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## Abstract

Tube gastrostomy by laparotomy has been one of the important operations for pediatric patients who have serious difficulty swallowing or eating. Percutaneous endoscopic gastrostomy (PEG) procedure has been reported in 1980 by Gauderer et al. [1]. Since PEG can be performed without laparotomy and general anesthesia, its use had spread rapidly from the 1990s in Japan. In the pediatric surgery, PEG has also become an alternative method for **gastrostomy** placement with the development of endoscopy. More recently, laparoscopy-assisted PEG can be considered when other minimally invasive methods such as PEG are not feasible or fail.

Tube jejunostomy is applied for pediatric patients who require enteral feeding but cannot receive nutrients from stomach by anatomical reasons. Purpose is not only injection of nutrients but also drainage of intestinal fluids and stool. Types of tube jejunostomy and postoperative management are described.

## Keywords

Gastrostomy • Percutaneous endoscopic gastrostomy (PEG) • Tube jejunostomy • Witzel jejunostomy • Stamm-Kader jejunostomy • Needle catheter jejunostomy

## 6.1 Indication for Gastrostomy

Tube gastrostomy is performed because a patient temporarily or permanently needs to be fed directly through a tube in the stomach. Reasons for feeding by gastrostomy include congenital anomalies of the upper gastrointestinal tract and disorders in sucking or swallowing. At the pediatric surgical

specialty, the main individuals which are susceptible to gastrostomy are children with esophageal atresia and severely retarded who have been performed long-term tube feeding. Indication for PEG was proposed by gastroenterological endoscopy guideline [2] (Tables 6.1 and 6.2).

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## 6.2 Selection of Gastrostomy Tube

The gastrostomy tube can be classified into four types: button type and tube type from the form of outside of the abdominal wall and bumper type and balloon type from the form of inside of the stomach (Fig. 6.1). In the case of the button type, the tube is noticeable and the accidental extraction is rare. But it needs delicate procedure at the time of opening and shutting of the button. In the case of the tube type,

**Table 6.1** Indication of PEG

1	<i>Ingestion/swallowing difficulty</i>
	Cerebrovascular disease, neuromuscular disease, head and facial injury, stricture of the laryngopharynx and esophagus, and gastroesophageal junction
2	<i>Repeated aspiration pneumonia</i>
3	<i>Inflammatory bowel disease</i>
4	<i>The purpose of decompression</i>
	Pyloric stenosis, upper small intestinal stenosis
5	<i>Others</i>

**Table 6.2** Contraindications of PEG

<i>Definitive contraindications</i>	Contraindication of ordinal endoscopic examination
	The stricture of the laryngopharynx or the esophagus
	The stomach not able to reach the abdominal wall
	Uncontrolled bleeding tendency
	Gastrointestinal obstruction
<i>Relative contraindications</i>	Excessive ascites
	Obesity
	Liver enlargement
	Gastric malignancy and acute mucosal lesion
	Diaphragmatic hernia
	Bleeding tendency
	Pregnancy
	Portal hypertension
	Peritoneal Dialysis
	Carcinomatous peritonitis
	Poor general condition
	Poor life prognosis
	Postsurgical condition for stomach
No Informed consent	

the accidental extraction is more frequent, but it is easier to connect the tube than the button type. In the case of the bumper type, it is hard to fall out and the time to replace is long (about 4–6 months) because of strong durability. But it causes pain at the time of replacement, and occasionally fistula injury occurred at that time. On the contrary, the balloon type is less painful at the time of replacement, but the frequency of accidental extraction is higher than the bumper type because of balloon injury or transpiration of distilled water. So interval of replacement is short (about 1–2 months). We should consider the tube selection comprehensively from both the ability of daily life of each patient and skill of caregiver.

## 6.3 Preoperative Examination

It is necessary to comprehend the position of the stomach, especially the relationship between the stomach and the abdominal wall. In patients with scoliosis, we should perform a preoperative upper gastrointestinal contrast study and confirm that the stomach is not located within the upper costal arch and that the gut is not located between the stomach and abdominal wall. Abdominal ultrasound and abdominal computerized tomography are helpful in understanding these anatomical features. In addition, the patient who is intended to undergo gastrostomy is often comorbid with gastroesophageal reflux disease (GERD), so it is important to perform 24-h pH monitoring and examine if GERD is present or not. Even in the case of percutaneous endoscopic gastrostomy (PEG), as most pediatric patients are performed under general anesthesia, it is essential to examine general conditions including respiratory function and coagulation status.

