

Detailed Article Summaries

*Aziz et al 2004*¹¹

Objective(s): To describe the authors' technique for image-guided percutaneous gastrostomy in neonates with esophageal atresia.

Methods: A retrospective single center study of 14 neonates (11 with esophageal atresia and a tracheoesophageal fistula (TEF) and 3 with esophageal atresia alone). The decision to use the image guided technique rather than a surgical technique was based upon the availability of an interventional radiologist and surgeon preference. The authors developed a new transhepatic approach for insufflating the stomach in infants with esophageal atresia alone. In the 11 patients with TEF, the stomach and bowels already contained air. Once the stomach was distended, a single retention suture (pediatric Cope gastrointestinal suture anchor, Cook, Bloomington, IN) was inserted. The guidewire was deployed through the retention suture needle prior to needle removal. The tract was dilated and the catheter inserted. The authors do not discuss method of dilation or the type of catheter though the pictures in the article show a Cope loop type catheter.

Results: Mean age at time of procedure was 5 days (range 1-27 days) and mean weight was 2.35 kg (range 0.80 – 3.89 kg). Nine procedures were done under general anesthesia and 5 with sedation and local anesthesia. Mean length of the procedure was 41.1 minutes (range 15 – 80 minutes). There were no intraoperative complications. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude their data shows the feasibility of their image guided percutaneous gastrostomy technique in neonates with esophageal atresia. They believe that despite the challenges to the interventional radiologist from a gasless stomach, the image guided procedure is superior to the open surgical technique. There was no discernible damage to the liver or other morbidity from the transhepatic approach possibly due to the small caliber spinal needle used for the procedure.

*Barkmeier et al 1998*¹³

Objective(s): Compare the results and costs of three different direct percutaneous gastrostomy procedures (fluoroscopically guided, endoscopic and surgical endoscopic).

Method: A retrospective, cohort study in a single hospital. Three groups of patients received the following procedures: fluoroscopically guided percutaneous gastrostomy/gastrojejunostomy (PFG, n = 42); percutaneous endoscopic gastrostomy/gastrojejunostomy (PEG, n = 45); and surgical endoscopic gastrostomy/gastrojejunostomy (SEG, n = 34). Actual placement methods and types of devices are not discussed. Demographics of the groups are similar and the minor dissimilarities are fully discussed in the reference.

Results: Success in achieving gastric access was 100% for PFG and SEG and 84% for PEG. Success for gastrojejunostomy was 91% (10/11) for PFG, 43% (3/7) for PEG and 0% (0/7) for SEG. All patients in whom PEG failed subsequently had successful PFG. There were no reported differences between groups for procedural or post-procedural complications. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: This study finds PEG followed by PFG followed by SEG for cost effectiveness (\$1870, 2041, 3075). This study supports PFG as the method of choice but clearly states that cost and other health related issues often determine method of choice for gastrostomy tube placement.

*Bazarah et al 2002*¹²

Objective(s): To report authors' experience with nonsurgical gastrostomy techniques, both endoscopic and fluoroscopic, including evaluation of indications, effectiveness, safety and problems for both techniques.

Method: A retrospective, cohort study in a single hospital comparing the results of PEG (n = 19) to PFG (n = 33). The demographics of the groups are similar though the age range for PFG includes at least one pediatric patient (2.5 years).

Results: Success in achieving gastric access was 100% for PFG and 89% for PEG. Transgastric jejunostomy was done in 18.2% (6/33) of PFG patients and 10.5% (2/19) PEG patients. Post-procedure pain management was needed less frequently in the PFG group compared to the PEG group (9% vs. 26%). Rates of minor complications were not statistically different between the two groups. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: This study finds PFG to be more cost effective than PEG (1141 vs. 1300 Saudi Riyal) and states that both methods are safe and effective.

Bell et al 1995

Objective(s): To assess the efficacy and safety of radiologically guided percutaneous placement of gastrostomy and gastrojejunostomy catheters.

Method: A retrospective study in one center of 519 percutaneous gastrostomy procedures in 478 patients. Gastroscopy was not performed before gastrostomy. Tubes were from 10.3 Fr to 14 Fr Cope loops depending

upon application (gastrojejunostomy – 482 procedures or gastrostomy – 12 procedures). Serial dilation was not done.

Results: Thirty-day follow up data was available for 457/519 (88%) procedures (median and mean follow-up periods of 15 and 32 weeks, respectively, range 4 – 308 weeks). The remaining patients were followed to release from the hospital and all were well with functioning gastrojejunostomies. The success rate for gastrojejunostomy was 482/507 (95.1%) with 14 (2.8%) catheters that could not be advanced past the pylorus and 11 (2.2%) were technical failures. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: Authors conclude that PFG is safe and effective. They are strong advocates of gastrojejunal placement of the tube contributing to the absence of clinically significant aspiration in their study. They conclude that tract disruption rates could possibly be reduced by gastropexy but that it would add time to the procedure and be of no benefit to about 94% of patients. They believe percutaneous placement of gastrojejunostomy catheters is the preferred method for long term enteral nutrition.

Boswell et al 1996

Objective(s): Evaluate the safety and efficacy of PEG with the “push” technique and T-bar fixation.

Method: A retrospective study in one center of all PEGs performed in pediatric patients (15 patients, mean age, 9 yr; range 3 mo – 17 yr) over a 31 month period. The gastrostomy procedure was done endoscopically using 4 T-fasteners (Brown/Mueller, Ross) to fix the stomach to the abdominal wall. Either 14 or 18 Fr balloon-retained G-tubes were placed with a modified Seldinger technique using the push technique following serial dilation of the tract.

Results: The use of T-fasteners prevented the stomach from falling or being pushed away during the procedure and allowed controlled tract dilation and tube placement. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors found the PEG push technique with T-fasteners to be safe and effective.

Brown AS, Mueller PR, Ferrucci JT 1986

Objective(s): To describe the use of a newly designed T-fastener to fasten the anterior gastric wall to the abdominal wall during percutaneous gastrostomy. This is the initial description of the use of T-fasteners.

Method: A prospective study of a newly designed nylon T-fastener (Brown-Mueller gastrostomy kit, Meditech Corp, Watertown, MA) in fluoroscopically guided percutaneous gastrostomy in 10 patients. Placement of 12 Fr to 16Fr Foley catheters was done with gastropexy using 4 T-fasteners by Seldinger technique and a serial dilation of the tract. In 4 cases, the catheter was inserted through a peel-away sheath. At 3-weeks the nylon fasteners are cut at the skin to release the T ends which pass into the gastric lumen for eventual harmless passage in the stool.

Results: The success rate for the insertion of the gastrostomy catheter was 100% (10/10). Feeding was started at 12 hours on all patients. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that the use of the T-fasteners allows for a more controlled insertion of the gastrostomy catheter thereby reducing complications such a looping of the guide wires or catheters within the peritoneum and leaking of gastric contents leading to peritonitis. The use of T-fasteners also allows for insertion of larger bore catheters during and more rapid maturation of the stoma.

Chait et al 1996

Objective(s): To evaluate the use of retrograde percutaneous placement of G or GJ tubes in a large pediatric population.

Methods: A retrospective chart review in a single center of the 511 patients in whom primary insertion of a G or GJ tube was attempted over a 4 ½ year time period. The charts of 453 patients (mean age, 3.8 years; range 26 weeks gestation to 18.6 years) were reviewed for complications both early (<30 days post procedure) and late (>30 days post procedure). Late follow-up (>30 days) was available for 395 patients (77.2%). Children were solid food fasted for 6 hours before the procedure and liquid fasted for 2 hours before. Children were given various courses of analgesics and anesthesia on a case dependent basis. Cefazolin sodium was given immediately before the procedure to reduce the risk of infection from gastric leakage and tract infection. A fluoroscope was used to monitor the procedure and ultrasound to identify the liver, spleen and adjacent organs. The stomach was insufflated with air and one retention suture was inserted into the stomach to pull the stomach against the abdominal wall. The Seldinger technique was used to puncture the stomach and dilation was done with a single dilator of similar size to that of the gastrostomy tube to be placed. A Cope loop gastrostomy catheter (Cook) was introduced over the guidewire. The loop was pulled up against the anterior abdominal wall. Catheters ranged in size from 8.5 to 12-Fr depending on the patient's weight. If a GJ tube was needed, a 5-Fr dilator was inserted after the Seldinger puncture. A 5-Fr JB-1 catheter (Medi-tech/Boston Scientific, Watertown MA) or a 8-, 10- or 12-FR GJ tube (Chait; Cook) was then inserted with continuous gentle traction on the retention suture. A peel-away sheath was not used for either procedure. Feedings were not initiated until at least 12 hours post-procedure. Patients were generally in the hospital for 2-3 days. Follow-up was done at 6-weeks.

Many catheters were replaced with a balloon-retention device (MIC*, Medical Innovation Corp, Draper, Utah). If a 12-Fr MIC* catheter is used, additional dilation may be required and this is usually done on an outpatient basis. Some patients chose to change to a LPFD such as the MIC-KEY* (Medical Innovations) or a mushroom device (Bard, Tewksbury, MA).

Results: Technical success rate for the procedure was 99% (505/511). The failures were the result of colonic interposition in two patients, hepatosplenomegaly in two patients and microgastria in two patients. In the 395 patients for whom long-term follow-up was available, the average time of follow-up was 423 days. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that percutaneous, fluoroscopically-guided, retrograde insertion of G and GJ tubes is a safe and effective means of providing enteral nutrition a pediatric population, particularly when there is neurological or oropharyngeal impairment. While the management of gastrostomy tubes is a challenge, a multidisciplinary approach that includes physicians, GI nutritional experts, home feeding nurses, dieticians and interventional radiologists helps to ensure successful management in the pediatric population.

Chan SC et al 2004

Objective(s): To report on the authors experience using a modified gastropexy technique during FPG with the insertion of a large-bore balloon-retained catheter in patients with head and neck tumors.

Method: A prospective study in a single center on 38 consecutive patients (34 men, 4 women, mean age 53.4 years, range 32 – 83 years). All patients had tumors of the head and neck region. FPG was done using gastropexy with two T-fasteners (Cope type from Cook, Bloomington, Ind.). A Seldinger insertion was done between the two fasteners. Dilation of the tract was done with a 19-Fr peel-away introducer sheath (Cook, Bloomington, Ind.). After dilation, a 14-Fr balloon-retained gastrostomy catheter (Balloon Replacement Tube, PEG-BRT, Cook, Bloomington, Ind.) was inserted and the peel-away sheath removed. The T-fasteners were cut 14 days after insertion. Feeding started 24 hours after insertion of the catheter. Patients were followed at days 14, 30 and 60.

