
History of Tube Feeding

The History of Surgically Placed Feeding Tubes

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ABSTRACT: Although supplemental enteral nutrition may have first been delivered by enema, the modern era of surgically placed feeding tubes began in the mid to late 1800s. Early procedures were generally disastrous, however, techniques rapidly improved. The basic techniques of surgical enteral access have not changed significantly in the last century, although endoscopic, radiologic and laparoscopic modifications have been described and adopted in the last 25 years. This article reviews some of the landmark surgical highlights in the United States and European literature regarding surgical enteral access.

Most nutrition support clinicians agree that when choosing the route of feeding, enteral nutrition is indicated as long as the gastrointestinal tract is intact and functional, and access can be obtained. Many ways of obtaining access are available, from bedside methods to those performed in the operating room, endoscopy suite, or radiology suite. Some of these methods are very similar, and many of these procedures were originally designed and described by surgeons. This article will focus on the history of surgical procedures for enteral access. The literature is full of other reviews of this topic; however, many of them do not reference the original articles. A wonderful exception to this is a review published by Gauderer and Stellato¹ in 1986, which is one of the most comprehensive historical articles available. They provide an excellent reference list of many of the original publications for the interested reader.

Ancient History of Feeding Tubes

Many authors have claimed that the early Greeks and Egyptians used animal bladders to give nutrient enemas. The original documentation of this, how-

ever, is difficult to find. Frequently, Herodotus' *Histories* (II:77) is quoted; however, the passage cited does not describe this:

"For three successive days in each month they purge, hunting after health with emetics and clysters [enemas], and they think that all the diseases which exist are produced in men by the food on which they live."²

Although enemas are described, there is no discussion in these passages of using them for nutrition support.

The other frequently quoted ancient source is the Ebers Papyrus, which is a 110-page Egyptian medical text written between 3000 and 1500 BC. Because it is written in hieratic script (a variant of hieroglyphs), it is quite impossible for most people to translate, as opposed to translating German or French. It is doubtful that many of the sources that reference the Ebers papyrus actually found a translation, much less translated it themselves. So although the ancients used enemas, it is quite difficult to determine if they were for anything besides "cleansing."

19th-Century Feeding Tubes

Medicine had not really progressed in this regard even up to the early 1800s in the United States, because enemas were used fairly frequently. In fact, after President James Garfield was shot on July 2, 1881, he underwent multiple enemas of broth to try to maintain his nutrition.³ He died from multiple ill-advised attempts to remove the bullet, which, upon autopsy, was shown to have caused no significant damage. If his doctors had not contaminated his wounds by manually probing them, he may not have become infected and therefore malnourished (he was alleged to have lost 130 pounds). As a result, he probably would not have required any artificial nutrition support and would have survived at least that assassination attempt.

William Beaumont, a United States surgeon, is credited with describing much of what we know today about gastric physiology and the effect of eating. He gleaned much of this early knowledge of the stomach from studying and experimenting on an unfortunate man, Alexis St. Martin. This patient had a gastrocutaneous fistula secondary to an accidental shotgun wound to the chest and abdomen in

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the early 1800s.⁴ Although he did not feed the patient through the gastrostomy, he learned and wrote quite a bit about the stomach. Through the early 1800s, the only “gastrostomies” and “jejunos-tomies” were accidental as a result of trauma. Surgical gastrostomies and jejunostomies that were created purposefully were “invented” in the 1800s.

One of the earliest feeding tubes attributed to a surgeon was actually an orogastric tube. John Hunter, a Scottish surgeon and comparative anatomist who practiced in England, created an orogastric tube made of whalebone covered with eel skin. Gastrostomy as a surgical procedure was proposed by several surgeons, including Charles Sédillot, a French surgeon, in 1846.⁵ Although he did not describe the procedure in detail in his first paper on the subject, he proposed many of the indications. In 1849, he described an operative gastrostomy performed on a human for the first time.⁶ Unfortunately for the early surgeons, the patients did not survive long. Most patients underwent autopsy, however, so the learning curve was significantly shortened.