## 6.4 Selection of the Operative Methods

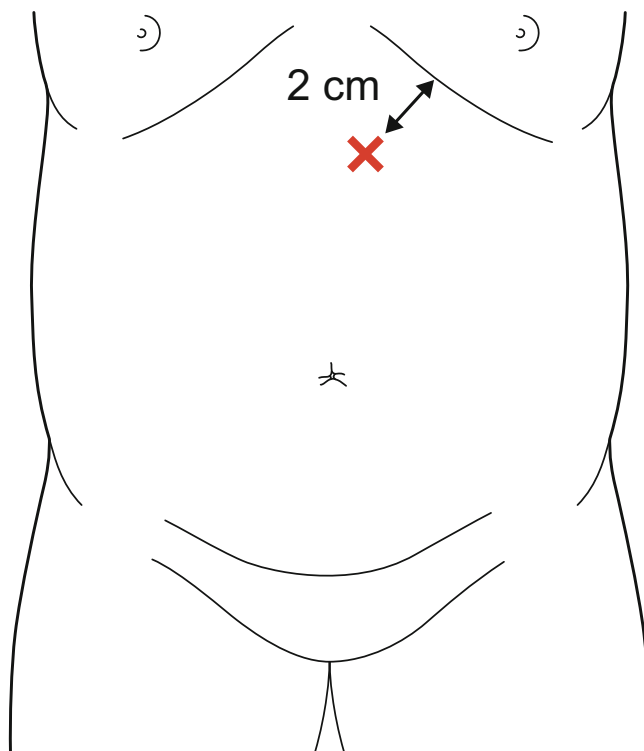
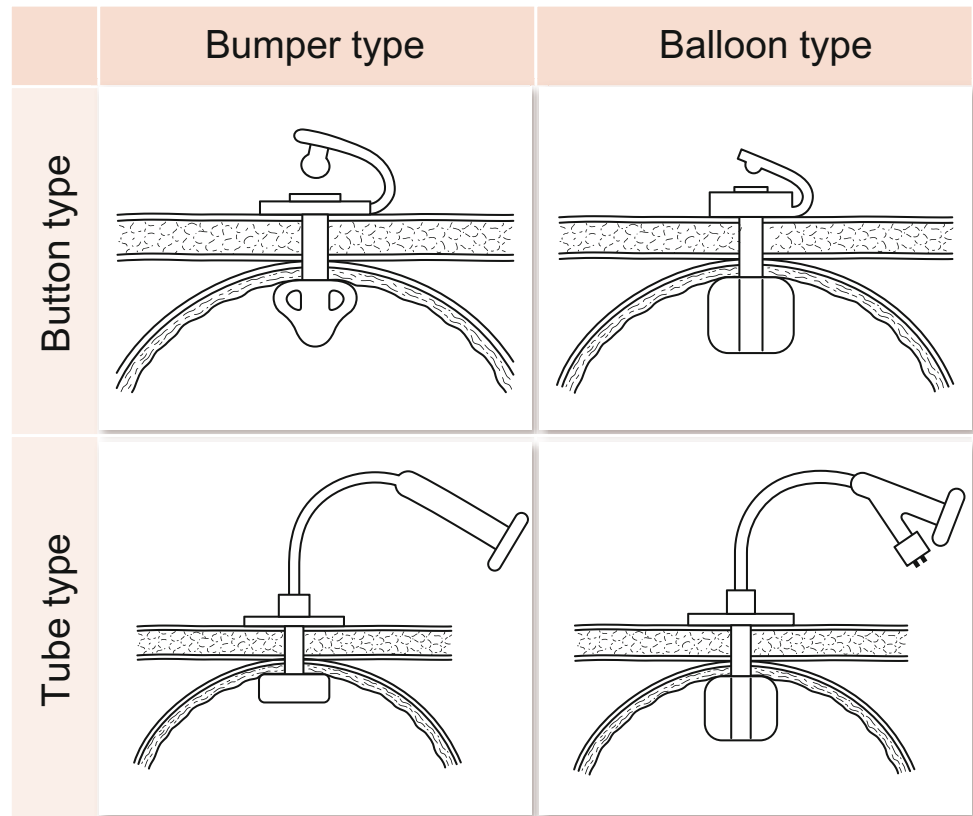
Which operative method do we select? Laparotomy or endoscopy? We should select by the following contents: (1) whether we can perform gastroscopy safely, (2) adequate size of gastrostomy tube, and (3) position of the stomach. Suitable age and weight are not defined, but there have been reports that PEG was performed on a 49-day-old baby weighing 3,626 g in Japan. In general, high level of skills is required to perform gastroscopy for newborn. The minimum diameter of the catheter kit for PEG is 14Fr (external diameter 4.0 mm), and it does not coincide with physical constitution and gastric volume. PEG can be performed even in small infants; however, laparoscopy-assisted PEG has further been reported to be a feasible and an alternative method.