Results: The FPG placement of the gastrostomy catheter was successful in 100% (34/34) patients. No complications were attributed directly to the gastropexy. No major complications were seen up to the 60-day follow-up visit. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: Authors conclude that modifications to the percutaneous gastropexy technique allow the placement of a large-bore balloon-retained catheter in patients with head and neck tumors for whom adequate nutrition is a serious health risk. T-fasteners can prevent intraperitoneal leakage of gastric contents and related peritonitis. The stoma formed by gastropexy also facilitates easier catheter replacement if needed. The authors also conclude that the 2 T-fastener gastropexy procedure shortens procedure time, reduces expense and no patients showed any adverse events related to the modified gastropexy procedure

Chan SC et al 2005

Objective(s): To describe the use of CT-guidance during percutaneous gastrostomy using T-fastener gastropexy in a patient with partial gastrectomy.

Method: A case report on a 59-year old woman who had received a total pharyngolaryngectomy for hypopharyngeal cancer and partial gastrectomy with Billroth II anastomosis for a bleeding ulcer. Percutaneous gastrostomy under CT-fluoroscopic guidance was planned due to difficult positioning of gastric remnants. Gastropexy was performed using 2 T-fasteners (Medi-tech/Boston Scientific, Watertown, MA). A Seldinger technique was used for placement of a 12-Fr pigtail gastrostomy catheter (Meditech/Boston Scientific, Watertown, MA) following serial dilation of the tract.

Results: The gastrostomy catheter was successfully placed with no complications, major or minor. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: This is the first report of CT-fluoroscopic guidance for percutaneous gastrostomy with a large-bore catheter in a single session. Authors conclude this is a clinically feasible procedure in specialized circumstances where gastric anatomy may be distorted by previous surgeries.

Chishty et al 2006

Objective(s): To study the safety and efficacy of percutaneous gastrostomy with gastropexy in patients with oropharyngeal and esophageal cancers.

Method: A prospective study in one center of 105 patients (75 men, 30 women; age range 23-82 years) all with cancer of the oral cavity, pharynx and esophagus. Five patients were ultimately excluded due to overlying viscera and/or high stomach position, therefore the number of procedures was 100. PRG was performed with a single T-fastener for gastropexy. Serial dilation of the tract was done (12-14F) prior to the placement of a 12-14F pigtail catheter.

Results: The success rate for the procedure was 100%. No major complications were noted during the 30 day follow-up. See Tables 2, 3 and 4 for mortality and complication rates. Feeding was started at 24 hours post procedure in all patients.

Conclusions: Authors conclude that PRG is a safe, effective, quick, and easy procedure that is very useful in patients with head and neck tumors where endoscopic procedures cannot be done. The gastropexy reduces the risk for intraperitoneal spillage and facilitates the placement of a larger size catheter which contributes to less blockage of the catheter once feeding starts.

Coleman et al 1990

Objective(s): To study the use of a modified version of the original Cope suture anchor for gastropexy during percutaneous enterostomy procedures.

Method: A prospective study in three (3) centers of 82 patients (70 men, 12 women, age range 23 – 97 years). A single modified Cope suture anchor was used for the procedure. After placement of the anchor, the tract was dilated over the guidewire and a G, GJ or J tube was inserted (Cope loop, Foley catheter, Carey-Alzate-Coons gastrojejunostomy; Cook). Depending upon the institution, the anchor was either (i) left in place for 2 – 3 weeks and cut or (ii) cut off at skin level immediately after tube placement.

Results: Of the 82 attempts at gastrostomy tube placement, 81 (99%) were successful. In two procedures, the anchors were misplaced and one jejunostomy failed. Both misplacements were early in study and were due to operator error. Procedure was altered to include injection of contrast media through the needle to confirm intraluminal position. Patients recovered after the misplacements. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: Authors conclude the use of an anchor device (gastropexy) makes the percutaneous procedure significantly easier and faster. The authors also state that though others report low complication rates, they believe the use of an anchor will minimize the risk of peritonitis.

Cope et al 1998

Objective(s): To present 10 years of the author's experience with PFJ.

Method: A retrospective study in two centers involving 62 patients (38 men, 24 women, mean age 57 years, range 26-89 years) who underwent PFJ. The procedures were being done for various reasons so the patients to be grouped into 4 subgroups, only two of which were involved in enteral feeding (n=41). The other two groups were for percutaneous catheterization of Roux-en-Y anastomosis for biliary access, drainage or dilation of stricture or for management of anastomotic leakage. Access to the jejunum is difficult as the bowel loops are mobile and slippery and a needle will often slide off the bowel wall. Various techniques were used to stabilize the bowel prior to puncture and multiple attempts were often required for a successful puncture. A single-suture gastric anchor attached the bowel loop to the abdominal wall. Serial dilation of the tract was followed by insertion of a 10 – 14Fr locking loop catheter, commonly a nephrostomy catheter or Wills-Oglesby gastrostomy catheter. The anchor suture was cut 2-4 days post procedure. In patients who were undergoing catheterization through a previous surgical feeding jejunostomy scar site (n=21), an anchor was used only if the operator found the bowel to be mobile.

Results: The success rate was 88% (36/41). See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that PFJ compares favorably to surgery and endoscopy and that bowel distention and jejunopexy are important to success of the procedure. In their opinion, only a single anchor is needed for the jejunopexy which allows for reliable tract dilation and two or three additional anchors do appear to reduce leakage of bowel obstruction due to kinking.

Cosentini et al 1998

Objective(s): To evaluate and compare outcomes of gastrostomy by three procedures – surgical, PEG and PRG.

Methods: A retrospective single center study of 82 patients (51 men, 31 women) – 14 surgical, 24 PEG and 44 PRG. The demographics and indications were similar for the various groups though there were 2 newborns in the surgical group. Prophylactic antibiotics were given to the surgical and PEG groups. The surgical procedure was done by Stamm or Weitzel methods for the placement of 14- or 24-Fr Foley catheters. The PEG procedure involved a 22-Fr PEG tube that was pulled through the abdominal wall. PRG was done with fluoroscopic guidance, serial dilation and then the placement of a 16-Fr gastrojejunostomy tube (Friction Lock Malecot, Cook). Feeding was started after 24 hours in the PEG and PRG groups and after the first post-surgical bowel movement in the surgical group.

Results: The technical success rate was 100% (82/82) across all types of procedures. See Tables 2, 3 and 4 for mortality and complication rates. There was no statistical difference among the various groups for major and minor complication rates before and after 14 days of occurrence.

Conclusions: The authors conclude that while surgical gastrostomy tube placement has diminished primarily due to (i) higher morbidity and mortality; (ii) higher cost; and (iii) risks associated with general anesthesia, it is still the method of choice when other surgical procedures are being performed for any reason. It should also be the method of choice when apposition of the stomach to the abdominal wall is in question. Surgical procedures may also be required if percutaneous and endoscopic methods fail.

Cozzi et al 2000

Objective(s): To discuss the indications for and results achieved with gastrostomy in oncology patients.

Methods: A prospective single center study of 51 procedures (41 gastrostomies, 6 gastrojejunostomies, and 4 jejunostomies) in 50 patients (30 men, 20 women; mean age- 61 years; range 37-87 years). One patient has a decompression gastrostomy and a feeding gastroduodenostomy. The wall of the stomach or jejunum was anchored to the abdominal wall but the method for anchoring is not discussed. Various tube types were used including 13 Abbott tubes (Abbott Laboratories, North Chicago, IL), 18- or 22-Fr; 29 vanSonnenberg tubes (Meditech, Boston Scientific Corporation, Watertown, MN), 14-Fr; and 6 Severini tubes (Mayo International, Milan, Italy), 12-Fr; and then various tubes ranging from 10-Fr to 22-Fr were used in the other patients. Gastrostomy buttons used were from Bard (C.R. Bard, Covington, GA).

Results: Gastrostomy was 100% (47/47) successful when it was performed even in patients with esophageal strictures. Placement of the tube directly into the jejunal loop was successful 75% (3/4) of the time it was performed. The one failure was due to the mobility of the jejunal loop and difficulty keeping it distended. Follow-up was possible in 84% (42/50) of patients. Thirty-five patients had a permanent gastrostomy tube, seven of whom were lost to follow-up. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The 100% success rate for percutaneous gastrostomy was noteworthy as 5 patients had undergone gastric resection and had a considerably reduced stomach volume (target volume). Authors note that fixation of the stomach to the abdominal wall allows the placement of larger bore tubes initially and reduces leakage of stomach contents into abdominal cavity. The authors acknowledge that jejunostomy is more complex than gastrostomy due to the mobility of the jejunal loop, the small volume of the loop and the difficulty maintaining distention with air during the puncture. The authors propose that percutaneous gastrostomy for feeding or decompression warrants wider and earlier use at the onset of symptoms. It provides good quality of life, is cost effective and requires only a short hospital stay.

Cwikiel W, Walther B 1996

Objective(s): To develop a simple radiological method for percutaneous gastrostomy.

Methods: A prospective, single center study involving 15 patients (9 men, 6 women; mean age 51.6 years; range 31-73 years) who underwent percutaneous placement of 5.3mm Foley catheter for enteral feeding. The air insufflated stomach was punctured and a 6-mm peel-away sheath with introducer (Cook Urological) replaced the puncture needle. The catheter was inserted through the sheath and the balloon inflated and pulled back to bring the stomach into close proximity with the peritoneum. A catheter fixation device was used to attach the catheter to the abdominal wall. Nutrition or drainage was allowed immediately.

Results: Technical success rate for catheter placement was 100% (15/15). All gastrostomies were functional at the 3-month follow-up. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that (i) the Foley catheter is the most suitable for long-term enteral feeding as it is well known, easy to replace, and aids in fixation of the stomach to the abdominal wall; (ii) the use of a peel-away sheath makes gastropexy unnecessary; (iii) the use of a peel-away sheath helps to prevent leakage of stomach contents during dilation; and (iv) their method is safe and cost-effective.