F. F. Maury, a surgeon at the Philadelphia Hospital, was an early pioneer in the gastrostomy procedure. In 1870, he described a 25-year-old man with an esophageal stricture that he treated from 1868 through 1869.⁷ The patient's stricture was unresponsive to dilation, and eventually nutrition was attempted with brandy, beef extract, and milk-punch enemas. Finally, he performed a gastrostomy in June of 1869 under chloroform anesthesia. He made a curvilinear incision of 4 inches, starting at the seventh intercostal space, extending inferiorly. This was continued into the peritoneal cavity, where the stomach was grasped with a forceps. A needle carrying silver suture was inserted longitudinally into the stomach wall. Two more needles with silver suture were placed perpendicular to the first needle (Figure 1A). The first needle and suture were removed and the second and third needles were pulled through the stomach, leaving the sutures in place (Figure 1B). The stomach was opened longitudinally between the entry and exit points of the second and third needles (Figure 1C). The sutures were divided, the short ends were brought out through the gastrotomy (Figure 1D), and, using these sutures, the stomach wall was sewn to the abdominal incision (Figure 1E). A tube was placed into the stomach for feeding. “Immediately after the operation, a small quantity of beef extract was gently thrown into the stomach, and followed in fifteen minutes by a little brandy and water.”⁷ Feedings and enemas were continued; however, the patient died 14 hours later.

One of the first patients to undergo gastrostomy who survived for any length of time was a patient treated by Mr Sidney Jones at St. Thomas's Hospital in England (the home of the Nightingale Training School for nurses).⁸ The 67-year-old patient had an esophageal cancer and considerable dysphagia and

weight loss. Using chloroform anesthesia, Mr Jones made a 3 1/2-inch incision along the line from the patient's nipple to his pubis. The stomach was sewn to the abdominal wound (he did not describe opening the stomach). A milk, brandy, and opium enema was administered before leaving the operating room. Milk and brandy were infused into the stomach on the second day. His subsequent care was fairly typical for the time, albeit very unconventional by today's standards: “During the day the nourishment he took consisted of six ounces of milk by the mouth; six enemata, each consisting of nine ounces of milk, one ounce of brandy and one egg. He also had seven pipes.”⁸ Despite this therapy, the patient expired approximately 1 month later.

Another early (1870) gastric procedure was performed on an 8-year-old boy who was a patient of L. L. Staton, a surgeon in North Carolina.⁹ Dr Staton is credited with being the first surgeon in the United States to perform gastrostomy with long-term survival. The boy had an esophageal stricture due to lye ingestion. Using chloroform anesthesia, Dr Staton made a 2 1/2-inch left subcostal incision. He pulled the stomach into the wound and made a 3/4-inch horizontal incision in the stomach. He inserted a spool-shaped tube into the stomach (the ends of the spool essentially acting as internal and external bolsters). This was attached to a soft rubber pipe with a hard rubber mouth. Milk was infused through the tube on the second day. Enemas of milk, egg yolks, and beef essence were continued. To prevent fatty acid deficiency, he had the boy's skin rubbed with cod liver oil. Within 2 months, the boy could chew his food and inject it into the tube; the patient allegedly died at age 26.¹⁰ This may have been one of the first descriptions of a “blenderized” formula.

Stamm Gastrostomy

In 1894, M. Stamm, from the University of Wooster, Cleveland, Ohio (now absorbed into Case Western Reserve University), published his description of a gastrostomy, which is still in use today, with only slight modification.¹¹ A 3-inch subcostal incision was made through which the stomach was grasped. A serosal incision was made on the stomach wall. A single 2-inch-diameter seromuscular purse-string using “strong silk” was placed. A size-15 catheter was inserted into the stomach and fastened with silk or catgut. The pursestring suture was tied to create a sphincter to prevent leakage. The stomach was sewn to the abdominal wall using 6 sutures by passing both ends of the pursestring “through the entire thickness of the abdominal wall on both sides of the wound.” Interestingly, the original description was in a dog, and the tube fell out after 5 days.