## 6.5 Operations

### 6.5.1 Gastrostomy by Laparotomy

The stomach is approached by a short left upper transverse incision. The gastrostomy tube is placed on the left upper quadrant approximately 2 cm apart from both the left costal arch and skin incision (Fig. 6.2). The gastrostomy tube is placed on the anterior surface of the lower body of the stomach, slightly on the side of the greater curvature. A

**Fig. 6.1** Type of gastrostomy tube



**Fig. 6.2** The location of gastrostomy

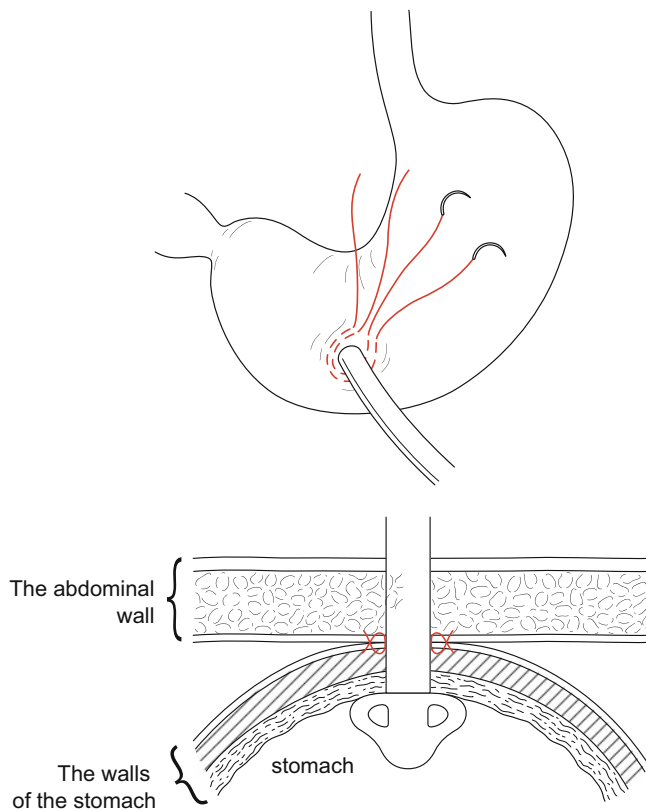
small incision is made on the stomach wall, and the gastrostomy tube is placed intragastrically (Fig. 6.3). Two purse-string sutures are placed using absorbable fine threads. Then the stomach wall near the tube is approximated to the abdominal wall by two or three sutures to facilitate the fixation and prevent leakage of gastric juice.

### 6.5.2 Percutaneous Endoscopic Gastrostomy (PEG)

There are pull procedure, push procedure, and introducer procedure. In the pull and push procedures, the gastrostomy tube is inserted into the stomach orally using a guide wire, so bacterial contamination and risk of infection are increased. In these procedures, two endoscopic insertions are needed during guide wire insertion and gastrostomy tube insertion. On the contrary, in the introducer procedure, endoscopic insertion is done only once, so risk of infection is less.

#### 6.5.2.1 Pull Procedure

An endoscope is inserted into the stomach under the left lateral decubitus position, and the stomach is dilated with sufficiently supplied air. Then the position is changed to