Davies RP, Kew J, West GP 2000

Objective(s): To describe the use of CT fluoroscopy only as the method for guiding a percutaneous jejunostomy in a patient.

Method: A single case report of a 66-year old man with a perforated esophageal carcinoma who underwent CT-fluoroscopy guided jejunostomy. Two Cope anchors (Cook) were placed and the tract was dilated with single advancement of a 14-Fr peel-away (Malecot Russell Gastrostomy set) over the guidewire. The Malecot Russell gastrostomy set was inserted through the sheath and the position checked with CT. The sheath was removed, the Malecot loops reformed in the jejunum and the loop position rechecked with CT.

Results: Tube was successfully placed with only CT guidance. Feeding started after overnight observation. At 30 day follow-up, there were no complications. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: Authors conclude CT-fluoroscopy facilitates puncture of the mobile, unopacified small bowel and ensures that non-targeted structures are not punctured. They also conclude that jejunopexy reduces jejunal mobility which can lead to difficulty in making an accurate puncture of the bowel.

deBaere et al 1999

Objective(s): To evaluate 1) feasibility, 2) complications, 3) adequacy of feeding support and 4) tolerability of fluoroscopically guided gastrostomy in cancer patients.

Method: A single center retrospective study of 508 gastrostomies in 500 consecutive patients (471 men, 29 women, mean age 57 years, range 28-82 years) who were referred to the center for PFG. The procedure was unsuccessful in 4 patients and 12 patients required a second procedure thus 508 procedures in 496 patients. Two or three T-fasteners (Brown-Mueller, Medi-tech/Boston Scientific, Watertown, MA) were used to establish

gastropexy. Serial dilation was done prior to placing a 16-18Fr Malecot nephrostomy catheter (Medi-tech) through a Peel Away sheath (Cook Europe).

Results: Technical success rate was 99% (508/512). In the four unsuccessful procedures, the stomach was insufflated but in 2 patients the stomach was covered by the liver/colon, in 1 patient the stomach remnant was too small after a partial gastrectomy and 1 patient refused the procedure after local anesthesia. Within 48 hours, feeding was started. T-fasteners sutures were removed at 3-weeks post insertion. Follow-up continued until death or removal of the tube (mean 7.2 months, range 1-56 months). See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that PFG was clearly superior in this application with cancer patients to PEG. They discuss the need for gastropexy acknowledging the disagreement in the literature over the need for gastropexy. The disagreement centers around the tension T-fasteners place on the gastric wall and the fact that it can cause ischemia leading to necrosis, widening of the gastrocutaneous tract. However, in the authors' minds, the advantages of gastropexy - rapid tract maturation, lower risk of peritonitis and intraperitoneal tube migration, the ability to initially place larger bore tubes and ease of tube replacement – outweigh the disadvantages. The authors believe that 3 moderately tight T-fasteners or two very tight fasteners is the probably the best option.

Deutsch et al 1992

Objective(s): To review the authors experience using 16-Fr self-retaining nephrostomy catheters placed by PFG.

Method: A retrospective single center study of 68 patients (41 men, 27 women; mean age 60.4 years) who underwent PFG without gastropexy. Single step dilation was done using a 16-Fr Peel Away sheath (Cook or Medi-tech/Boston Scientific, Watertown, MA). A 16-Fr nephrostomy catheter with large side holes and a self-retaining, locking pigtail loop was inserted and the sheath removed.

Results: The procedure success rate was 100%. The mean procedure time was 7 minutes. Thirty day follow-up was done on 94% (64/68) of patients. See Tables 2, 3 and 4 for mortality and complication rates. Major complications included aspiration in two cases which resulted in death in one patient. One patient suffered respiratory arrest after stomach insufflation (probably due to restriction of the diaphragm by the large stomach) and recovered within 24 hours without aspiration.

Conclusions: The authors conclude that there is no convincing evidence for the need of gastropexy in adult patients and consider that the puncture for the placement of T-fasteners constitutes a greater risk than not performing gastropexy. They also conclude that a large bore (16-Fr) self-retaining, Cope-loop gastrostomy tube can be placed without gastropexy and with a single step dilation. They recommend PFG as it eliminates the need for anesthesia, shortens procedure time and hospital stay compared to surgery, and eliminates the need for unobstructed transesophageal access required by endoscopic procedures.

Dewald et al 1999

Objective(s): To evaluate the safety and effectiveness of PFG and gastrojejunostomy with gastropexy.

Method: A retrospective chart review of 643 patients (411 males, 232 females, mean age 57 years) referred to a single center for gastrostomy or gastrojejunostomy. Twenty-eight (28) patients were not included in the final results as catheters could not be safely placed in these patients due to position of overlying organs. Overall, 615 patients were included and 701 procedures (643 gastrojejunostomies and 58 gastrostomies) were done on those patients (including revisions). T-fastener (Brown/Mueller, Medi-tech/Boston Scientific, Watertown, MA) gastropexy usually with 3 fasteners was performed on all patients followed by serial dilation of the tract and placement of a 14-Fr gastrojejunostomy tube or a 12 – 14 Fr gastrostomy tube. All tubes had pigtail retention devices. The T-fasteners were clipped at the skin surface at 12 – 14 days post procedure. Complications were defined at study onset. Dislodgement of the tube by the patient or caregiver was not considered a complication. Patients followed for <14 days who did not develop a complication were not included in the complication rates. All patients followed up for <1 month were not included in the 30 day mortality rate.

Results: The success rate for catheter placement was 100%. Thirty-day follow-up was available in 61% (393/643). The mean follow-up was 15 weeks. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that PFG and gastrojejunostomy tube placement using gastropexy is safe and effective. The major advantages were placement of larger bore tubes and ease of gastric tract access in cases of early tube removal. The authors provide a summary table comparing their results to those of other studies using >100 patients, both with and without gastropexy. Their results compare favorably. The authors also contend that once gastropexy is mastered, it does not substantially increase procedure time and it may, in fact, slightly lower complication rates.

Dinkel et al 2002⁴

Objective(s): To report the authors' experience introducing PRG catheters into a hospital where only surgical and endoscopic procedures had been done previously.

Methods: A prospective single center study of 26 patients (22 male, 4 female; median age 63 years) with head and neck tumors using PRG with T-fastener gastropexy for the initial placement of a balloon retained catheter (Balloon Replacement Tube, PEG-BRT; Cook Incorporated, Bloomington, IN). Patients were not suited for PEG placement of the catheter due to obstruction of the esophagus, inability to transilluminate, or recent surgery in the head and neck region. PEG had failed in 31% of the cases and was judged likely to fail in another 27% of the cases. Two (2) to four (4) T-fasteners (Cope GI suture anchor, Cook, Bloomington, MA) were used for gastropexy. The peel away introducer was 4-Fr larger than gastrostomy tube (12- to 18-Fr). Technical success was judged fluoroscopically. T-fasteners were cut after 7-12 days. Follow-up was done for at least 30 days. All complications during this period were included in the results.

Results: Technical success rate was 100% (26/26) as confirmed by fluoroscopy at the end of the procedure including 8 cases where PEG had failed. The median total procedure time was 34 min (range 20 – 90 min). See Tables 2, 3 and 4 for mortality and complication rates. One major complication resulted from the patient injecting excessive nutritional fluid into the balloon port rather than the feeding port resulting in explosion of the balloon, spillage of the fluid into the peritoneal cavity and dislodgement of the device. Peritonitis resulted and was treated successfully. The only minor complication was site infection (4%).

Conclusions: Authors conclude that the use of balloon-retained feeding catheters in PRG is safe and effective and particularly of value in patients with head and neck malignancies.

Friedman et al 2004

Objectives: To evaluate the complications associated with percutaneous, retrograde, image-guided insertion of G and GJ tubes in a pediatric population.

Methods: A retrospective, single center study of 253 tubes (208 G tubes, 41 GJ tubes and 4 G/GJ tubes) placed in 208 patients (median age 15 months; range 7 days – 18 years) over a 4 year period (1995-99) using the technique of Chait et al 1996 involving a single retention suture gastropexy.

Results: Technical success rate was 100% (253/253). See Tables 2, 3 and 4 for mortality and complication rates. Intussusception is one of the minor complications reported in this study at an overall rate of 8% (20/253) or a rate of 49% (20/41) in patients receiving a GJ tube.

Conclusions: The authors report that peritonitis, which led to the one death in this study, was the most common major complication (3%) and that early recognition of peritonitis in young infants can be difficult where irritability may be misinterpreted particularly in neurologically impaired infants. The major complication rate reported in this article is comparable to what has been reported in the literature but the minor complication rate of 75% is very high compared to published data. It is difficult to determine exactly how the authors calculated the minor complication rate as the numbers printed in the published table do not equal the 75% rate. The authors also note that they include tube related complications in their overall minor rate and many other authors do not. The authors also report <30 and >30 day complication numbers which are difficult to interpret as published. However, despite the difficulties analyzing the numbers as published, it is clear that there is a very high complication rate in this pediatric study. The authors finally conclude that many complications are associated with retrograde percutaneous G and GJ tube placement in their pediatric population and though most are minor, major complications, including death, do occur.

Funaki et al 2000

Objective(s): To prospectively evaluate two fluoroscopic gastrostomy procedures.

Methods: A prospective single center study of 128 patients (60 men, 68 women; mean age 64.2 years; range 18 – 103 years) undergoing placement of either pigtail-retained or mushroom-retained catheters. One placement was unsuccessful due to the colon intervening between the stomach and the abdominal wall. Seventy-five (75) patients received 12- or 14-Fr pigtail catheters (Wills-Oglesby or Mallinckrodt, Cook, Bloomington, IN) and 52 received 20-Fr mushroom-retained catheters (removable pull-PEG, Medical Innovations, Draper, UT). Tubes were generally placed based upon practitioner's preference but pigtail were preferentially placed in patients with head, neck or esophageal malignancies and mushroom in neurologically impaired or combative patients. Two or three T-fasteners (Cope, Cook or Brown/Mueller, Boston Scientific, Natick, MA) and serial dilation were used to place the pigtail catheters under fluoroscopic guidance. Gastropexy suture were cut after two weeks.

