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SURGICAL ENDOSCOPY
and Other Interventional Techniques

Prospective evaluation of novel system for jejunal feeding

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Abstract
Background: Enteral nutrition should be restored immediately after trauma, acute lesion, or surgical intervention. Nutrition through nasogastric tubes is often not feasible in patients in the posttraumatic state in medical intensive care units because of recurrent episodes of gastroesophageal reflux and subsequent aspiration due to gastric paresis. Placement of nasojejunal tubes with available techniques is unreliable.
Methods: We developed a new combined catheter system for jejunal delivery and simultaneous drainage of gastric juice (Cath-in-Cath, PreOx-RS, Germany).
Conclusion: In this article, this new tube system is presented. The safety and excellent efficacy of the novel system for enteral nutrition therapy are reported in the first series of patients worldwide.

Key words: Tube feeding — Enteral feeding — Jejunal feeding

It is generally accepted that early enteral feeding is beneficial for the patient due to fewer complications [1, 2]. In particular, for patients in ICUs, maintenance of an intact intestinal mucosa is of critical importance for the prevention of significant complications. A reduction of enterogenic infection caused by translocation of bacteria from the intestinal tract as a consequence of increased intestinal permeability and loss of intestinal mucosal barrier function can be achieved [13]. Lack of enteral feeding leads to reduced gut hormone secretion and reduction of bile flow. Billiary stasis may play a major role in the development of cholestasis, biliary sludge, and cholelithiasis [8]. These sequelae can be avoided when enteral feeding is started immediately after intervention or trauma.

However, early enteral feeding of the patient in the posttraumatic state is frequently difficult to accomplish since gastric emptying is delayed after injury [4]. Nasogastric feeding may cause gastric reflux, with the consequence of aspiration of the feeding solution leading to pneumonia. Therefore, in the early postoperative period transpyloric feeding could provide a safe method for enteral nutrition therapy.

Currently, several different tubes and methods for tube placement are available. Bedside placement of the tube system is preferred since it circumvents the need for transportation of critically ill patients. A very safe, quick, and reliable tube placement is described by Damore et al. [5] and Brandt and Mittendorf [3] using the through-the-scope method. The feeding tube is placed through the therapeutic endoscopic biopsy port of the gastroscope distal to the ligament of Treitz.

Our novel tube system represents a refined application with an additional benefit of preventing gastric liquid aspiration, a common problem seen in patients with gastroparesis. Currently, in many patients a second tube is inserted transnasally to bring relief from gastric juice. It has been strongly suggested that nasogastric tubes are an important risk factor for nosocomial sinusitis in ICU patients, and this observation is associated with the, simultaneous utilization of both nostrils for nasogastric intubation [6]. Nosocomial sinusitis may predispose the patient to pneumonia through aspiration of infected secretions from the sinuses. Therefore, our idea was to use only one nostril for jejunal feeding plus suction of gastric juice. We evaluated a two-lumen tube (Fig. 1). The tubes and all accessories necessary for their placement are manufactured as a kit by PreOx-RS GmbH.

Materials and methods

Description of the tube

The jejunal tube has an outer diameter of 9 Ch. lt consists of polyurethane and barium sulfate to provide contrast for X-ray examina-

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Fig. 1. The two-lumen tube Cath-in-Cath.

tion. There are green depth marks every 10 cm; providing good visual control and facilitating the exact placement of the tube. A special treatment of the surface optimizes the tube's sliding properties in the working channel, thus circumventing the need for MCT oil lubrication. The optimum flow rate is achieved by reducing the tube wall to a minimum thickness and by integrating a uniquely designed reversible connector. The diameter of the tube is not confined at its distal end, thus preventing drugs insoluble in water from being retained at its tip.