The Stamm gastrostomy is still in wide use today (Figure 2A–F). Many surgeons use a separate stab wound for the tube instead of bringing it out of the operative wound, and many use 2 pursestrings

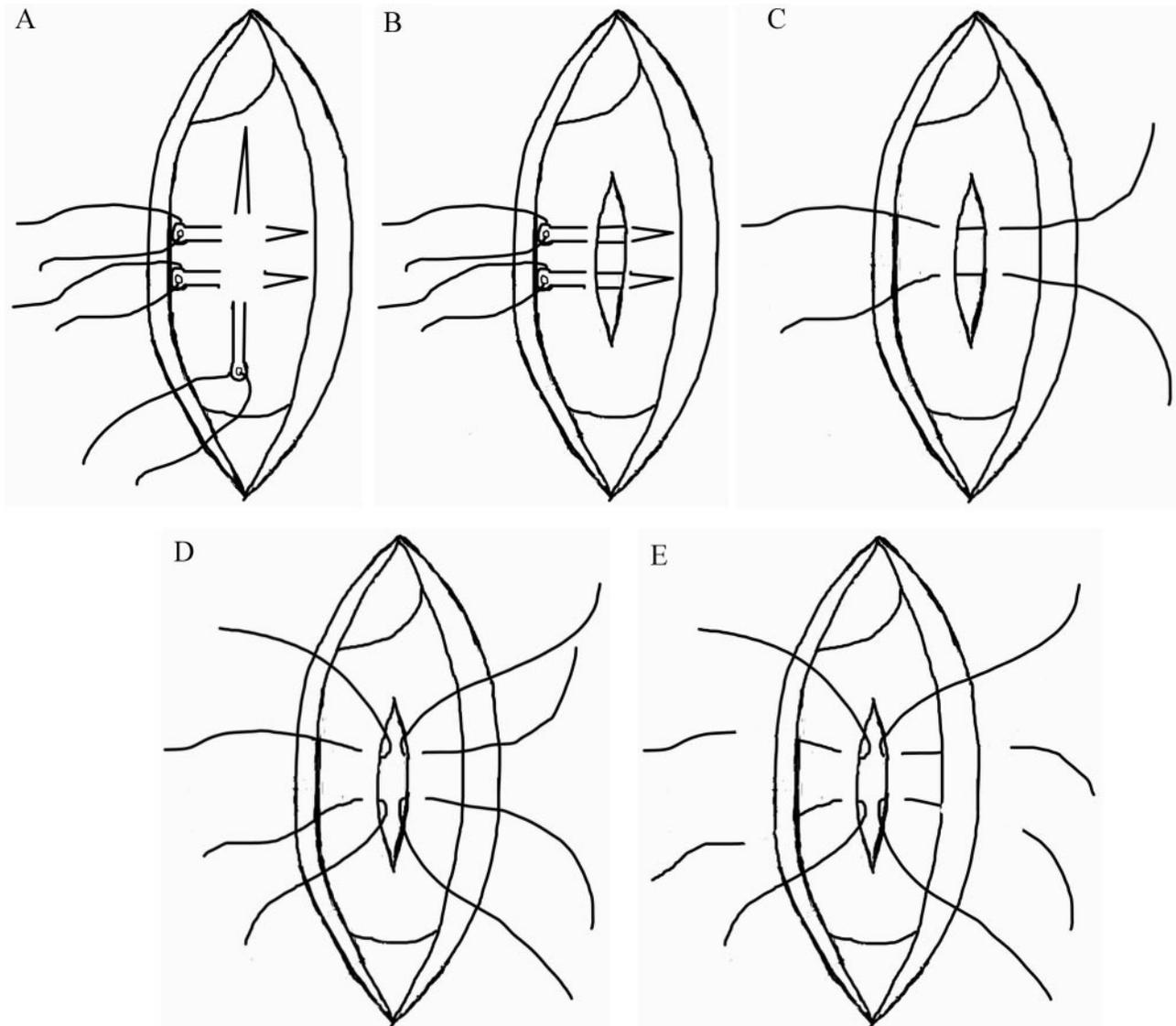


Figure 1. Maury gastrostomy. A. A needle carrying silver suture was inserted longitudinally into the stomach wall. Two more needles with silver suture were placed perpendicular to the first needle. B. The first needle and suture were removed and the second and third needles were pulled through the stomach leaving the sutures in place. C. The stomach was opened longitudinally between the entry and exit points of the second and third needles. D. The sutures were divided and the short ends were brought out through the gastrostomy. E. The stomach wall was sewn to the abdominal incision.

instead of 1. Most surgeons pex the stomach to the abdominal wall with 3 or 4 sutures instead of 6 and just sew them to the peritoneum instead of bringing them full thickness through the abdominal wall. The tube used commonly today has a balloon for an inner bolster to help hold the stomach against the abdominal wall and an external bolster to prevent the tube from migrating into the peritoneum.

