease of tube placement; cost-efficiency; timely fulfillment of calorie requirements; and minimal procedure-related complications. In terms of fulfilling calorie requirements sooner, some studies [13–18] favor the NJ tube, while others [19, 20] favor the NG tube. But overall, the associated complications of aspiration, pneumonia, "of aspiration pneumonia" and death do not appear to significantly differ [13–24]. Two main caveats apply: First, in general, NG placement is much easier, and NJ placement is more difficult and takes longer. However, placement time certainly depends more on the specific institution's capability, the technique used, and the available resources. The overall success-failure rate of placement is operator-dependent. Moreover, the reported delay in NJ placement [19, 20] probably does not translate into any clinical significance. By the same token, while NG placement may be easier, the time to reach the calorie goal can be affected by gastric emptying status, which most studies do not elaborate on. Hence, interpreting the overall outcome can be challenging. Second, the usual clinical endpoints of interest are the rate of aspiration and the possibly associated complication of pneumonia. Heyland et al. [25], using a radioisotope, demonstrated that the incidence of gastroesophageal regurgitation and microaspiration is higher with NG tubes. But no one has been able to demonstrate a temporal relationship between aspiration and aspiration pneumonia. Most studies use ventilator-associated pneumonia (VAP) as an outcome, but diagnosing VAP in the ICU is difficult; in addition, several independent variables are not controlled for in most studies. One of us has personally witnessed a temporal relationship between aspiration, aspiration pneumonitis, hypoxia, and death, in both NG and NJ patients.

Clinical assessment

We therefore agree with the general wisdom [24, 26] that vigilant clinical assessment is most important. NG feeding is certainly simple and economical. The head of the NG patient's bed should always be elevated, to minimize the incidence of reflux and aspiration. A daily (or even more frequent) assessment for possible feeding intolerance and for any delay in gastric emptying should be performed; any problems should prompt a switch to NJ placement. Once the NJ tube has been placed, the clinician must continually make sure that it is fully advanced, that it stays advanced, and that it has not fallen back into the stomach. Assessment of gastric residual volume should be carfully monitored.

NJ placement techniques

In most cases, NJ tubes are placed by a blind technique, with the assistance of the patient's positioning and prokinetic medications [27]. The goal standard has been fluoroscopic or endoscopically guided placement, with a nearly reported 100% success rate. But fluoroscopic or endoscopically guided placement is time-consuming and, in most institutions, not always practical. Several new techniques are now available, including transnasal endoscopic placement [28, 29], a self-propelled Tiger Tube (Cook Medical Inc., Bloomington, IN) [30], and the Cortrak system (Viasys Medsystems, Wheeling, IL) [31]. At our institution, we use the Cortrak system; most of our ICU nurses are fully trained and skilled in NJ placement, and we have not noticed any significant delay in placement. Clinicians must be cautious and vigilant, making sure that the tube does not remain too proximal in the duodenum (which often leads to gastroduodenal reflux or to tube dislodgement back into the stomach).

Complications

Most reported complications are related to the tube itself [32, 33]. Reported tube malpositions in the right mainstem bronchus [AS MEANT?] have resulted in pneumothorax and hypoxia. Several case reports have noted tube malpositions in the intracranial space [AS MEANT?] through the cribriform plate, resulting in craniofacial trauma. Incomplete advancement, or dislodgement, of NG tubes has injured the esophagus. Metheny et al. [32] advocated routine X-ray confirmation of all tube placements, pointing out that auscultation (particularly with NG placement) is not always reliable.

The NG tube is often associated with an increase in gastric residual volume, which predisposes to aspiration and respiratory compromise [33]. In our ICU, where the NJ tube is frequently used, we have observed an increased incidence of tube-feeding-related diarrhea. That increased incidence is not cited very often in studies comparing NG and NJ feeding. We do not know whether the diarrhea is related to feeding directly into the small bowel, or whether it is dependent on the formula and its concentration.

A known, albeit uncommon, complication is tube-feeding-related nonocclusive bowel necrosis (NOBN). Thus far, 40 cases have been reported [34–44] in the English-language literature. Most of those cases developed postoperatively after major abdominal operations and after FJ tube placement [34, 38–40, 42, 44]. The remaining cases were in trauma or burn patients. Marvin et al. [35] described 13 trauma patients with NOBN, over a 5-year period, for a reported 0.3% incidence. After 8 years in practice, one of us recently encountered his first case of NOBN – in an 18-year-old woman with severe traumatic brain injury, 10 days after her admission (Fig. 1). The clinical manifestation in this patient was very insidious (as commonly reported in the literature), with nonspecific signs and symptoms of feeding intolerance. Her diagnosis was confirmed by a pneumointestinalis on the abdominal computed tomography (CT) scan (Fig. 2). The pathophysiology of NOBN is still not well defined; several theories have been suggested, including, to name a few, a state of hypoperfusion secondary to vasopressors, bowel distention, and hyperosmolarity of the tube feed. Treatment remains early diagnosis and surgical intervention.