**Fig. 6.3** Placement of gastrostomy tube

supine. The endoscope is rotated to the lower anterior surface of the stomach, and we visualize the transmitted light through the abdominal wall. Then the operator pushes the abdominal wall and confirms that the gastric mucosa is protruding using hand pressure (Fig. 6.4a). Thus, the most suitable puncture point is decided. At this time, the operator should confirm the vessel of the abdominal wall to avoid useless bleeding. At this point, the operator sterilizes the skin around the puncture point and performs local anesthesia. The needle for PEG is then navigated into the stomach while looking at the endoscopic monitor (Fig. 6.4b). To prevent puncture of the intestines, an operator must confirm that air suction does not happen until the needle reaches the stomach. In the case of the button type, the operator measures the distance to the stomach at puncture test and selects a tube with a length of 1 cm longer than the measurement in adults. For children, it is recommended to select a tube 1 cm shorter than measurement. T- or Y-shaped incision about 1 cm long is made, and the subcutaneous tissue is exfoliated. A loop wire is then passed through the puncture needle and is introduced into the stomach. Then the endoscopist grasps the loop wire with a snare and pulls the loop wire and endoscopy out of the oral cavity (Fig. 6.4c). The loop wire and the device with the gastrostomy tube are tied and pulled out from the stomach to the abdominal wall.

The device with the gastrostomy tube should be pulled back slowly with great care to avoid injury of the mucosa (Fig. 6.4d). The endoscopist inserts the fiber scope again and observes the tube position, bleeding, or mucosal damage (Fig. 6.4e).

### 6.5.2.2 Push Procedure

This procedure is performed in the same way until insertion of endoscope and puncture, but a guide wire is inserted instead of a loop wire and is pulled out from the oral cavity. The device with the gastrostomy tube is inserted into the stomach along with a guide wire through the oral cavity. The operator pulls it out from the abdominal wall. After removal of the guide wire, the endoscopist observes the gastrostomy tube.

### 6.5.2.3 Introducer Procedure

The stomach wall and abdominal wall are fixed under endoscopic observation. In children, three approximations are recommended due to thinness of the abdominal wall and gastric wall and to prevent tearing injury by fine threads. The stomach wall fixture is packaged in the same gastrostomy kit. T- or Y-shaped incision about 1 cm long is made, and the subcutaneous tissue is exfoliated. The operator punctures the stomach wall, pulls the inner barrel and inserts the guide wire, and extends the gastric fistula by inserting the dilator along the guide wire. After dilation, the operator inserts the gastrostomy tube along the guide wire.

## 6.5.3 Laparoscopy-Assisted PEG

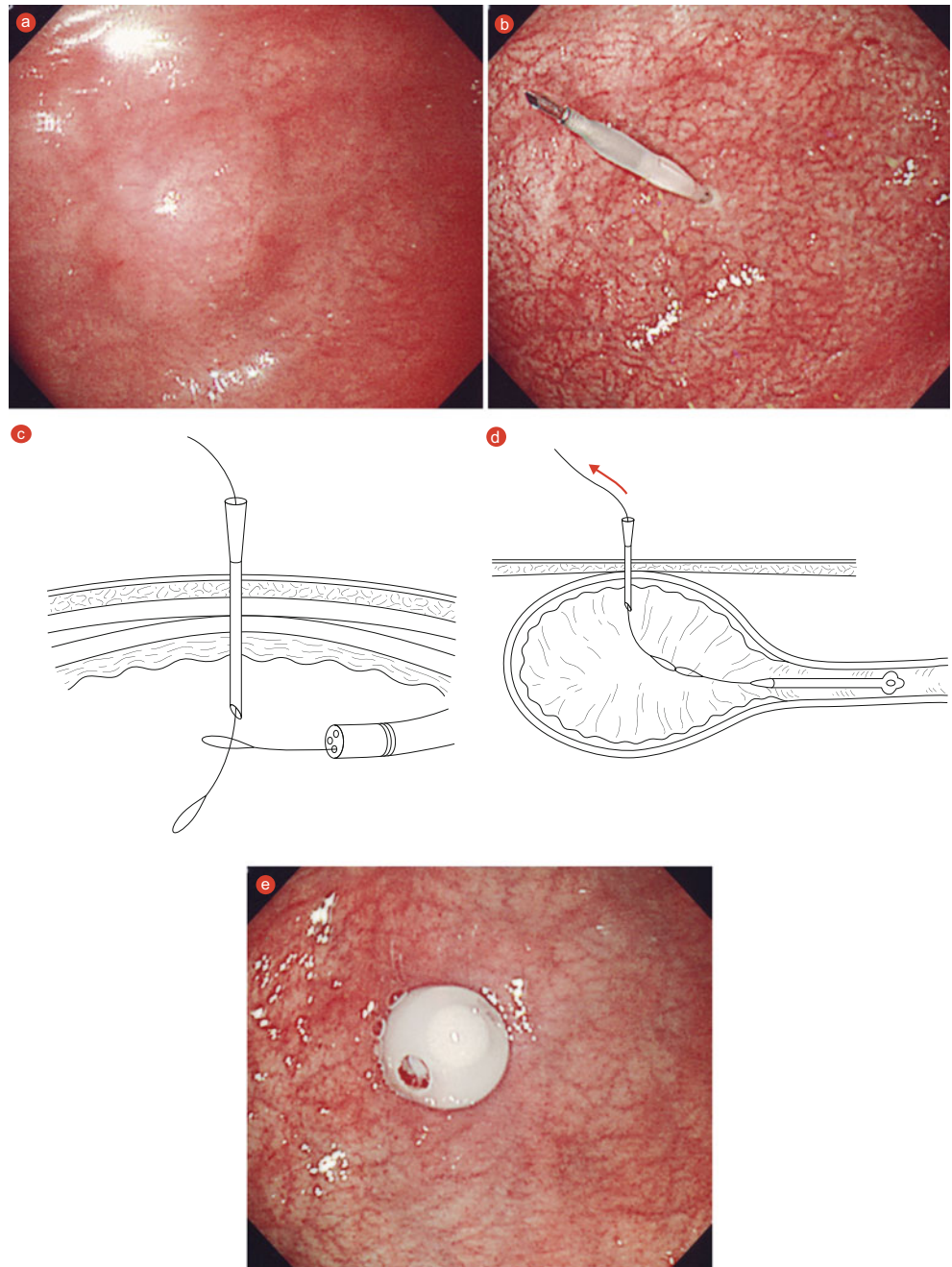
PEG cannot be performed in cases when the bowel is between the stomach and the abdominal wall, or when the stomach is located cranial to the left costal margin. In these cases, gastrostomy can be performed safely under laparoscopic guide and aid. Port for laparoscopy is made on the umbilicus, and PEG can be performed safely by observing intraperitoneal conditions. The operator can guide the gastric wall to the portion of gastrostomy by making additional port for the forceps; however, we must be aware that excessive traction of the stomach causes dehiscence of gastrostomy or buried bumper syndrome.

