TYPES OF SUTURES AFFECTING GASTROINTESTINAL ANASTOMOSIS ..

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GASTROINTESTINAL ANASTOMOSIS:

In general ,**surgical anastomosis** is a surgical technique used to make a new connection made between two body structures that carry fluid, such as blood vessels or bowel. For example, a colonic anastomosis is used to restore colonic continuity after the resection of coloncancer.

Key Points in gastrointestinal anastomosis:

• Pay attention to basic surgical principles
• Sub-mucosa is the layer of strength
• Use synthetic absorbable suture materials
• Appositional techniques are best
• Intestinal sutures should engage at least 3 - 4 m
m of sub-mucosa
• Intestinal sutures should be no further apart than
2 - 3 mm
• Always handle bowel wall using atraumatic technique
• Examine the integrity of your anastomsis visually
• Minimize trauma and contamination.
• Maintain good blood supply to the surgical site.
• Avoid tension across the suture line as this may increase the possibility of leak and/or breakdown.
• Pay attention to your established criteria when suturing intestinal defects

Type of suture materials:

The ideal suture material is one that is easy to handle, ties without fraying, is easy to sterilize, elicits little or no inflammation, and maintains the strength of the anastomosis during the lag phase of healing. None of the currently available suture materials fulfills all of these criteria.

Absorbable sutures:

- **Catgut**. Catgut is NOT recommended for any visceral organ surgery. Its unpredictable absorption and rapid loss of tensile strength in such situations may result in an unacceptably high number of anastomotic leaks and /or breakdown. Use of catgut suture in gastrointestinal surgery is not recommended.
- **Dexon, Polysorb, and Vicryl.** Synthetic absorbable braided suture (i.e., polyglactin, poly-glycolic acid) have become very popular. The braided nature however does result in increased tissue drag and difficult knotting ability.
- **Biosyn and Monocryl**. These sutures have similar properties to Dexon, Polysorb and Vicryl however they are monofilament. They were developed to overcome the problem of tissue drag and knot slipping found in the braided synthetic absorbables. Their predictable hydrolytic absorption is unaffected by their immediate environment (i.e., infection, contamination, hypoproteinemia).They retain high tensilestrength for a long period of time (2-3 weeks) and have very good handling characteristics.These suture materials are ideal for use in gastrointestinal surgery. These sutures are the authors choice for gastrointestinal surgery.
- **PDS and Maxon**. PDS and Maxon, are synthetic absorbable monofilament suture materials with similar properties to that of Dexon and Vicryl. They have been shown to retain approximately 70% of their tensile strength at 3-4 weeks, and are absorbed by hydrolysis (unaffected by infection, contamination, hypoproteinemia). These suture materials are ideal for use in gastrointestinal surgery. Possible disadvantages include stiffness, a tendency to kink and prolonged absorbtion time

Nonabsorbable sutures:

- **Nylon, Polypropylene**. Monofilament, nonabsorbables are excellent suture materials for use in contaminated or infected surgical sites. They have a high tensile strength, are relatively inert in tissue, noncapillary, and do not act as a nidus for infection. These materials pass through tissue with essentially no tissue drag and have excellent knot tying security at sizes 3-0 to 5-0. For their properties, effectiveness, and cost, these are the author's nonabsorbable sutures of choice for intestinal anastomosis and enterotomy closure. Possible disadvantage of these materials is their memory.

- **Silk, Mersilene, Bronamid, Vetafil**. In general, stay away from burying multifilament or braided nonabsorbable suture material. These sutures may harbor infection for years and may result in suture related abdominal abscesses ordraining tracts. They should never be used in gastrointestinal surgery.

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Needles:

Swaged-on "atraumatic" reversed cutting, narrow taper point, or fine taper-cut needles can all be used for gastrointestinal surgery. The author prefers a narrow taper point needle. Needle diameter should approach the diameter of the suture.

Suture Placement:

When suturing intestine, sutures should be placed 3- 4 mm from the cut edge of the intestinal serosa and no more than 2 - 3 mm apart.
It is important to recognize everted mucosa and be sure the 3 - 4 mm bite in the intestinal wall is not just in mucosa but engages all layers of the intestinal wall. Measure your intestinal wall bite from the cut edge of the serosa.

Suture Patterns:

There is considerable controversy regarding specific suture pattern for use in small intestinal surgery. Everting, inverting, and appositional suture patterns have been used experimentally and clinically for suturing enterotomies and anastomoses. Appositional patterns are recommended as they cause little lumen compromise postoperatively.