Inserting the tube through a working channel requires a tube length of 270 cm. This is approximately double the length of an endoscope, with an additional 30 cm for handling. It enables the endoscope to be removed without having to change the position of the jejunal tube. The gastric decompression tube has an outer diameter of 16 Ch. It consists of crystal-clear polyurethane. To avoid irritation of the gastric mucous membrane, the distal end of the tube has a pre-shaped soft tip of 2.5 cm that is radiopaque due to the addition of barium sulfate. The maximum inner lumen as well as 22 staggered drainage eyes over a distance of approximately 20 cm allow for efficient drainage of the stomach.

A transfer cannula with a closed tip facilitates the diversion of the jejunal tube from oral to nasal. The kink-resistant guidewire of high tensile strength has a diameter of 0.036 in. and a length of 300 cm. It consists of Nitinol (a nickel/titanium alloy) and is Teflon coated. A 3-cm soft tip facilitates the guidance of the tube and reduces the risk of lesions during application.

The jejunal tube has a reversible Tuohy/Borst connector that is connected to the Y adapter of the gastric decompression tube. Easy handling and safe connection are provided by Luer Lock joints. The inner diameter of these connectors has been increased to allow both inner tube insertion and aspiration of gastric fluids.

All components of the tube kit were designed and manufactured to establish optimum flow rates.

Placement of the tube

For the placement of the jejunal feeding tube, a gastroscope with a 3.7-mm channel is used (GIF 1 T-20, Olympus, Germany). A comprehensive inspection of the upper gastrointestinal tract is done first. The endoscope is placed into the duodenum as far as possible. The guidewire is inserted to stabilize the tube. The tube is placed as far as possible into the jejunum under direct vision (Fig. 2). By continuously pushing the tube forward, the endoscope is drawn back, thus keeping the tip of the tube distal to the ligament of Treitz. As soon as the endoscope is completely retracted and reaches the lips of the patient, the tube is fixed by hand and the endoscope is removed from the tube (Fig. 3). Then the guidewire is removed, and the tube is transferred through the nose (Fig. 4). The gastric tube is pushed forward using the jejunal tube as a guide. The jejunal tube remains fixed by hand directly in front of the patient's nose. When the proximal part of the tube can be gripped, the jejunal tube is tightened and the gastral tube is pushed into the stomach (Fig. 5). The length of the gastral tube should be between 60 and 80 cm aborally. Finally, the jejunal tube is shortened directly behind the proximal end of the gastric tube, and both tubes are connected with a Y connector (Fig. 6).

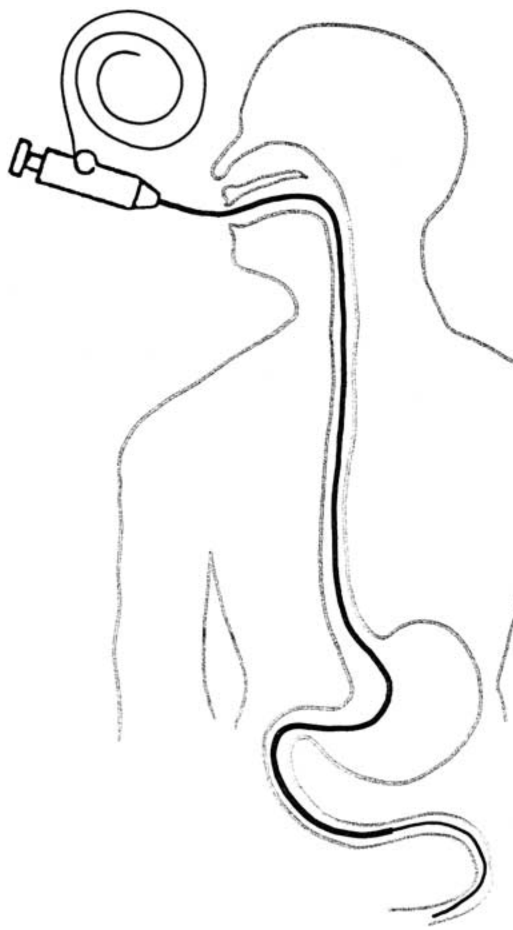

Fig. 2. Placement of tube with inserted guidewire as far as possible into the jejunum under direct endoscopical vision.