Dragstedt Gastrostomy

Many other modifications of the Stamm gastrostomy have been described since then. In 1933, L. R. Dragstedt, from the University of Chicago, the originator of vagotomy and pyloroplasty, described his

technique of gastrostomy that he performed on 6 patients with esophageal cancer.¹² He used a spindle-shaped brass tube plated with gold, which was inserted into the stomach. Similar to Staton's tube, the spool ends acted as internal and external bolsters to prevent migration of the tube. The stomach was closed with a running suture and 2 pursestring sutures. Dragstedt's main modification was to wrap greater omentum around the shaft of the tube (between the stomach and the peritoneum) in order to prevent leakage of gastric contents and subsequent peritonitis. A sharply pointed cap was screwed onto the other end of the spindle to pierce the abdominal wall 2–3 inches from the abdominal

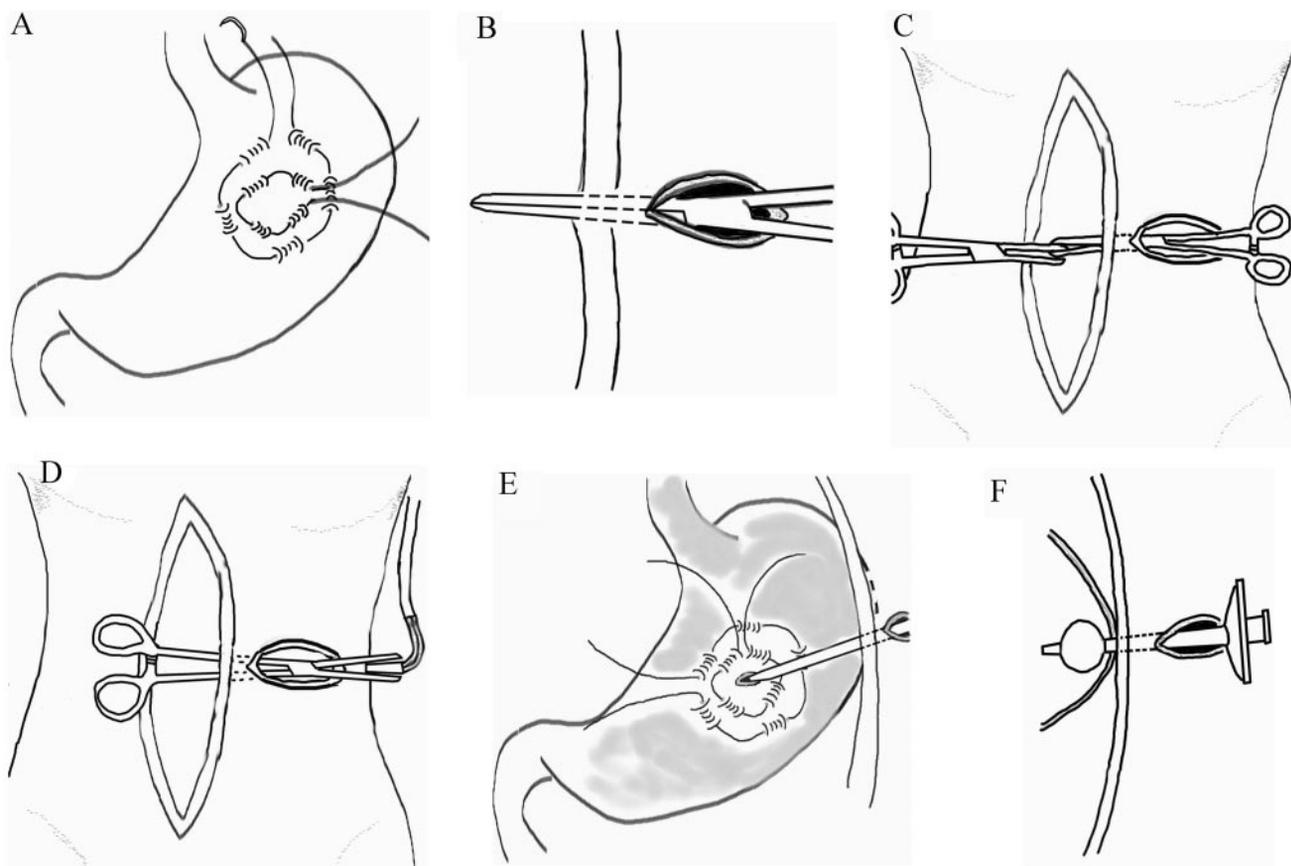


Figure 2. Stamm gastrostomy. A. Two purse string sutures are placed in the anterior gastric wall. B. A large clamp is placed through the abdominal wall (from outside to inside). C. The first clamp is grasped with a second clamp and the latter is dragged back through the abdominal wall. D. The gastrostomy tube is grasped with the second clamp and the tube is brought through the abdominal wall. E. The gastrostomy tube is inserted through a stab wound in the middle of the purse strings, and the purse strings are tied. F. The stomach is brought up to the abdominal wall and sutures are used for pexis.

incision in order to get the tube outside the abdominal cavity. The spike was then replaced with a blunt cap or rubber tube, depending on whether the tube was in use or not.

Janeway Gastrostomy

In 1913, Henry H. Janeway, of Bellevue Hospital in New York City, proposed another way of performing a gastrostomy, which is not used frequently today but certainly has its indications.¹³ It is permanent because a tube is created from the anterior wall of the stomach, which is brought out to the skin as a stoma (Figure 3). The advantage (other than its permanence) is that a small-bore tube can be inserted to instill food or medication and it is withdrawn afterwards. In his paper, Janeway described constructing a 4- to 5-cm gastric tube, in the mid-body of the stomach with “an oblique direction to the left.” In his description, the tube was brought out as a stoma through the incision. Today, a separate stab wound is usually made. Although he described a