A peroral technique was used to place the mushroom-retained catheters using a single T-fastener (Cope GI suture anchor, Cook). The gastropexy suture was cut after the snare was pulled from the stomach out the mouth. The mushroom catheter was attached and pulled from the mouth out the stomach. A single step dilation was performed before the tube was pulled through the opening. Close clinical follow-up was done on 88% (112/127) of the patients. Mean follow-up on pigtail patients was 90.9 days (range 1-420 days) and on mushroom patients 95.8 days (range 2-441 days). Five patients were lost to follow-up.

Results: Technical success rate was 99% (127/128). See Tables 2, 3 and 4 for mortality and complication rates. One mushroom and 19 pigtail-retained catheters were removed during the study when patients were able

to resume eating. Four pigtail and two mushroom-retained catheters were converted to gastrojejunostomy tubes due to reflux.

Conclusions: The authors found no significant difference in morbidity or mortality between conventional and oropharyngeal radiologic gastrostomy. They found mushroom-retained catheters to be superior to pigtail-retained due to larger lumen and better retention mechanism. They also prefer the peroral placement as it does not require gastropexy which they consider to be an additional risk.

Funaki et al 2001

Objectives: To study two percutaneous fluoroscopic procedures and two catheters – balloon-retained and mushroom-retained.

Methods: A retrospective single center study of 80 patients (41 men, 39 women, mean age, 64.5 years; range 27-95 years). The type of catheter placed was dependent on the preference of the attending physician. For balloon-retained devices, PRG was the technique used. A two or three T-fastener (Cope, GI suture anchor, Cook; Brown/Mueller, Boston Scientific) gastropexy was established, the tract was serially dilated to accept a peel-away sheath 6-Fr larger than the catheter. A 16-, 18-, or 20-Fr single-use balloon-retained catheter was inserted through the sheath. The sheath was removed and the balloon inflated. The T-fasteners were removed 2 weeks post-procedure. For the mushroom-retained catheter, a PEG “pull” procedure was used to place a 20-Fr mushroom-retained catheter by pulling it from the mouth into the stomach. The catheter was lubricated (Surgilube, Fougere, Melville, NY) and coated with povidone-iodine (Betadine, Purdue, Norwalk, CT). A single T-fastener was used to establish a gastropexy prior to the gastric puncture. Once the guidewire and snare were in place, the gastropexy fastener was cut and the catheter tube pulled through the gastric incision. Two patients were lost to follow-up. Mean follow-up for balloon-retained catheters was 171.1 days (range 16-372 days). Mean follow-up for mushroom-retained catheters was 149.4 days (range 1-399 days). The Chi-square test was used to assess statistical significance.

Results: Technical success rate was 100% (80/80) which includes both procedures. See Tables 2, 3 and 4 for mortality and complication rates. Chi square statistical analysis showed no significant differences in major or minor complication rates between the two techniques. Tube complications were significantly higher in balloon-retained catheters ($p < 0.001$).

Conclusion: The authors conclude that both of the methods and devices used in this study are equivalent in success and complication rates. Both tubes provided good patency based upon their large diameters and that the mushroom-retained catheter appears to be more durable than the balloon-retained catheter. The balloon-retained catheters have a high rate (68%) of dislodgement caused by balloon breakage or deflation. The authors also conclude that the use of gastropexy contributed to the lack of leakage of gastric contents and allowed tube replacement early post-procedure. There is a placement bias in this study which the authors state reflects standard day-to-day practice and shows the importance of having different methods and catheters available for different patient conditions (e.g. head/neck tumors, neurological disorders, combative).

Given et al 2005

Objective(s): To evaluate the feasibility of primary insertion of large bore button-type gastrostomy catheters,

Methods: A retrospective study of 105 patients (70 male, 35 female; age range 25 – 84 years) who underwent primary insertion of 18-Fr button gastrostomy catheters (MIC-KEY, Ballard Medical Products, Kimberly-Clark, Draper, Utah) by PRG. T-fastener gastropexy was performed in all patients. Balloon-dilation of the tract was followed by an appropriately sized device.

Results: Technical success rate was 100%. Follow-up was available in all patients for periods ranging 8 – 42 months. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that large bore (18-Fr) button gastrostomy devices can be safely placed as the primary gastrostomy device. Long-term patency is improved by the large bore of the device decreasing blockage and lack of dislodgement of the device.

Halkier, BK, Ho CS, Yee CA 1989

Objectives: To describe the authors experience with PRG for gastrojejunostomy.

Methods: A retrospective, single center study of 252 patients (164 men, 88 women; mean age, 61.3 years; range 16 to 94 years). Serial dilation was done up to 9-Fr prior to the insertion of a 9-Fr Kifa catheter that was advanced through the pylorus into the duodenum and then to the duodenojejunal flexure. The catheter was secured to the skin with a Molnar disc or tape and sutures. Feeding was started shortly after the procedure as nutrients were being delivered to the jejunum and not the stomach. After the first 90 patients, the authors modified the technique by using a 10-Fr Cope-type Perculex catheter (Cook Bloomington, IN) rather than a straight 9-Fr Kifa catheter.

Results: Technical success rate was 99% (250/252). See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that percutaneous gastrostomy by the Seldinger technique can be performed by one operator trained in radiological techniques and is the preferred method for gastrostomy, except when bedside insertion is mandatory. They report that they have successfully been able to puncture the air-distended stomach without resorting to T-fasteners, larger needles, glucagon administration, a trocar method, or intragastric balloon methods. The authors acknowledge that 4 patients had surgical morbidity related to peritonitis and one patient died but they had not yet adopted the use of T-fasteners to help prevent peritoneal leakage. This article was published just 4 years after the introduction of percutaneous methods and the use of gastrostomy so the author's method was still relatively unrefined.

Hicks et al 1991

Objective(s): To report the authors experience with percutaneous gastrostomy and gastroenterostomy.

Methods: A retrospective single center study of 158 patients (63 men, 95 women; mean age 67 years; median age 71 years). T-fastener (Meditech, Watertown, MA) gastrostomy was used in seven (7) patients (4.4%) including one patient on peritoneal dialysis, one uncooperative patient and one patient with ascites. 90% of the tubes were placed for feeding purposes, 10% for decompression. The first 36 patients undergoing gastrostomy received 16- or 18-Fr Foley catheters (Bard, Covington, GA); 86 received 12- or 14-Fr Cope-type catheters (Cook, Bloomington, IL). Carey-Alzate-Coons gastrojejunostomy tubes were placed in 36 patients. All catheters were placed using the Seldinger technique. Serial dilation was used to place the Cope catheters with Foley and GJ tubes being placed through a peel-away sheath. T-fasteners were placed before catheter insertion when used. Feedings started on the day after placement for G tubes and the same day for GJ tubes.

Results: Technical success rather was 100%. More than one puncture was required in 10 (6%) of the cases usually because the stomach deflated during the procedure. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that their results compare favorably with surgical and PEG gastrostomy as a safe and effective means of enteral nutrition or decompression. Foley catheters had a higher rate of major complications than other types of tubes so the authors recommend Cope type catheters for gastrostomy.

Ho T, Margulies D 1999

Objective(s): To report on a adverse event related to the retention of T-fasteners after removal of a PEG tube.

Methods: A case report on a single patient who developed a pneumoperitoneum from an eroded T-fastener. The 88-year old patient had undergone PEG for placement of a GJ tube. The procedure included formation of a gastrostomy with T-fasteners. The T-fasteners are usually removed 1-3 weeks after tube placement.

Results: Six months after the original procedure and two months after removal of the GJ tube, the patient developed abdominal pain that worsened over 3 days. The patient had missed follow-up, allowing the permanent suture material to remain in place for 6 months. There were two small fistulous openings with granulation tissue on the anterior abdominal wall. An abdominal series showed pneumoperitoneum and the presence of 3 T-fasteners in the stomach. A small gastric resection was required. The patient did well following the surgery.

Conclusions: To the best of the author's knowledge, this is the first such reported complication related to gastrostomy. The authors recommend the use of absorbable suture material which would greatly reduce the risk of such a complication.

Ho et al 2001

Objective(s): To provide information on the 1) authors' technique for PRG, 2) patient selection, and 3) complications.

Methods: Following site preparation, gastrostomy is performed using the Cope GI suture anchor set (Cook, Bloomington, IN). The tract is dilated to 16-F and a 16-F multipurpose Cope loop-type is inserted into the stomach. For gastrojejunostomy, a 12-F GJ tube (Cook Inc.) is the authors' standard. Occasionally, a Carey-Alzate-Coons double lumen GJ tube is used when an opening is required in the stomach and proximal small bowel. The gastric anchor is cut between days 7 and 10 days post procedure.

Results: Authors report that approximately 400 procedures were done in 5 years. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: Authors conclude that PRG and percutaneous gastrojejunostomy are safe, effective and well-established procedures with broad clinical applicability.

Janik et al 2004

Objective(s): To analyze a large group of pediatric patients with persistent gastrocutaneous fistula (GCF) following removal of a gastrostomy tube and determine which factors, if any, correlate to the persistence of a GCF.

Methods: A retrospective single center study of all children who had a gastrostomy created between 1992 and 2002. For the purpose of this study, a GCF was defined as a fistula between the stomach and the skin that had

not closed by 1 month after the removal of the gastrostomy tube and that required surgical closure. Patients were divided into two subgroups as defined by Gordon and Langer (): ≤ 8 months since the formation of the gastrostomy and >8 months since the formation of the gastrostomy. Data were analyzed by the Chi square technique and complimented with a power calculation for factors analyzed.

Results: Mean time between gastrostomy tube removal and closure of the fistula was 0.8 months for children with spontaneous closure and 1.7 months for children requiring surgical closure. The only factor that correlated to persistent GCF was the time elapsed between gastrostomy creation and removal of the gastrostomy catheter. Table 3 in this publication shows that the rate of persistent GCF by tube characteristics (chemical composition, intragastric configuration and type of tube). The MIC-KEY tube is specifically cited in this table.

Conclusions: Persistent GCF is a well recognized outcome of chronic gastrostomy tube use though the reason for the persistence is not really known. The current study shows that though grossly it appears there is a trend toward inflatable intragastric balloons favoring spontaneous closure, the trend does not reach statistical significance ($p > 0.05$). No one type of procedure for gastrostomy appears to favor persistent GCF though there were not enough PEG insertions in this study for significance. Authors conclude that the best practice to avoid persistent GCF is to remove gastrostomy tube as soon as possible.