Results

The Cath-in-Cath system was endoscopically placed into 36 patients from different intensive care units of Giessen University Hospital. Patients' diagnoses are described in Table 1. Mean time for tube placement was 10 ± 3 min. X-ray control showed a correct placement of the tip of the tube distal to the ligament of Treitz.

Complete enteral nutrition could be started immediately after tube placement, although in most patients it was slowly increased, starting with 500 ml of a low-molecular formula diet on the first day. The amount of applied formula diet was increased according to the tolerance of the patient. After week all patients were able to accept 2000–2500 ml of a low-molecular formula diet.

Mean usage time of the tube was 12.5 ± 7.7 days (range, 2–31 days) (Table 1). Reasons for removal of the tubes are listed in Table 2. Most patients recovered and were able to eat, so the tubes could be removed (n = 17). Ten patients died. All deaths were unrelated to catheter placement. In 9 patients, long-term enteral nutrition was necessary. These patients received a percutaneous endoscopic gastrostomy (PEG). Only in the beginning of development of the tube system were dislodgement (n = 2) and tube obstruction (n = 1)

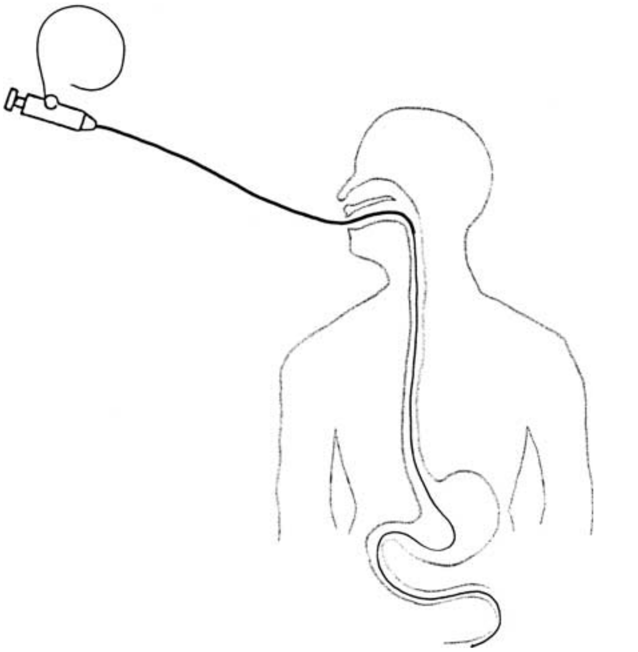

Fig. 3. Retraction of the endoscope: as soon as the endoscope reaches the lips of the patient, the tube is fixed by hand and the endoscope is removed from the tube.

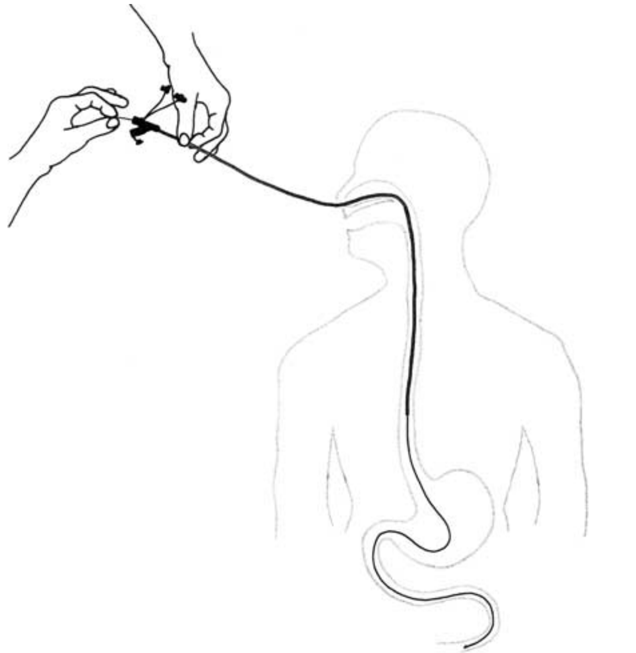

Fig. 5. Placement of the gastric tube using the jejunal tube as a guide. The length of the gastral tube should be between 60 and 80 cm aborally.