particular orientation of the gastric tube, authors have described creating the tube in other directions (Figures 4–6).¹

Percutaneous Endoscopic Gastrostomy

The most important modern advance in the technique of inserting gastrostomies was actually not surgical, although a pediatric surgeon, M. W. L. Gauderer, was involved, along with gastroenterologist J. L. Ponsky.¹ Together, they developed the technique of percutaneous endoscopic gastrostomy (PEG) insertion, which was first performed in 1979 on a 6-month-old child at the University Hospitals of Cleveland (Case Western Reserve University). This technique can be applied in the operating room, the endoscopy suite, or at the bedside. Some of its advantages are that it is cost-effective because it does not have to involve operating room or anesthesia costs, and it does not require an abdominal incision, with its attendant complications. The technique has been modified by radiologists into a per-



Figure 3. Janeway gastrostomy. A tube of anterior stomach wall is created from a raised flap and brought out as a stoma to the skin.

cutaneous radiologic gastrostomy (PRG), which is performed somewhat similarly except that fluoroscopy or ultrasound is used.

Witzel Gastrostomy

To surgeons today, Witzel is synonymous with jejunostomy; however, the original description in 1891 was actually that of a gastrostomy.¹⁴ Witzel was a professor of surgery at the University of Bonn in Germany who described a new technique of gastrostomy tube insertion. He made a 3-inch-long left subcostal incision and brought out a large section of the anterior stomach wall through the wound. He inserted a pencil-sized tube into a hole in the stom-



Figure 5. Depage gastrostomy.

ach and sewed the tube to the stomach with catgut. He enveloped the tube with 2 parallel folds of the stomach and sewed the free margins of the folds together with 3 or 4 Lembert sutures and several "ordinary" sutures. He made the tunnel approximately 1 inch long. He then attached the stomach to the abdominal incision. Johnston et al,¹⁵ from the Washington University School of Medicine, subsequently modified this; the technique was presented at the Southern Surgical Association in 1981. In his modification, the gastropexy (attachment of the stomach to the abdominal wall) was eliminated. It is interesting that the discussants of the Johnston et al¹⁵ paper all recommended this modified procedure and stated that it should replace the Stamm gastrostomy, which has not occurred.