Jensen SW, Eriksen J, Kristensen K 2006

This English abstract of a Danish article reports two cases of colocutaneous fistula and severe osmotic diarrhea in small children immediately following replacement of PEG gastrostomy device with a MIC-KEY button. The button subsequently migrated into the colon.

Kavin H, Messersmith R

Objective(s): To describe complications associated with T-fastener gastropexy and the management of the complications.

Methods: Case report study of 3 patients in whom T-fasteners were retained resulting in complications 8 to 13 weeks after the initial gastrostomy procedure.

Results: In each of the three patients, T-fasteners from a gastropexy procedure were not removed post procedure. In Case 1, the patient complained of drainage 7 weeks after the gastrostomy tube was removed. X-ray showed 3 of 5 T-fasteners from the original procedure were still present. Endoscopy was required 13 weeks post gastrostomy to remove two of the three retained fasteners and the third one was later extruded in a pustule at a cutaneous drainage site. The patient recovered within two days. In Case 2, a single T-tack gastropexy was done in the original gastrostomy. Two months post procedure, the patient complained of a gastrocutaneous fistula and leakage around the catheter site. A CT scan of the abdomen showed the retained T-fastener embedded in the anterior abdominal wall. The wound was probed with a hemostat and the fastener removed. The patient healed and the fistula closed in several days. In Case 3, 10 weeks after a PRG with 2 T-fastener gastropexy was successfully performed, the patient developed an infection and gastrocutaneous fistula near the stomal site. X-ray showed 2 retained T-fasteners. EGD showed that the tube had migrated out of the gastric lumen. An interventional radiologist probed the tract to restore access and removed the tube and t-fasteners. A replacement tube was inserted and the fistula closed with a few days.

Conclusions: T-fasteners are usually cut within 1-21 days post gastrostomy procedure. However, some radiologists bury the sutures below the skin rather than removing. As shown in this report, retention of the fasteners can lead to complications related to foreign body presence such as inflammation and infection. The authors recommend T-fastener removal within 5-10 days after tube insertion.

Kozarek et al 1995

Objective(s): To evaluate the initial placement of the One-Step button (Applied Medical Technology, Independence, Ohio) for use, ease of insertion and short- and long-term safety profile.

Methods: A prospective multi-center (5 sites) study of 86 patients undergoing PEG placement without gastropexy of a 24-Fr One-Step button gastrostomy device. Gastric puncture was done was Seldinger technique and the guide wire transposed to the mouth. A stoma measuring device was passed over the wire to determine the correct shaft length for the button device. A device equal to or slightly longer than the stoma measurement was then inserted over the wire.

Results: Technical success rate was 83% (71/86) with stoma measurement problems contributing to the majority of the problems. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that the advantages of the button device are outweighed by the problems associated with the placement procedure. Some of the problems may be avoided with prophylactic use of antibiotics, correct measurement of the tract and the use of a shaft length at least 1 cm longer than the measured tract.

Laasch et al 2003

Objective(s): To compare PEG with PRG and a new hybrid technique (per-oral image guided gastrostomy – PIG).

Methods: A prospective, nonrandomized, three center study (160 patients) combined with retrospective chart review of 200 patients to compare PEG, PRG and PIG. Fifty (50) consecutive PEGs and fifty (50) consecutive PRGs were performed. Techniques were modified for the PIG to place a 20-Fr over-the-wire MIC gastrostomy tube in 60 patients. The endoscopic findings of 200 previous PEG procedures were also reviewed to determine whether clinically relevant information is gathered during endoscopy frequently enough to justify PEG which is generally not as successful technically as radiological procedures and often contraindicated. Gastrostomy was not performed. For PEG, 24Fr Pull-I gastrostomy tubes (Cook) were used and for PRG either 10.5Fr Tilma or 12Fr Ultrathane gastrostomy (Cook). The 20-Fr MIC over-the-wire push gastrostomy tubes (Kimberly-Clark), designed for endoscopy, were used in the modified, image-guided technique. Antibiotic prophylaxis was not used for PEG according to UK guidelines.

Results: Technical success rates were similar for all procedures (see Table 4) however 40% (24/60) of the patients receiving the hybrid PIG technique had a previous failed attempt at PEG or were not suitable for PEG. Mean procedure time for PIG was 39.5 minutes (range 35.4 – 43.7 minutes). Clinically relevant data was found during endoscopy in only 21% (42/200) patients and it was always related to peptic disease. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: Authors conclude that while PEG is often perceived as having the benefit of a “free” endoscopic exam but based upon their work that is not the case. Therefore, this should not prevent patients from considering radiological procedures. When head and neck cancer is present in patients, PRG continues to be the method of choice. In the author’s opinion, their hybrid method offers the advantages of both PEG and PRG – large bore tubes, minimal sedation, readily identify surrounding organs, gastrostomy not required, lower risk.

Laing B, Smithers M, Harper J 1994

Objective(s): To assess the safety of PFG. The primary outcome measure was the incidence of morbidity and mortality from PFG.

Methods: A retrospective review of the medical records of 70 patients (45 men, 25 women; mean age of 60 years; range 18-86 years; median age 65 years). Patients underwent the PFG procedure using a Seldinger technique for the insertion of a 12-Fr standard percutaneous gastrostomy set (Cook, Australia). Feeding was started 24 hours post procedure. If the patient was in the hospital solely for the insertion of the feeding tube, the mean length of stay was 3 days. If a change of tube is required, a minimum of six weeks was allowed for tract maturation. If the tube was dislodged with a well established tract present, it was usually replaced with a 12- to 16-F Foley catheter.

Results: Technical success rate was 98% (69/70). The median period for follow-up was 2.5 months though 32% (22/69) was lost to follow-up after the 3-5 day hospital admission period. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that PFG is at least comparable to PEG in safety and efficacy. The PFG procedure is simple and requires only a basic facility. The authors state that it should be the first-line option for enteral feeding.

Lorentzen et al 2007

Objective(s): To evaluate the safety and effectiveness of PRG using ultrasound and fluoroscopy and a simplified gastrostomy.

Methods: A prospective, single center study of 154 consecutive patients (56 males, 98 females, mean age 73 years) using PRG guided by ultrasonography (US) and using only a single T-fastener during the procedure. Ultrasonography was used to identify organs surrounding the stomach and puncture the stomach as it allowed real time visualization of the puncture needle. A single puncture was done creating a tract for a Cope T-fastener (Cook, Europe) as well as a guidewire over which dilation and tube insertion could be performed. The T-fastener was used to ensure that the guidewire does not get out of the stomach during dilation. Serial dilation was done from 12- to 16-Fr and a peel away sheath was introduced. The T-fastener external suture was held tight by hand during dilation. A 14-Fr balloon-retained silicone gastrostomy tube (Flocare, Switzerland) was inserted and the sheath peeled away. The T-fastener suture was released by cutting at skin level. The gastrostomy tube was pulled up against the gastric wall to affix the stomach to the abdominal wall (tube gastrostomy). Flushing with saline started 4 hours post procedure. Follow-up was done for 30 days.

Results: Technical success rate was 98%. Two patients suffering from neurological disorders dislodged their catheters into the peritoneal cavity. Laparotomy was done on both patients but the patients died post-laparotomy. A third patient developed peritonitis with ascites 2 days post-procedure, drainage was done and the tube removed. The patient died 15 days post-procedure. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions:

The authors state the PEG and PRG have been shown to be safe and efficient alternatives to surgical gastrostomy with significantly lower complication rates. They conclude that US is the most favorable imaging method as it allows real time visualization of the needle thereby avoiding inadvertent organ puncturing. They also state that the use of T-fasteners is controversial since there are some potential complications (pain, skin excoriation) associated with the fasteners. But, while the T-fastener technique used in this procedure has some advantages (time, no need for return visit), the two fatal cases of tube dislodgement and two cases of deep stomal infection might have been avoided if the more conventional T-fastener procedure had been used. The authors conclude that US and fluoroscopic guided PRG with a 14Fr balloon-retained catheter is a feasible technique with a high success rate. The authors summarize PRG studies since 1990 with more than 100 patients.

Lyon et al 2003³

Objective(s): To study the feasibility of primary button gastrostomy insertion with T-fastener gastropexy as the authors had significant problems with dislodgement with pigtail or balloon-retained tubes.

Methods: A prospective study in two centers of 53 patients (33 men, 20 women; mean age 63.4 years) to investigate the feasibility of using PRG and gastropexy with T-fasteners for the *de novo* placement of a button gastrostomy device. Three (3) or four (4) T-fasteners (Boston Scientific, Natick, MA) were used to establish gastropexy. In order to ensure accurate tract length (critical to the success of this procedure), an angioplasty balloon catheter was used to measure the tract length. A gastrostomy device 5mm longer than the measured tract was chosen to ensure a good fit. The angioplasty balloon was used for initial dilation followed by 18-Fr dilator before device insertion over the guidewire. One center used the 14-Fr Mic-Key G device (Ballard Medical Products, Kimberly-Clark, Draper, UT) and the other the 14-Fr Cubby device (Corpak, Wheeling, IL). T-fasteners were removed at 2-5 days post procedure in all patients.

Results: Technical success rate was 98% (52/53 patients) which compared favorably to the success rate for the insertion of non-low profile gastrostomy catheters. Follow-up was done on a daily basis while in the hospital and weekly after discharge. There were no major complications. Minor complication rate was 9.6% (5/52). The mean survival rate for the MIC-KEY G tube was 15.8 weeks (range 3-27 weeks) and the Cubby survival rate was 11.1 weeks (1-28 weeks). See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions:

While the replacement rate for the balloon catheters was high in this study, the authors note that the catheters can easily be replaced at bedside or even in a physician's office, eliminating the need for a visit to radiology or the hospital. The authors note that replacement of the balloon catheter with a mushroom type catheter lengthens time to future replacement. *De novo* placement of mushroom catheters was not recommended as they do not have an end hole so they cannot be placed over a guide wire. At the conclusion of the study, authors recommended *de novo* placement of button-type gastrostomy catheters without the need for a mature tract. Gastropexy was considered critical to the success of the procedure as it allowed placement of a large-bore catheter. They also recommend balloon dilation of the tract as it puts less stress on the gastropexy.

McQuaid KR, Little TE 1992 (two fatal complications)

Objectives: To describe two fatal complications resulting from blind placement of a button gastrostomy device.