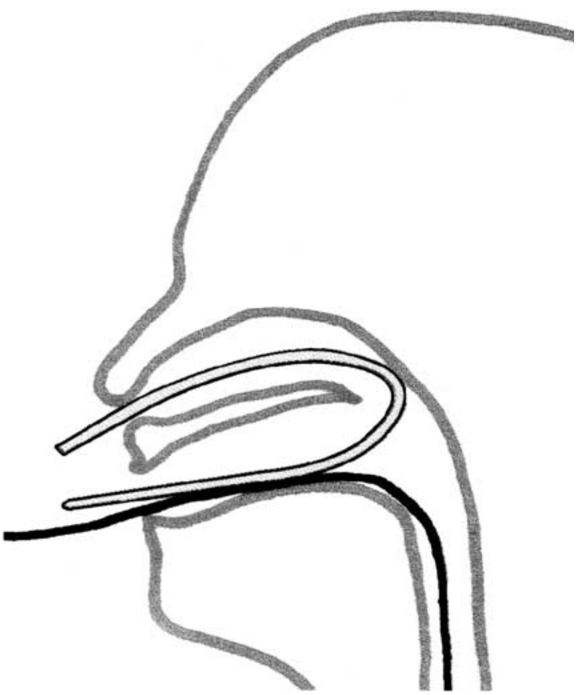

Fig. 4. Removal of the guidewire and nasal transfer of the tube.

detected. Tube obstruction was due to the wrong application of medicines. Guidelines for drug application through the tube were evaluated. Involuntary retraction of the tube by the patient led to tube dislodgement. Appropriate external fixing of the tube is necessary.

Gastric aspirates were collected. Mean volume of gastric juice was 132 ml (87–156 ml) each day.

There were no episodes of pneumonia. Radiological follow-up of abdomen and chest were carried out by an experienced radiologist every 2 days within the first 2 weeks and then every 2 weeks, as well as auscultation and examination of laboratory parameters (markers of inflammation and oxygen supply) did not show any evidence of pneumonia.

Discussion

In order to start enteral nutrition immediately after trauma, acute lesion, or surgical intubation in patients in ICUs, jejunal feeding is recommended.

Several tubes for jejunal feeding are available on the German market. Usually, these tubes have a length of 114–250 cm and a diameter of 8–12 Fr. Most tubes are made of polyurethane. There are different techniques for tube placement [9]. Blind placement appears to be unreliable for jejunal tube placement and is therefore not recommended. Placement under direct radiographic control has the disadvantages that it takes too long to place and patients as well as staff members are exposed to intensive radiation. Magnetic guided enteral feeding tubes are magnet-tipped tubes that are dragged into proper position with an external magnet [n]. It is difficult to place these tubes far into the jejunum distal to the ligament of Treitz, so that reflux of enteral feeding solution in gastricatomy can be avoided. Placement of the tubes is mostly done with the pull-along technique using an endoscope: the tip of the tube is grasped with forceps and the tube is towed to the correct location. Complications are caused by retraction of the feeding tube during endoscopic withdrawal. The through-the-scope technique is a very simple but effective method to place feeding tubes for intestinal feeding far into the jejunum [12]. This method was successfully practiced by Damore