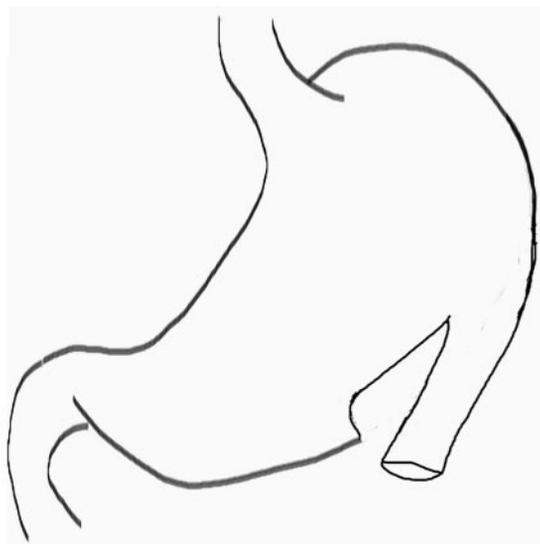


Figure 4. Beck Jianu gastrostomy.

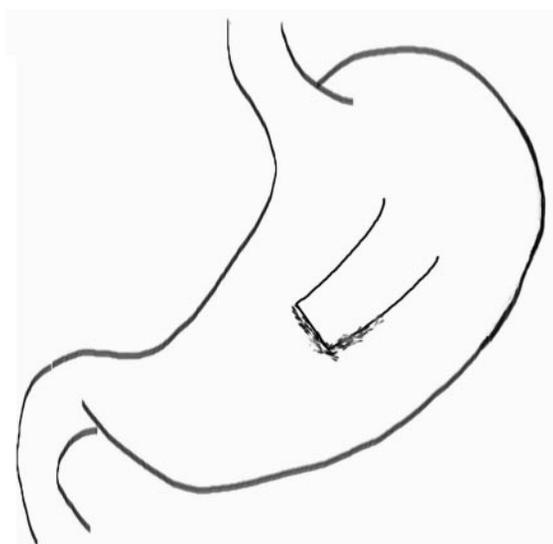


Figure 6. Hirsch gastrostomy.