Methods: A case report study of two patients from two hospitals who developed fatal complications following the blind placement of a Bard gastrostomy button (Bard Interventional Products, Billerica, MA) as a replacement device in a established stoma.

The first patient was a 52-year old male who was having a 4-year old Sacks-Vine type tube replaced. In the original procedure, the stomach was pulled up against the abdominal wall for 10 days and then released. The stoma was measured during the replacement procedure and a 24-Fr device that was approximately 4.4 cm long was blindly placed in a stoma that measured 3.5 cm. The button was easily placed and 100ml of saline infused through the device. Opening the anti-reflux valve caused the saline to reflux onto the skin. The patient was discharged on tube feedings.

The second patient was a 23 year old woman with end stage COPD from cystic fibrosis on the waiting list for double lung transplantation. During the initial procedure, a 20-Fr PEG tube was placed uneventfully during previous sinus surgery. Placement was verified endoscopically. The patient requested replacement of the initial tube with a button for cosmetic reasons. This was done 6.5 weeks after the initial procedure. Endoscopy was not used for the replacement procedure due to the patient's respiratory insufficiency. The initial tube was gently removed without difficulty. The stoma was measured and an 18-Fr 1.7 cm replacement device was placed. Gastric contents flowed freely from the button. Fluid was not injected into the button. The patient was discharged to resume nocturnal feedings.

Results: The 52-year old male returned to the hospital 14 hours post-procedure with signs of peritonitis and died shortly thereafter. Shortly before his death, a contrast study showed the button tip lying in a closed-off

peritoneal pocket, surrounded by bowel. Autopsy revealed that the abdominal wall and fascia were in fact 3.5 cm thick as measured but the stomach had detached from the abdominal wall and formed a long fibrous tube 8 cm long. The button tip had perforated this long tract and was located in the peritoneal cavity.

The 23-year old female returned 4 weeks after the replacement procedure complaining of discomfort around her stoma during feeding. She noted that the area was hard and tender after feeding. There was moderate granulation at the stoma site. The button seemed to be too tight so the decision was made to place a longer tube (2.4cm). Following tube replacement and air injection into the new tube, the patient complained on respiratory difficulty and suffered a cardiopulmonary arrest. She could not be resuscitated and died. Autopsy revealed a chronic fibrotic cavity between the stomach and abdominal wall. A fistulous tract connected this cavity to the stomach. It was determined that the original 1.7 cm tube was inside this cavity and feedings drained into the stomach but the longer 2.4 cm second replacement tube passed through this cavity and into the liver. The air injection resulted in an air embolism that passed through the hepatic veins into the heart.

Conclusions: The authors conclude that (i) the length of the established stoma/tract cannot always be measured accurately and that tracts that develop around PEG tubes are not always, short, simple, straight tracts, (ii) blind placement of buttons is potentially dangerous, (iii) air should not be injected into the button during the placement procedure, (iv) infusion of fluid with subsequent efflux upon opening of the anti-reflux valve does not guarantee intragastric placement. They recommend endoscopic visualization or fluoroscopic guidance for placement of the Bard button including measurement of the tract and use of a guidewire for placement. If the tract is >4.3 cm, they do not recommend button replacement.

Modesto VL, Harkins B, Calton WC 1994

Objective: To describe a laparoscopic gastrostomy technique that includes a 4-point gastropexy.

Methods: Standard patient prep was done for a laparoscopy. The laparoscope was inserted at the umbilicus and carbon dioxide was insufflated. Two T-fasteners (Brown/Mueller, Ross) were inserted under direct visualization. The gastrostomy was serially dilated up to 18-Fr with the T-fasteners providing countertraction during dilation. The catheter is inserted and two more T-fasteners are inserted anterior to the catheter. Once the final two fasteners are in place, the balloon is inflated

Results: None given, article is a technique description.

Conclusions: None given, article is a technique description.

Moote et al 1991

Objective(s):

Methods: A laboratory in vitro (canine stomachs) and in vivo (canines) study to evaluate the safety of inserting gastrostomy catheters percutaneously without gastric fixation (gastropexy). Authors summarize that at their institution, percutaneous gastrostomy was primarily done with 9 and 10 Fr catheters without gastric fixation (about 350 patients). However, tube blockage was an ongoing problem with these small bore catheters. Initial placement of a large bore (14-Fr) catheter would minimize blockage but the safety of such a device without gastric fixation has not been studied. An in vitro experiment was designed with five canine stomachs (sealed at both ends to give a closed system) to look at leakage around dilators (8- to 18-Fr) inserted through a single gastrostomy at maximum gastric volume (10 mm Hg). If there was no leakage, external pressure was applied to the stomach producing pressures up to 100 mm Hg. The dilator was then removed and the pressure required to produce a lead through the defect at 20%, 40%, 60%, 80% and 100% of maximum volume was recorded. This was repeated 3X for each specimen.

PFG was also performed in vivo on 5 canines. It was a one-step procedure without gastropexy. Serial dilation to 14Fr was performed to produce a 14Fr stoma in the anterior gastric wall. All catheters were inserted and immediately removed. Regular feedings were started the morning after the procedure and the subjects were sacrificed on day 7 and necropsied. This should have put subjects at maximum risk for intraperitoneal leakage.

Results: Results showed that even with maximum gastric distension, there was no leakage around tubes up to 18-Fr. If the tube was removed, leakage was related to the size of the gastric stoma though it was difficult to product leakage through an 8-Fr stoma. In the in vivo study, there was no evidence of gastric leakage or peritonitis at necropsy.

Conclusions:

Authors conclude that small and large catheters can be inserted with or without gastric fixation though dislodgement of larger bore catheters (≥ 14 -Fr) may lead to increased risk of intraperitoneal leakage.

Moses PL, Morse RA, Smith RE 1995 (fatal complication)

Objective(s): To describe a fatal complication resulting from the blind placement of a gastrostomy button and the misinterpretation of the contrast study done which delayed the diagnosis of the misplaced button.

Methods: A case study of a 62-year old man who presented for a button gastrostomy replacement of a 20-Fr Bard (Bard Interventional Products, Tewksbury, MA) PEG tube. The existing tube was removed without incident. A 3.4 cm, 24-Fr Bard button was inserted through the existing stoma according to standard protocol. There was no leakage and the button was easily rotated. The patient was discharged with care, feeding and follow-up instructions.

Results: Patient presented 10 days post-procedure complaining of pain related to use of the gastrostomy button. He had significant tachycardia and a soft and diffusely tender abdomen. Lab values showed an elevated white cell count but were otherwise unremarkable. An abdominal series was performed and interpretation was that the button was in the gas-filled stomach. The films also appeared to show a pneumoperitoneum. An NG tube placement was difficult and little material was aspirated. Gastrographin was instilled through the button and showed what was thought to be gastric outlet obstruction. There was a presumption of gastric perforation so a laparotomy was done revealing the button transversed the gastrocolic omentum and terminated in the lesser sac which was filled with the enteral feedings (4+ for WBCs and mixed flora). The stomach was intact. The patient subsequently expired in ICU. No postmortem exam was done.

Conclusions: The mechanism of device failure cannot be determined since it was initially placed blind though possibilities include initial placement tangential to the greater curvature of the stomach or subsequent dislodgement into that space. The distention of the lesser sac with the enteral feedings resulted in misinterpretation of the radiographic studies. Various techniques can contribute to successful placement of replacement tubes including (i) proper measurement of the fistulous tract, (ii) contrast studies to confirm proper placement, and (iii) endoscopic confirmation of placement with a narrow caliber scope through the actual device. The authors caution that blind placement of a button device carries risks that practitioners should be aware of and take precautions to prevent.

O'Donovan NA, Heelan JA 1995

Objective(s): To describe the author's technique for PRG without gastropexy to determine overall success rate of the technique as well as the need for gastropexy.

Methods: A retrospective, single center study of all cases during a 14 month period of 24 patients (12 males, 12 females; age range 55 – 75 years) who had gastrostomy tubes inserted by a PRG without gastropexy. The stomach was punctured and serial dilation was performed. A 12-Fr Cope loop type gastrostomy tube (Cook Inc.) was inserted. Follow-up was done for 14 months.

Results: Technical success rate was 100%. See Tables 2, 3 and 4 for mortality and complication rates. No major complications occurred.

Conclusions: The authors conclude PRG is safe and effective with morbidity and mortality comparable to, if not less than, surgical and endoscopic procedures. Gastropexy does not appear to be required in the patient group in this study. However, there may be situations where it is appropriate such as newborns, infants, patients with spinal deformities and when it is difficult to keep the stomach distended with air. Radiologic gastrostomy can be easily mastered and carried out in an institution with fluoroscopic equipment.

Pitman et al 2003

Objective(s): To describe the author's methodology for PRG and the complications and pitfalls associated with the procedure.

Methods: A retrospective, single center study of 23 patients who underwent PRG. T-fastener gastropexy was performed. The authors claim gastropexy with 4 T-fasteners can reduce the pain associated with dilation as well as the size of the potential pneumoperitoneum from the procedure. The retention sutures are removed 10-14 days post-procedure. A balloon-retained gastrostomy tube was used though the size of the tube is not discussed. Serial dilation was performed and a peel away sheath was used to place the device. Authors recommend that if equipment from several manufacturers is used, the tube and peel-away sheath should first be checked to ensure the deflated balloon will fit down the sheath.

Results: Two of the 23 patients could not have the procedure. In one, the location of the transverse colon interfered with the procedure and in another a nasogastric tube (for insufflation) could not be placed. From the article, it appears that the success rate was 100% in the remaining 21 patients. Three patients required a second procedure resulting from retention balloon failure (n=1) and tube removal by the patient (n=2). See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions:

Authors conclude that PRG is a useful and safe procedure for those patients in who endoscopically placed gastrostomy is not an option. Knowledge of abdominal anatomy in order to avoid damage to adjacent structure (liver, small bowel, etc.) is critical to a successful PRG procedure as is the formation of a gastropexy. Potential morbidity comes from damage to adjacent organs, peritonitis from stomach contents leaking, early hemorrhage from tract infection.

Ringwald-Smith et al 2000

Objectives: (1) Compare complications related to the feeding devices that occur during feeding with two types of LPFDs, (2) compare nutritional impact of two LPFDs, (3) select one LPFD for use at St. Jude's Childrens Research Hospital and (4) develop care guidelines.