Fig. 1: Intraoperative finding of tube-feeding-related transmural bowel necrosis of the proximal jejunum

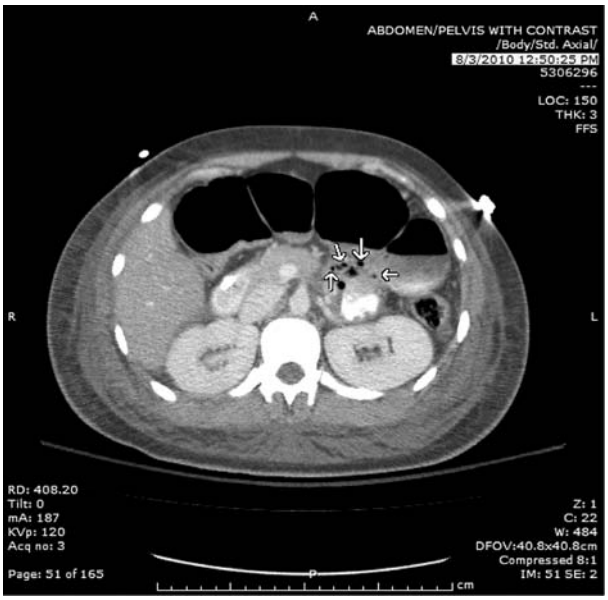

Fig. 2: Computed tomography scan of the abdomen demonstrating a pneumointestinalis (arrows)

Invasive (permanent) gut access

Most ICU patients who have a prolonged recovery or who are ventilator-dependent are offered more permanent access for invasive feeding, for the sake of their comfort (similar to the timing and thought process for tracheostomy). However, the exact indications for invasive feeding access in ICU patients have not been extensively studied and are not necessarily the same as the general indications [45–47]. Moreover, in our ICU, where a number of patients typically have severe head trauma, most will require prolonged feeding access long into their rehabilitative recovery phase. Permanent feeding access is more secure and reliable; not incidentally, it often assists with the ease of placement into a rehabilitation facility.

Percutaneous endoscopic gastrostomy (PEG)

The traditional operating room surgical open gastrostomy (SOG) [48] has now given way to the less invasive, more economical, and much more steadfast efficiency of bedside PEG [49]. Several comparison studies between SOG and PEG have been performed [50–53], but none applied to ICU patients. Dwyer et al. [54] demonstrated the cost benefit of bedside PEG in surgical/trauma ICU patients, as well as its safety benefit in relation to SOG. The safety benefit has also been demonstrated by other studies [55, 56].

Techniques

The most common PEG technique is the "pull" technique, first described by Gauderer et al. [49]. It was first performed in a pediatric population, but is now performed in patients of all ages and in various care settings [45–47]. In addition, a variation of a "push" technique is available; it can be performed using endoscopic [57–60] or fluoroscopic [57, 61–63] guidance, with or without gastropexy. The "pull" and "push" techniques have equivalent outcomes and efficacy. Several "push" technique studies [58–60] have suggested a possible lower

infection rate, because the tube is not dragged through the contaminated oral and gastrointestinal tract; however, the sample sizes were small, so definitive conclusions are not possible.

Complications

PEG is generally considered very safe, with very low procedure-related complications and with almost no associated mortality [45]. Any associated mortality is always associated with the underlying disease [46]. The reported overall complication rate [46–56] can be as low as 0% [56] or as high as 16% [47], but interpreting those results is difficult because of the variation in sample sizes, in patient populations, and in definitions of complications. Schulenberg et al. [64] reported PEG-related complications that required surgical intervention, over a 3-year period: of more than 1200 PEGs, the complication rate was just 2.1%.

The most common recognized complication of PEG is peristomal site infection [65]; the ranges from 0 to 47% [50–56, 66–71]. Again, interpreting results can be difficult because of the variation in patient populations, in prophylactic antibiotic use, and in sample sizes. Several randomized controlled trials of prophylactic antibiotic use [66–71] after PEG have suggested a lower infection complication rate, but all of those trials were marred by the lack of sample size calculation. Most were in non-ICU patients.

Infection rates after PEG in trauma patients populations have been reported by Dwyer et al. [54] as 1% ($n = 95$); by Carrillo et al. [55] as 0% ($n = 54$); and by Lockett et al. [47] as 5.4% ($n = 11$). The overall incidence appeared to be small. Uncommon complications have also been recognized, such as tube dislodgement [55], including a "buried bumper syndrome" [72]; tube leakage internally and externally [54]; pneumoperitoneum [73, 74]; and inadvertent injury to other internal organs [64].

Laparoscopic tube placement

Viable technique that has replaced SOG is less invasive laparoscopic approach [75, 76]. In patients undergoing laparotomy and who will need long tern gut access for nutrition support SOG or FJ should be done at the time of the operation. And yet PEG can even be performed safely despite a prior laparotomy [77]. Because it is more invasive than PEG and is associated with the complications of the underlying surgical procedures [50, 53], laparoscopic assisted gastrostomy has a higher complication rate than PEG.

Conclusion

In summary, the current standard for nutritional support of critically ill and injured patients is enteral (gut) access. The issue of pre- *versus* post-pyloric access remains controversial, with still-uncertain clinical implications. Clinicians must be aware of tube-related malpositions, even though such complications are uncommon. The unusual presentation of NOBN also requires vigilance. PEG offers the most efficient, economical, and secure permanent feeding access.

Conflict of interest

The authors declare that there is no conflict of interest.

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