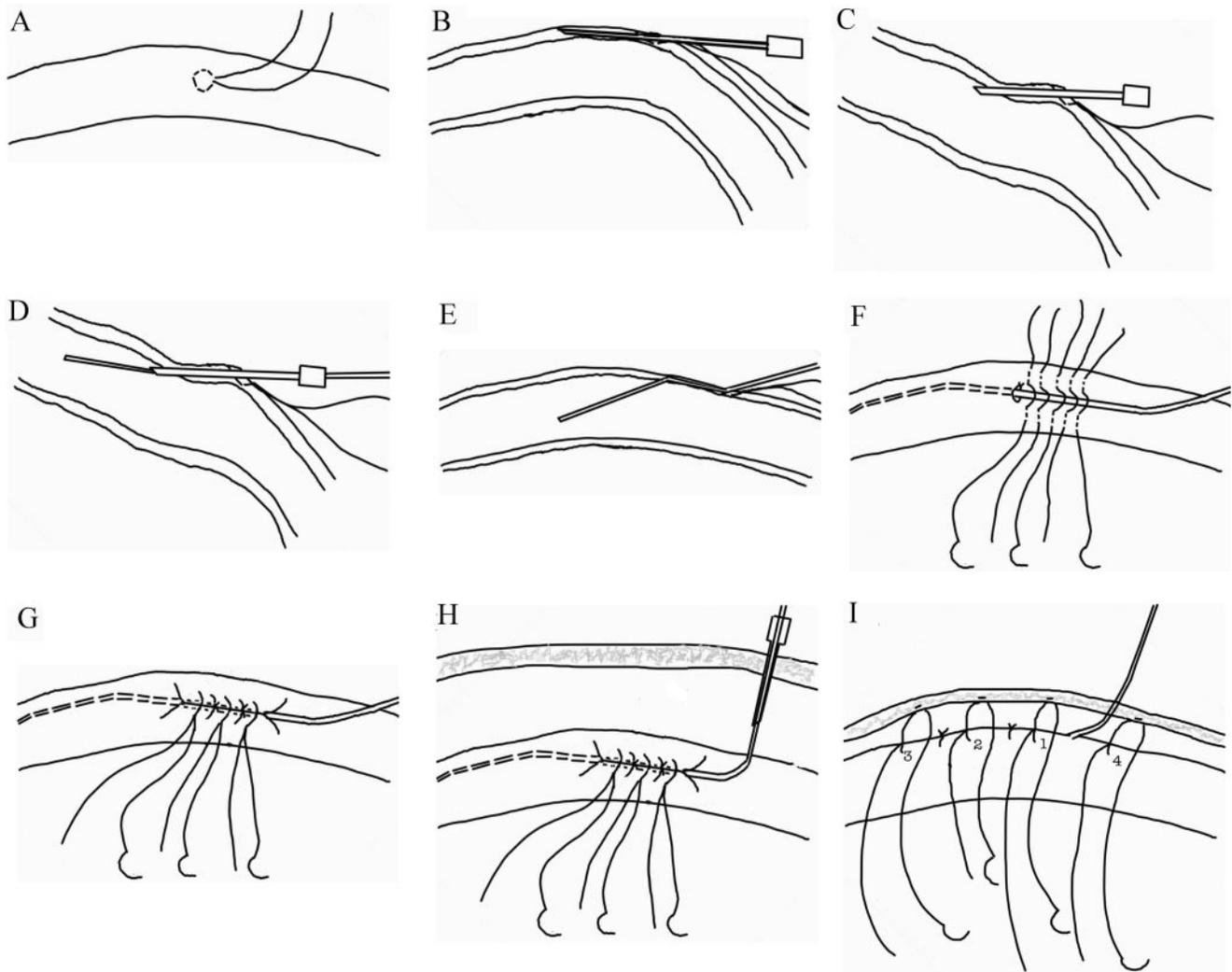


Figure 7. Needle catheter jejunostomy. A. A seromuscular purse string is placed on the anti-mesenteric side of a proximal loop of a small bowel. B. A large-bore needle is placed through the middle of the purse-string suture and tunneled in the seromuscular layer of the intestinal wall. C. After several cm, the bowel lumen is entered with the large-bore needle. D. The needle catheter is threaded through the large-bore needle into the bowel lumen. E. The large-bore needle is removed, leaving the catheter tunneled through the bowel wall and entering the intestinal lumen. F. A Witzel tunnel is created around the needle catheter, saving the first, third, and fifth sutures for pexis of the intestine to the abdominal wall. G. The sutures are tied, completing the tunnel. H. A second large-bore needle is inserted through the abdominal wall in order to pass the needle catheter outside the abdominal cavity. I. The remaining needles/sutures are used for pexis of the loop of jejunum to the abdominal wall, in the order shown. A fourth suture is placed proximally to take tension off the catheter. The outside assembly is attached and is sewn in place.

Jejunostomies

Although the most common insertion technique for jejunostomy tubes is called a Witzel jejunostomy, Surmay performed the first jejunostomy in 1878.¹⁶ A few years later in 1885, C. H. Golding-Bird¹⁷ described a jejunostomy performed in Guy's Hospital in London on a 46-year-old man with 10-month history of pyloric obstruction. He grasped the jejunum 2 inches from duodenum and sewed it to the lower end of the incision. The patient was fed by rectum and mouth until the third day, when the jejunum was opened. He noted:

“As long as the meal amounted to a pint. . . the patient. . . had a severe attack of indigestion, but that this ceased when the meal did not exceed ten ounces. . . Everything went on perfectly well till the ninth day, the patient putting on flesh; but on that day, through an error in feeding him, some food passed into the peritoneum and he died in twelve hours.”¹⁷ Apparently, medical errors were killing patients back then also.

Lee and Gould¹⁸ of the London Temperance Hospital also described a jejunostomy in 1885 in a 46-year-old man with pyloric obstruction from cancer. They used a midline incision and brought the

jejunum into the wound. The jejunum was sewn to the wound with a double row of silk sutures. Post-operatively, the patient was given enemas every 4 hours:

"He was ordered an enema of four ounces of strong beef-tea and egg digested with a drachm [1/8 of an ounce] of Benger's liquor pancreaticus every four hours. . . ." ¹⁸

The patient vomited for the next 3 days. The bowel was opened on day 2, and 1 ounce of cream and 1 ounce of peptonized beef-tea was injected. The patient received more suppositories and injections of morphine and ether and then died 36 hours later.