## 6.6 Purpose of Tube Jejunostomy

**Injection of nutrient:** The patients with gastrointestinal obstruction and eating disorder (e.g., gastroesophageal reflux, cerebral palsy) are subject to tube jejunostomy.

**Drainage of intestinal fluids and stool:** The patients with bowel dysfunction (e.g., total colonic aganglionosis, CIIPS)

**Fig. 6.4** Pull procedure. (a) Endoscopic observation on the site for gastrostomy. (b) The needle is navigated into the stomach under endoscopic observation. (c) Endoscopist grasps loop wire with snare and pulls loop wire and endoscopy out of the oral cavity. (d) Loop wire and gastrostomy tube are tied and pulled from the stomach to the abdominal wall. Device with gastrostomy tube should be pulled back slowly. (e) Endoscopist inserts fiber scope again and observes the tube position, bleeding, and mucosal damage



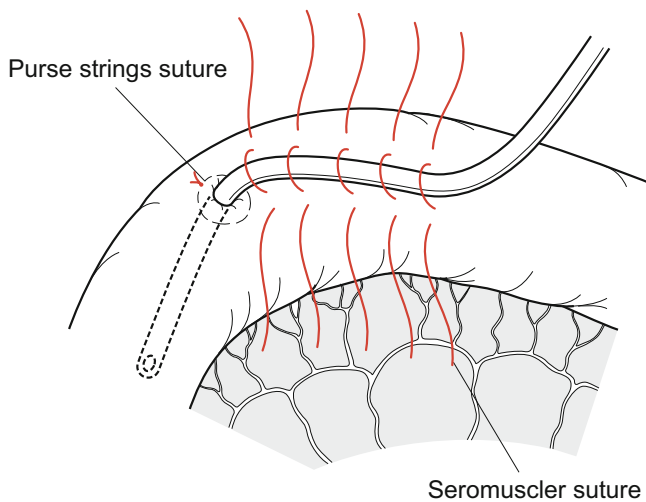
and requiring intestinal tract decompression (e.g., meconium-related ileus, intestinal perforation) are also the subject to tube jejunostomy.

## 6.7 Types of Tube Jejunostomy

There are three kinds of methods of tube jejunostomy.