Table 1. Patient characteristics

Diagnosis	Age (Years)	Length of tube use (days)
Polytrauma	36	10
Pancreatitis	35	15
Stenosis of A. carotis interna	65	8
Apallic syndrome	67	5
Brain abcess	51	3
Subdural hematoma	80	2
Accident	23	27
Accident	23	18
Aneurysma, pneumonia	61	19
Intracranial bleeding	19	30
Sepsis, peritonitis	48	6
Intracranial bleeding	53	12
Intracranial bleeding	26	10
Coronary heart disease	65	8
Coronary heart disease	72	13
Sepsis	68	9
Rupture of abdominal artery	74	6
Short bowel syndrome, gastro paresis	39	29
Intracranial bleeding	31	18
Intracranial bleeding	52	10
Accident	24	8
Mallory–Weiss syndrome (rupture of esophagus)	44	31
Brain abcess	53	5
Subileus	70	14
Coronary heart disease	52	12
Sepsis	64	8
Polytrauma	24	9
Pancreatitis	39	14
Coronary heart disease	80	11
Coronary heart disease	68	9
Accident	43	7
Intracranial bleeding	71	13
Subileus	52	3
Accident	27	8
Coronary heart disease	78	15
Polytrauma	30	25
Median value	52	10
Mean value	50	12.5
Range	19–80	2–31

Table 2. Causes of tube retraction

Cause	No. of patients
Patient death[a]	10
Patient recovery	17
Dislodgement	2
TUBE obstruction	1
PEG placement	9

[a] Unrelated to catheter placement

et al. [5] and Brand & Mittendorf [3]. Currently, through-the-scope tubes available on the German market are made of polyvinyl chloride (PVC). This material should not be used for enteral feeding. The softeners in the PVC material are washed out by the fat-containing feeding solution. The material hardens and causes ulcers in the esophageal and intestinal region. In the Cath-in-Cath system, polyurethane is used for both tubes. Additionally, the tip of the gastric decompression tube is specially shaped and softened to avoid gastric ulcers.

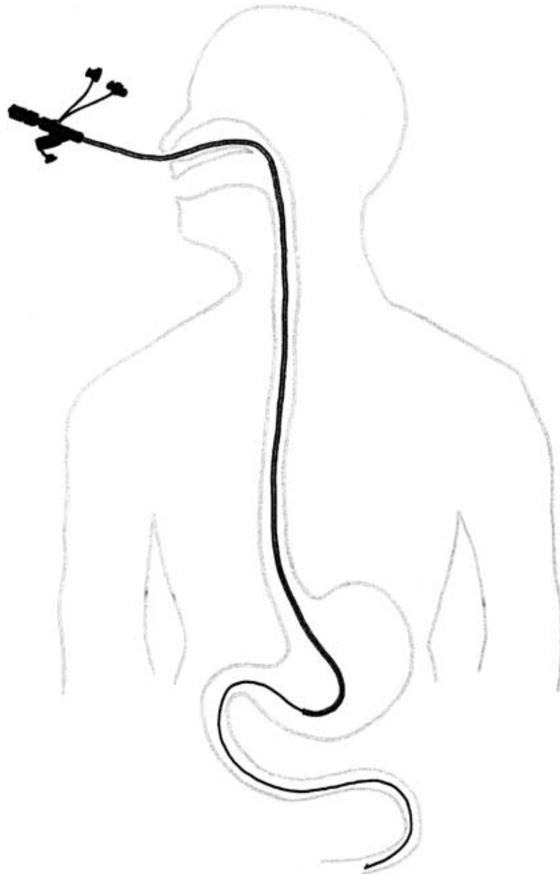

Fig. 6. Shortening of the jejunal tube directly behind the proximal end of the gastric tube and connection of both tubes with a Y connector.

Parallel to feeding the patient into the jejunum, gastric juice that is collected in the atonic stomach can be sucked out. There is sufficient evidence that gastroesophageal reflux is strongly associated with ventilator-associated pneumonia [14]. Consequently, removal of gastric juice and jejunal feeding have a protective effect. To date in most patients a second tube for decompression has been inserted so that each nostril contains one tube. However, nasogastric tubes are an important risk factor for nosocomial sinusitis in ICU patients. Anaerobic bacteria from sinus ostria may migrate along the nasogastric tube [11]. Thus, combination tubes such as Trelumina and Dobbhoff–Sonde are used. Placement of these tubes is unreliable since they are placed with the pull-along technique. In our Cath-in-Cath system, the gastric decompression tube is pushed forward using the placed jejunal tube as a guide. Thus, only one nostril has to be used for our tube-in-tube-system.