Many modifications of this type of jejunostomy have been made; today, the jejunum is not sewn to the abdominal incision, but a tube is placed through a hole in the jejunum, which is brought out through the abdominal wall. In 1892, Maydl¹⁹ described a Roux-en-Y jejunostomy. This is a permanent tube, similarly to the Janeway gastrostomy. The feeding tube can be inserted for administration of nutrition or medications and then removed when complete. Eiselberg²⁰ modified the Witzel gastrostomy and applied it to the jejunum. Unfortunately for Eiselberg, this procedure has henceforth been called a Witzel jejunostomy.

Needle Catheter Jejunostomy

Another modification of the jejunostomy is the needle catheter jejunostomy, described in 1973 by Delany et al²¹ from Montefiore Hospital and the Albert Einstein College of Medicine. They described the use of this tube in 42 patients who had undergone upper gastrointestinal tract surgery. A purse-string suture is placed in the jejunal wall (Figure 7A). A large-bore needle is inserted through this pursestring and advanced through the seromuscular layer of the bowel for approximately 2 1/2 inches (Figure 7B and C). A small-bore catheter is inserted through this needle and the needle removed, creating a sort of seromuscular "Witzel" tunnel (Figure 7D and E). Some surgeons currently add a true Witzel tunnel in addition to the seromuscular tunnel (Figure 7F and G). The catheter is brought out through the abdominal wall with another large-bore needle (Figure 7H). The original authors did not fix the jejunum to the anterior abdominal wall, as opposed to how it is usually performed today. In addition, many surgeons pex the entire loop of jejunum to the abdominal wall with multiple sutures so as to prevent a small-bowel volvulus around the anchoring stitch (Figure 7I). Interestingly, Delany et al²¹ described using the needle catheter jejunostomy for IV fluids in addition to tube feedings.

Transgastric Jejunostomy

A tube that combined a gastrostomy tube with a small-bowel feeding tube was introduced by Moss²²

from the Rensselaer Polytechnic Institute of New York in 1984. The use of this tube allowed the stomach to be decompressed, whereas feedings could be administered into the small bowel, eliminating the need for 2 tubes. Other manufacturers have made several modifications, but the overall technique includes placing a Stamm gastrostomy tube for decompression. The tube has a distal extension that is manipulated into the duodenum or even the jejunum for feeding. This is usually placed surgically but also has been used by radiologists.

Laparoscopic Feeding Tubes

The latest development in the surgical insertion of feeding tubes has been the availability of laparoscopic techniques. Gastrostomy tube insertion was described before jejunostomy tube insertion. Some of the first reports of laparoscopic gastrostomies were published in 1991 by Shallman from Our Lady of Lourdes Health Center, Pasco, Washington;²³ Edelman and Unger²⁴ and Edelman et al²⁵ from Miami, Florida; and Reiner et al²⁶ from Cornell University. Their procedures involve grasping the stomach and fixing it so as to insert a tube using a modification of the Seldinger technique. Murphy et al²⁷ from the University of South Florida in Tampa actually pexed the stomach to the anterior abdominal wall and then pierced the stomach with a cutting trocar placed through the 10-mm port. In 1992, Morris et al²⁸ from the University of Pennsylvania described a laparoscopic jejunostomy, which is essentially an extracorporeal Stamm jejunostomy. Duh and Way²⁹ from the University of California, San Francisco added t-fasteners (similar to those used by radiologists placing PRG tubes). Many other authors have modified the laparoscopic jejunostomy insertion in minor ways, such as using peel-away sheathed catheters³⁰ or Seldinger technique.³¹ There is no significant advantage to inserting feeding tubes laparoscopically as a stand-alone operation, but these techniques can be invaluable additions to other laparoscopic procedures, ranging from diagnostic laparoscopy to gastric and colon resection.

Conclusion

In summary, the modern era of surgical feeding tubes began in the mid to late 1800s and progressed fairly rapidly. The Stamm gastrostomy, which has been only slightly altered, was described in 1894. Witzel¹⁴ described his gastrostomy insertion technique in 1891, and it was modified to apply to jejunostomy tubes in 1895. These 2 procedures are probably the most common open surgical techniques of feeding tube insertion in use today. Although minor modifications of these procedures have been described, including the use of laparoscopy, these basic approaches have withstood the test of time and have not changed substantially in over 100 years.

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