Method: A retrospective, single center study of 36 pediatric oncology patients (20 males, 16 females, median age 12.1 yr, range 1 month – 18 yr) who underwent percutaneous placement of an enteral feeding tube. Twenty nine (29) received a standard G tube initially and 7 received a low-profile feeding device (LPFD) initially (3 MIC-KEY®, 4 Bard® button). There is no discussion of the actual placement methods.

Results: After their tracts matured, 16 patients converted from a GT to a MIC-KEY and 7 more converted to a Bard button. Six never received a LPFD. Median time of nutritional support was 8.3 months (range 17 days to 23 months). (1) Mechanical complication rates were higher for the MIC-KEY due to the balloon, (2) Post-enteral feeding status of the two groups (MIC-KEY and Bard) was similar, (3) the MIC-KEY was chosen for use at St. Jude's and (4) care guidelines were established and published in the article. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: Both LPFD tested were effective in providing nutritional support. Though the MIC-KEY had higher complication rates due to the balloon, they were minor and easily managed. The authors conclude the positive aspects of the MIC-KEY outweigh the complications. The MIC-KEY was easier to replace and caused less pain during changing/replacement, therefore increasing patient satisfaction.

Ryan et al 1997

Objective(s): To assess the success and complication rates of PRG or percutaneous gastrojejunostomy with gastropexy.

Methods: A retrospective, single center study of 316 patients (141 men, 175 women, mean age 64.6 years, range 27 – 90 years) using radiologic gastrostomy (269 patients) and gastrojejunostomy (45 patients) with T-fastener gastropexy (two patients ultimately could not have the procedure). Study included 158 procedures for feeding and 111 procedures for decompression. Four (4) T-fasteners (Brown-Mueller, Medi-tech/Boston Scientific) were used in the gastropexy. The Seldinger method was used for tube placement including serial dilation to 14-Fr with a 14-Fr peel away sheath. The specific type of tube used was not stated in this reference. The T-fasteners were cut at 21 days and follow-up was done out to 21 days.

Results: The technical success rate was 99.4% (312/316). See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that gastropexy appears to substantially reduce intraperitoneal leakage, facilitates the use of larger bore tubes and allows easy catheter replacement. It may also produce tamponade at the insertion site which may reduce bleeding. The authors also discuss the effects of ascites on the placement of a gastrostomy including the improvement in the results of the procedure when gastropexy is used in the presence of ascites. Once the T-fastener technique is learned, it does not significantly increase procedure time. The authors include a table that summarizes results from previous studies of radiologically placed gastrostomy tubes. Authors conclude percutaneous radiologic gastrostomy results with T-fastener gastropexy are superior to those with nongastropexy.

Sadler et al 1999

Objectives: To describe a simplified gastropexy technique for use with PRG.

Methods: A review of 30 patients treated over a one year period in a single hospital. Following standard patient preparation, a single T-fastener (Cope GI suture anchor, Cook, Bloomington, IN) in a 17-gauge introducer needle is used to puncture the stomach. The puncture needle is withdrawn and the guidewire and suture left in place. The suture is then secured to the protective plastic cover from a scalpel by cutting two small slots on opposite sides of the cover and wrapping the suture around the cover in the slots effectively "locking" the suture in place. A small dilator is passed over the indwelling guidewire allowing it to be replaced with a heavier guidewire for catheter insertion. The tract is serially dilated and the catheter inserted (14-Fr gastrostomy or 12-Fr gastrojejunostomy). Controlled countertraction prevents movement of the stomach during insertion. The suture wrapped around the plastic sheath was left in place for 7-10 days.

Results: Technical success rate was 100%. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that gastropexy was not routinely required for gastrojejunostomy. They have a relatively low threshold for using the procedure, particularly in cachectic patients with limited healing powers and patients with ascites where it is difficult for adhesions to occur to form a tract due to the presence of the ascites. For gastrostomy with large-bore, blunt end catheters where the use of a sheath is required for their insertion, they use T-fasteners without scientific proof of their usefulness as they feel the procedure facilitates tract dilation and catheter insertion. Their method limits the number of gastric punctures to one thus decreasing risk to the patient. Their method of tightening the suture around the scalpel cover allows relaxed tension on the fastener post-procedure to reduce the risk of complications due to skin irritation.

Saini et al 1990

Objectives: Describe authors' experience with PRG using T-fastener gastropexy in 125 patients.

Method: A retrospective, single center study of 125 patients who underwent PRG with T-fastener gastropexy using 4 T-fasteners. Introduction of the gastrostomy tube was done by the Seldinger technique or trocar method. Serial dilators were advanced over the guide wire or a peel away sheath/dilator was used. Gastrostomy catheters ranged in size from 12- to 18- Fr. All patients were available for 2-week follow-up but only 63 (50%) continued to at least 30 day follow-up (average 3.5 months, maximum, 1 year). Outcome measures (complications, feeding success) were calculated based upon 63 patients.

Results: Gastrostomies were successful in 124 of 125 patients (99%). See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that gastropexy (i) facilitates the insertion of large-bore catheters (>12-Fr) which are less likely to occlude; (ii) prevents inadvertent insertion or migration of the tube into the peritoneum; (iii) prevents leakage of gastric contents into the peritoneum. The authors also conclude that the use of PRG has the advantage of permitting identification of patients where the colon lies anterior to the stomach and would interfere with the percutaneous procedure. The authors also conclude that radiologically guided tube gastrostomy is very low-risk and allows flexibility in selection of tube size.

Silas et al 2005

Objectives: To compare the indications, complications, efficacy and outcomes of PRG and PEG.

Methods: A retrospective analysis of 193 gastrostomy catheters placed by PRG and 177 by PEG in a single tertiary care, university-based hospital. Mean age of PEG patients was 68 ± 15 years; mean age of PRG patients was 63 ± 14 years. There were 100 (56%) male patients in the PEG group and 114 (59.1%) male patients in the PRG group. Follow-up time to death or discontinuation of the tube in the PEG group was 174 days (range 4-877 days) and for the PRG group 108 days (range 3-376 days). For PRG, two or three T-fasteners were used to establish a gastropexy. An 18-gauge needle was used to access the gastric lumen, a guidewire inserted and the tract dilated. A pigtail-retained gastrostomy tube was inserted. Feeding was started 24 hours post-procedure. Gastropexy sutures were removed at 10 days. For PEG, the "pull" technique was used with no gastropexy. The gastrostomy tube was secured with a plastic bolster. Feeding was started 24 hours post-procedure. Antibiotic prophylaxis was used only in PEG. Chi-square and t-tests were done for comparison of patient characteristics and complications. Multivariable logistic regression analysis was done to identify factors associated with early and late complications.

Results: Technical success rate was 100%. In this study, in-patient status and PRG correlated to short-term complications regardless of other demographic characteristics. In-patient status and malignancy correlated to long term complications. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that both PRG and PEG are safe and effective and that the differences between outcomes are primarily related to the lack of antibiotic prophylaxis in the PRG group. Patient education about gastrostomy tubes and stoma care will go a long way to preventing pain and inadvertent tube removal.

Smith SE. Clancy TV 1998

Objective(s): To describe two cases of colcutaneous fistula following PEG tube placements and provide a survey of the literature for this complication.

Methods: A case report study of two patients (1 female, 72 years of age; 1 male, 64 years of age) from a single hospital. Both patients had their initial tube placed by PEG. There is no additional discussion of insertion method.

Results: The first patient presented 3 months after the initial procedure with her tube reported to be "not working". Tube was replaced without problems using a Bard replacement kit. Two days after the replacement, the patient presented at the ER with frequent bowel movements containing enteral formula. There was no evidence of peritonitis. An abdominal CT showed that the tube had migrated out of the stomach was between the stomach and the splenic flexure of the colon. Contrast medium injected through the tube entered both the stomach and colon. Enteral feeding was stopped and PEG tube connected to gravity drainage. The patient was unresponsive by evening and was resuscitated and transferred to ICU. Urosepsis was diagnosed and treated. At the family's wish, treatment was restricted to comfort care due to the patient's advanced age and general poor health. She expired 3 days later.

The second patient presented 6 months post initial insertion of a PEG tube complaining the tube was "not working". The tube had been shortened several times over the 6 months to improve performance. The tube was replaced by a Foley catheter without any difficulties. Three (3) days after the tube change the patient presented in the ER with diarrhea containing enteral formula and fecal material was present at the tube insertion site. Other signs appeared within normal limits. Gastrograffin introduced through the catheter entered the transverse and descending colon. No contrast material entered the stomach or duodenum nor was there intra-abdominal extravasation of contrast material. Enteral nutrition was stopped and a nasogastric tube was inserted for enteral

nutrition. The PEG tube was removed from the colon and the fistula covered with an ostomy bag and closed spontaneously after the patient returned to the nursing home.

Conclusions: The authors conclude that while the PEG method is relatively easy to perform, this does not diminish the types of complications that can accompany the procedure. While gastrocutaneous fistula is the most common, colocolic fistula is rare but can occur at any time following tube placement. In the patients reported here, the initial tubes were changed several days prior to the patients presenting in the ER. Clinical signs of the problem include sudden change in bowel habits, diarrhea containing enteral formula, the presence of fecal material at the tube site, feculent vomiting and fecal drainage from the tube site. The authors report that most such fistulae close spontaneously if there is no bowel obstruction though persistent fistulae may require surgical repair. "Tube not working" complaints should be addressed early to avoid serious complications post PEG procedures.

Thornton et al 2000

Objective(s): To evaluate the use of PRG in patients who had a failed PEG or were deemed unsuitable for PEG.

Methods: A retrospective single center study of 42 patients (28 men, 14 women; mean age 60 years; range 18 – 93 years) who had either undergone a failed PEG or were deemed unsuitable for a PEG procedure. PRG was performed using T-fastener (Brown/Mueller, Meditech/Boston Scientific, Boston, MA) gastropexy. Four fasteners were used for gastropexy except when the puncture site was intercostal in which case two fasteners were used. The Seldinger method was used for tube placement. The tract was serially dilated to 14-Fr and a 14-Fr peel away sheath inserted through which the 14-Fr gastrostomy catheter was passed. For GJ tube placement, the guidewire is manipulated through the ligament of Treitz. T-fasteners were removed after 10-14 days.