A problem in our initial experience was the dislodgement of the tube, which highlights the need foran appropriate external fixing of the tube to prevent involuntary retraction.

With the Cath-in-Cath system, we present a possibility to place a tube into the jejunum with the through-the-scope technique and also insert a gastric decompression tube in patients with gastric paresis. Placement of the tube-in-tube system can be done as a bedside procedure. For trained physicians, it is simple and fast. Radiological control is not necessary.

Enteral feeding can be started immediately after tube placement. Starting enteral nutrition within 24 h after admission to the ICU may decrease gut permeability and prevent the patient from developing multiple organ failure [10]. The Cath-in-Cath system allows the patient to be fed independently from gastric function.

Conclusions

Using Cath-in-Cath polyurethane tube, we evaluated an optimized method to place a jejunal feeding tube combined with gastric suction as a beside procedure for patients in ICUs. The advantages of the Cath-in-Cath tubes are that only one nostril has to be used for feeding and suction, the endoscopic placement of the tube-in-tube system is performed at the patient's bedside, and placement is easy, safe, and quick.

References

1. Alexander JW (1990) Nutrition and translocation. JPEN 14: 170–174
2. Alexander JW (1999) Is early enteral feeding of benefit? Intensive Care Med 25: 129–130
3. Brandt CP, Mittendorf EA (1999) Endoscopic placement of nasojejunal feeding tubes in ICU patients. Surg Endosc 13: 1211–1214
4. Carlin CB, Scanlon PH, Wagner DA, Borghesi L, Geiger JW (1999) Gastric emptying in trauma patients. Dig Surg 16: 192–196
5. Damore LJ, Andrus CH, Herrmann VM, Wade TP, Kaminski DL, Kaiser GC (1997) Prospective evaluation of a new through the scope nasoduodenal enteral feeding tube. Surg Endosc 11: 460–463
6. Desmond P, Raman R, Idikula J (1991) Effect of nasogastric tubes on the nose and maxillary sinus. Crit Care Med 19: 509–511
7. Gabriel SA, Ackermann RJ, Castresana MR (1997) A new technique for placement of nasoenteral feeding tubes using external magnetic guidance. Crit Care Med 25: 641–645
8. Kelly DA (1998) Liver complications of pediatric parenteral nutrition — epidemiology: Nutrition 14: 153–157
9. Keymling M (2001) Nasale Sonden. In: Löser C, Keymling M (eds) Praxis der Enteralen Ernährung: Indikationen, Technik, Nachsorge. Thieme, Stuttgart pp 52–56
10. Kompan L, Kremzar B, Gadzijev E, Prosek M (1999) Effects of enteral nutrition on intestinal permeability and the development of multiple organ failure after multiple injury. Intensive Care Med 25: 157–161
11. Le Moal G, Lemerre D, Grollier G, Desmont C, Klossek JM, Robert R (1999) Nosocomial sinusitis with isolation of anaerobic bacteria in ICU patients. Intensive Care Med 25: 1066–1071
12. Ott L, Annis J, Hatton J, McClain M, Young B (1999) Postpyloric enteral feeding costs for patients with severe head injury: blind placement, endoscopy, and PEG/J versus TPN. J Neurotrauma 16: 233–242
13. Peng YZ, Yuan ZQ, Xiao GX (2001) Effects of early enteral feeding on the prevention of the enterogenic infection in severely burned patients. Burns 27: 145–149
14. Torres A, EI-Ebiary M, Soler N, Monton C, Fabregas N, Hernandez C (1996) Stomach as a source of colonization of the respiratory tract during mechanical ventilation: association with ventilator-associated pneumonia. Eur Respir J 9: 1729–1735