### 6.7.1 Witzel Jejunostomy (Fig. 6.5)

The Witzel jejunostomy is the most common method of jejunostomy creation. It is an open technique where the jejunostomy is created on the jejunum approximately 20–30 cm distal to the ligament of Treitz. A purse-string suture is placed at the site of the antimesenteric border, and the catheter is anally inserted into the intestinal lumen. Then the catheter is tunneled 2–3 cm long by seromuscular



**Fig. 6.5** Witzel jejunostomy. The purse-string sutures are secured and then the catheter is tunneled in a seromuscular groove

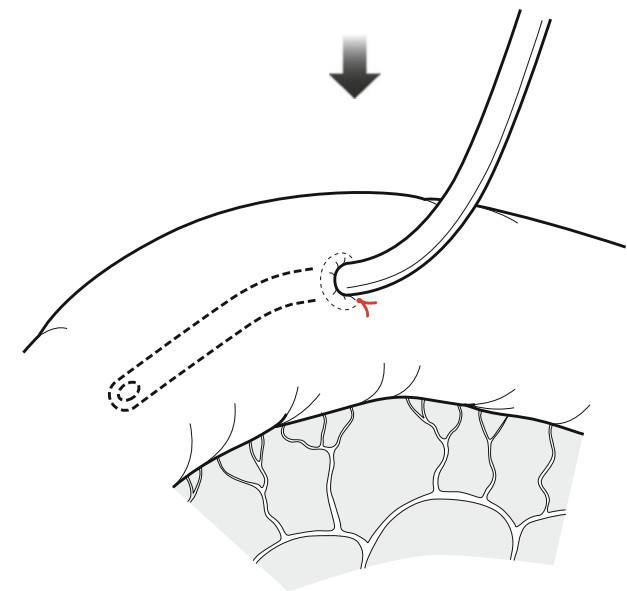
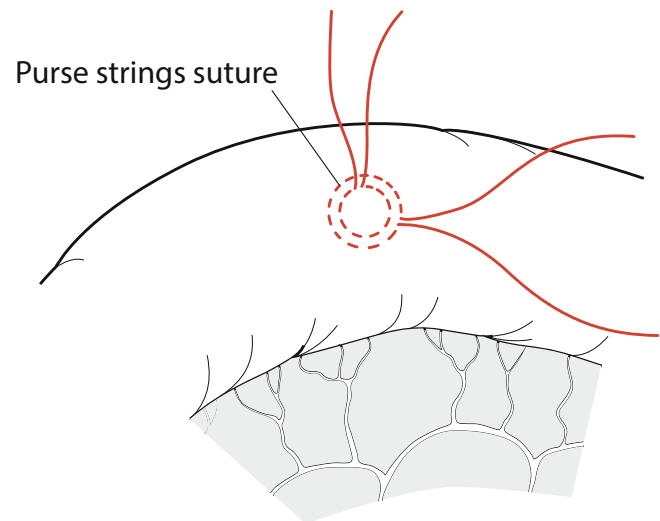
sutures. The serosa around the jejunostomy tube is fixed to the abdominal wall with three to five sutures.

### 6.7.2 Stamm-Kader Jejunostomy (Fig. 6.6)

Two subsequent purse-string sutures are placed at the site of the antimesenteric border of the jejunum. A stab wound is placed on the skin, and the distal end of the tube is drawn into the abdomen. A hole is placed in the middle of the purse-string sutures and then the tube is inserted. The purse-string sutures are secured, invaginating the serosa around the tube as the sutures are tied down. The serosa around the catheter is tacked to the abdominal wall with three to five sutures.

### 6.7.3 Needle Catheter Jejunostomy (Fig. 6.7)

A needle catheter is inserted into the antimesenteric side of the jejunal wall and is passed through the submucosal layer to prevent from fistula formation after removal of the catheter. The needle is withdrawn over the catheter, and a purse-string suture is made on the jejunal wall around the catheter. The catheter is threaded through the anterior abdominal wall; finally the loop of jejunum is attached to the parietal peritoneum and then the catheter fixed to the skin.