Results: The technical success rate was 98% (41/42). Twenty-six patients received G tubes and 15 GJ tubes. CT guidance was utilized in some patients due to obstructions and abnormal anatomy. Failure to transilluminate the anterior abdominal wall was the most common reason for PEG failure (n=22). In 16 of these patients, the stomach was lying high, underneath the rib cage making the choice of a gastrostomy site difficult. In these cases, either a steep cephalad track angulation was used or an intercostal approach was necessary. In the five patients with cardiorespiratory decompensation, PRG was performed with local anesthesia and minimal sedation with the patient in a semi-upright position. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that PRG should be the primary method for insertion of enteral feeding tubes in the technically difficult patient population where PEG has been unsuccessful. They also suggest that PRG should be the primary method of gastrostomy in patients with ALS where the stomach is frequently located under the rib cage due to left diaphragmatic paralysis. PRG offers the patient the best chance of success and saves time and money.

Thornton et al 2002

Objective(s): To determine whether there is an advantage to using gastropexy during PRG.

Methods: A prospective, randomized study of 90 patients (66 men, 24 women; mean age 62 years, range 20-90 years) using PRG both with (48 patients) and without T-fastener gastropexy (42 patients). All patients were treated identically except for the performance of a T-fastener gastropexy; some patients received a gastropexy and some did not receive a gastropexy. Four (4) t-fasteners (Boston Scientific, Natick, MA) were used at the corners of a 2-cm square around the gastropexy site. The gastrostomy tube insertion was done using the Seldinger technique. In all patients, the gastrostomy tract was serially dilated to 16-Fr prior to the insertion of a 14-Fr gastrostomy tube (Cook, Bloomington, IN) over a guidewire and through a 16-Fr peel away sheath. The T-fasteners were removed with 7 days post-procedure.

Results: Technical success rate was 100% (48/48) for patients with gastropexy and 93% (39/42) for those with no gastropexy. See Tables 2, 3 and 4 for mortality and complication rates. There was no difference in fluoroscopy time observed between the two groups.

Conclusions:

The authors conclude that T-fastener gastropexy should be used whenever large bore (>12 Fr) gastrostomy tubes are required. They agree with Moote⁵⁴ that no signs of peritonitis or intraperitoneal leakage are seen with or without gastropexy. The authors also conclude that the incidence of major complications (9.5%) in patients without gastropexy is unacceptable and that the minor complications associated with the gastropexy (site pain and skin excoriation) resolve upon removal of the T-fasteners within 7 days.

vanOverhagen et al 2000

Objective(s): To assess the feasibility and safety of percutaneous jejunostomy using various techniques.

Methods: Prospective, observational study of 49 patients who underwent 53 procedures (34 men, 15 women; mean age 59 years; range 22 – 83 years). In all patients, the stomach had been removed or was inaccessible for feeding. The technique used for jejunostomy during this study was refined over time. The jejunum was identified by ultrasound and punctured at an oblique or perpendicular angle under ultrasonographic guidance by

a free hand method. Initially a 6-Fr catheter was inserted over a guidewire but this was changed to a 10-Fr pigtail catheter. Visualization of the jejunum could be difficult so glucagon administration was added to the procedure to distend the jejunum. Cope suture anchors (Cook) were also added to the procedure to help maintain the position of the guidewire inside the jejunum. The tract was then dilated to 10-Fr with a tapered dilator prior to catheter insertion. The Cope anchor was cut 2 weeks post procedure. Saline was infused into the catheter for 24 hours prior to starting feeding. Patients were followed for 30 days post procedure.

Results: The technical success rate was 87% (46/53). Six of the seven failures occurred prior to starting the use of nasogastric tubes, anchors and glucagon. Twenty-two gauge puncture needles were used in 5 of the 7 failures. The needle size was subsequently changed to 17 gauge. In univariate analysis, only the Cope suture anchors significantly contributed to higher technical success ($p = .003$). The median catheterization period was 49 days (range 1 – 597 days) for 43 patients who had their tubes removed and 410 days (range 139 – 482) for three patients who still had functioning tubes. See Tables 2, 3 and 4 for mortality and complication rates.

Conclusions: The authors conclude that percutaneous jejunostomy with ultrasonographic and fluoroscopic guidance is a feasible and relatively safe procedure for long-term enteral feeding in patients in whom the stomach has been removed or is inaccessible. In their opinion, PRG is superior making percutaneous jejunostomy desirable only when gastric feeding is suboptimal or aspiration occurs and transgastric conversion is not feasible.

Wollman B, D'Agostino HB 1997

Objective(s): To evaluate the safety, efficacy and usefulness of PRG and PEG.

Methods: A retrospective single center study of 182 percutaneous gastrostomy procedures (68 PRG, 114 PEG) done over a 3 year period. The authors do not discuss specifics of their methods.

Results: The technical success rate was 100% (68/68) for PRG and 95% (108/114) for PEG. Thirty day follow-up was available in 68% (46/68) of the PRG patients and 69% (79/114) of the PEG patients. Incidental abnormal findings were noted in 28% (32/114) of the PEG patients. In 10% of the patients, the endoscopic findings resulted in concomitant endoscopic biopsy or additional medications. No biopsy showed evidence of malignancy. See Tables 2, 3 and 4 for mortality and complication rates. There were no statistical differences between 30-day follow-up, mortality or complications between PRG and PEG.

Conclusions: The authors conclude that PRG may have broader indications than PEG. In fact, PRG can be used when PEG has failed. They also state that their data complements other published data supporting a higher success rate and fewer major complications with PRG.

Yarze et al 2001

Objective(s): To investigate the feasibility and safety of early feeding following the initial placement of one-step button (OSB) gastrostomy catheters.

Methods: A prospective single center study of 25 patients (18 men, 7 women; mean age 63 years) using PEG without gastropexy for the placement of One-Step Button Devices (OSB) (Boston, Scientific Corporation, Watertown, MA). A 24-Fr Microvasive kit was used for button placement by the Seldinger technique. The stoma measuring device contained in the kit was used to ensure proper button shaft length. The button was snug but could be easily rotated and a few millimeters of the shaft were visible above skin level. Button gastrograms were performed 3 hours after PEG to ensure proper placement.

Results: Feedings were started 4-6 hours post-procedure as there was no extravasation of the contrast medium during the gastrogram. Nine patients had the PEG on an inpatient basis as they were hospitalized for other reasons. The other 16 patients has PEG on an outpatient basis. Pneumoperitoneum occurred in 19 patients (76%) although extravasation of contrast was not seen in any patient.

Conclusions: Seventy-six percent (19/25) of patients experience pneumoperitoneum though the authors do not speculate on the reason for this high rate. In 2 of the 3 patients who developed cellulitis, button extrusion occurred several weeks after the cellulitis was treated. The authors speculate that though they may have placed the buttons too tightly leading to the extrusion, they do not believe that to be the cause. Rather, they believe the cellulitis was truly the cause of the extrusion. The authors performed the procedures from this study on 30 subsequent patients and all patients did well. They believe that early feeding following initial placement of a One-Step Button gastrostomy device is safe and well-tolerated.

Yip D, Vanasco M, Funaki B 2004

Objective(s): To compare the complication rates and performance of tubes in percutaneous mushroom gastrostomy, balloon gastrostomy and gastrojejunostomy.

Methods: A retrospective single center study of 203 patients (95 men, 108 women; mean age 63.9 years) who underwent PRG or percutaneous gastrojejunostomy between September, 1999 and April 2001. Tubes were placed by either conventional Seldinger technique or by oropharyngeal technique. The oropharyngeal technique using 20-Fr mushroom catheter (Pull-PEG, Boston Scientific, Natick, MA) was the preferred method except where contraindicated by head, neck or oropharyngeal cancer in which case a 18-Fr balloon-retained catheter

(Microvasiv, Boston Scientific, Natick, MA) was inserted. In patients at risk for aspiration, gastric atony or gastric outlet obstruction, a 14-Fr gastrojejunostomy tube (Carey-Alzate-Coons, Cook, Bloomington, IN) was inserted. For mushroom catheters, a single T-fastener (Cope GI suture anchor, Cook) was placed. Once the snare was pulled out of the mouth, the gastropexy suture was cut, the tube attached to the snare and then placed by the "pull" technique. For balloon-retained catheters, 2-3 T-fasteners (Cope, GI suture anchor, Cook or Brown/Mueller, Boston Scientific, Natick, MA) were used for gastropexy. The tract was serially dilated to accept a 24-Fr peel away sheath. An 18-Fr catheter was inserted and the sheath removed. The T-fasteners were released 2 weeks post-procedure. For GJ placement, 2-3 T-fasteners (same used for balloon-retention) were used for gastropexy. The site was serially dilated to accept the peel-away sheath. A 14-Fr Carey-Alzate-Coons GJ tube (Cook, Bloomington, IN) was inserted and the Malecot retention device deployed. The T-fasteners were removed 2 weeks post-procedure. Follow-up was done through chart review through January 10, 2002.

Results: One hundred twelve patients (112) received a total of 114 mushroom-retained gastrostomy tubes. Forty-two patients (42) received 67 balloon-retained catheters. Forty-nine (49) patients received 69 GJ tubes. See Tables 2, 3 and 4 for mortality and complication rates. There were no statistically significant differences between procedural complications among the different types of tubes. Mushroom-retained catheters had significantly fewer complications than balloon-retained or GJ tubes.

Conclusions: The authors believe this was the first single institution comparison of the various types of gastrostomy catheters. The authors concluded that patients without gastroesophageal reflux prior to the gastrostomy procedure are unlikely to benefit from placement of a GJ tube. Therefore, gastrostomy should be the procedure of choice without previous evidence of reflux or an indication requiring GJ placement. The high mortality rate with GJ tubes was related to the fact that clinicians prefer GJ tubes in patients with significant comorbidities. GJ tubes had a high rate of malfunction due to clogging and almost 30% of the GJ tubes in this study had to be replaced compared to less than 2% of the larger bore mushroom- or balloon-retained tubes. Even when a larger bore GJ tube was used, the length of the tube was likely to increase the rate of clogging. The authors recommend the use of gastrostomy unless the patient has known gastroesophageal reflux. The various procedures had similar procedure complication rates. Mushroom-retained catheters had the best overall tube patency and lowest tube complication rates.

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