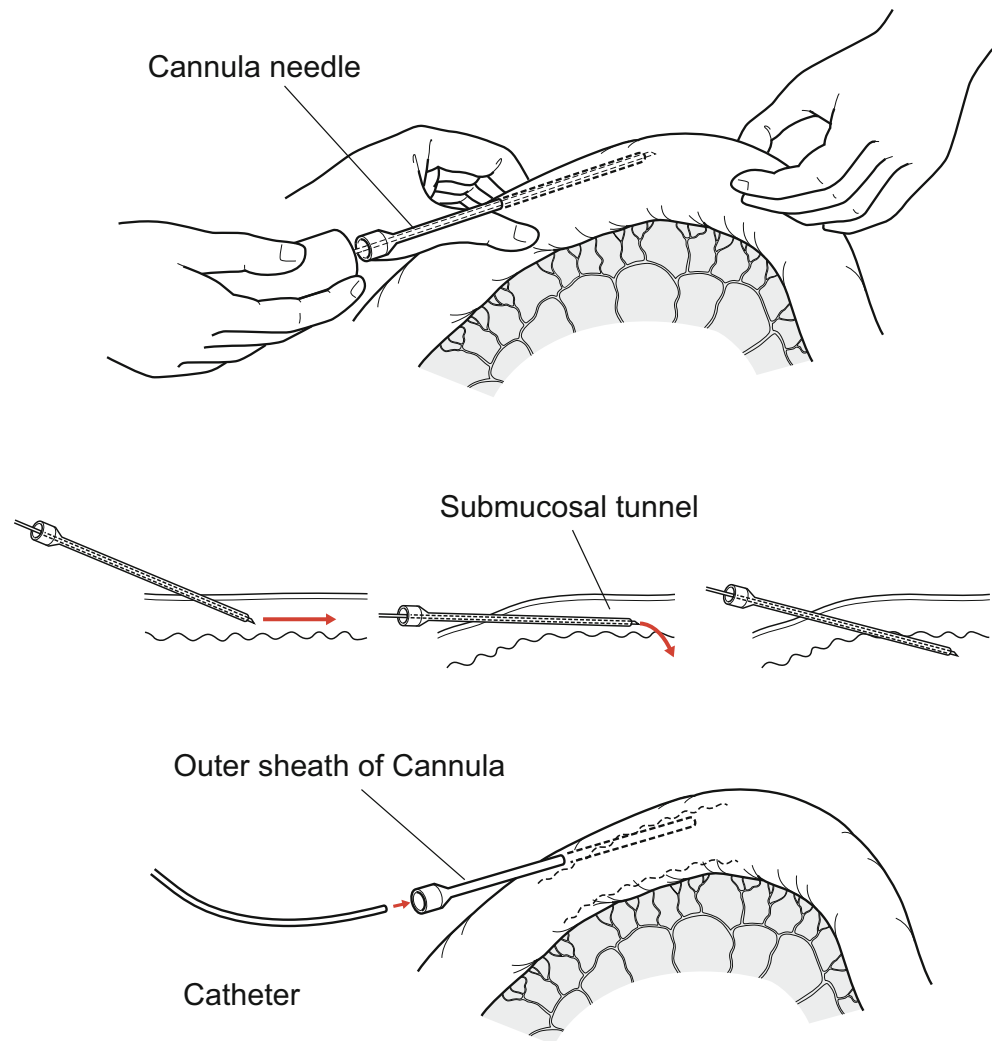
**Fig. 6.6** Stamm-Kader jejunostomy. Two subsequent purse-string sutures are placed at the site of the antimesenteric border. The purse-string sutures are secured, invaginating the serosa around the tube as the sutures are tied down

## 6.8 Postoperative Management

### 6.8.1 Management After Fistula Formation

**Dermatitis:** This is caused by leakage of intestinal fluids or nutrient and skin rash by the fixing tape. To reduce dermatitis, it is necessary to wash the skin and paste adequate coating materials.

**Fig. 6.7** Needle catheter jejunostomy. The needle is inserted to the intestinal wall and a submucosal channel is made in the antimesenteric intestinal wall. And the catheter inserted to the outer cylinder



Formation of granulation: This is caused by infection of the fistula and chronic stimulation. Fixing the catheter without pressing the same site is necessary.

Accidental extubation and self-extubation of the catheter: When the catheter is fixed to the skin, it is necessary to put a mark on the catheter. We must take care not to loosen anchoring sutures and peeling off of the fixing tape.

### 6.8.2 Management of the Catheter

Obstruction of the catheter: It is caused by nonuniformity of mixing and consolidation of nutrients by enteric bacteria. It is necessary to dissolve the powdered nutrients with lukewarm water thoroughly so as not to leave solid components and to administer the nutrient within 8 h after mixing. We should flush the catheter using lukewarm water before and after administration.

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