-Everting:
Everting patterns (i.e., horizontal mattress) have been shown to encourage adhesions and result in lumen stenosis. This technique is NOT recommended. The everting technique is not to be confused with the mild eversion of mucosa that occurs in the appositional techniques described below.

-Inverting:
In small animals adequate lumen diameter is an important consideration with any technique. Inverting patterns result in substantial lumen compromise of the small intestine and are NOT recommended in dogs and cats.
-Apposition:

Anatomic apposition of individual layers of the bowel wall (i.e., mucosa, submucosa, muscularis, and serosa) result in primary intestinal healing. This technique is superior to inverting or everting techniques because apposition of intestinal margins eliminates lumen compromise. This is the authors preferred technique for suturing all hollow viscus organs in the abdominal cavity. Suture patterns of choice include:

1-Simple interrupted apposing. This technique involves suturing all layers of the intestinal wall and tying the knots on top of the serosa to approximate cut edges. The sutures should be tied tight enough to effect a watertight seal, yet not so tight as to blanch the tissue and cause ischemia of intestinal margins. This technique is simple, fast, reliable, and does not result in lumen compromise.

2- Simple continuous apposing. This technique is similar to the simple interrupted appositional technique however, a continuous suturepattern is used rather than an interrupted pattern. Advantages include faster anastomosis, equal suture tension over the entire anastomosis, airtight-watertight seal, and mucosal eversion is minimized. This is the authors preferred suture pattern for suturing all hollow viscus organs in the abdominal cavity.

In this article , I'm going to discuss some operative details& details about suturing techniques.

Approach Considerations:

Preoperative nasogastric aspiration is usually required. Similarly, urinary catheterization is necessary in critically ill patients, during emergency resections, or when infraumbilical incision is used to protect the urinary bladder from injury during laparotomy.

An exploratory laparotomy may be performed. If the disorder is diagnosed preoperatively, the pathology can be identified and the part of the intestine to be resected can be isolated and excised. Continuity is restored by performing the anastomosis.

Sometimes, the resection and anastomosis of the bowel could be components of another major surgical procedure, such as a Whipple procedure, gastrectomy, urinary diversions, or resection of a retroperitoneal tumor.

Incision and Exposure:

Adequate access is the key to ensuring successful intestinal anastomosis. A midline incision is commonly used for the majority of abdominal operations. The use of self-retaining retractors ensures adequate exposure. Exposure in pelvic operations can be improved by changing the position of the patient (Trendelenburg position) so as to displace small-bowel loops away from the pelvis. Packing the small bowel with wet sponges also improves exposure in pelvic procedures. A supraumbilical transverse incision is frequently used in younger children.

Bowel Resection:

The portion of bowel to be resected should be adequately mobilized. Mobilization is rarely a problem with the small bowel, which can be easily brought to the surface. However, the large bowel (especially the retroperitoneal segments) should be adequately mobilized by dividing the lateral peritoneal reflection. Bowel mobilization, in addition to facilitating resection, ensures tension-free anastomosis.

After mobilization of the bowel, the next step is division of the mesentery. Principles to be followed in division of the mesentery include the following:

- Transillumination to identify mesenteric blood vessels
- Isolation of vessels by dividing surrounding fat

- Division between clamps
- Ligation with suitable sutures to prevent knot slippage

On-needle transfixation of large vascular pedicles with nonabsorbable sutures is a safer method. Bleeding or hematoma formation within the leaves of mesentery should be avoided, and preservation of vascular arcade to the bowel ends should be ensured so as to have satisfactory vascularity of the anastomosed bowel. Alternatively, the mesentery can be divided with an ultrasonic scalpel.

The next step is division of the bowel. This is done by applying a non-crushing clamp on the bowel end used for anastomosis and applying crushing clamps on the bowel to be resected so that the intraluminal contents of the resected bowel do not contaminate the peritoneal cavity. Clamps are applied from the anti-mesenteric end, and care should be taken to avoid crushing of the mesentery.

The bowel is divided with a knife close to the crushing clamp so as to preserve adequate bowel length distal to a non-crushing clamp for anastomosis. The direction of division is oblique to ensure an adequate lumen and to maintain a longer length of the mesenteric end as compared to the anti-mesenteric end. The specimen is removed with clamps in situ.

Care should be taken to avoid spillage of enteric contents during bowel division. Alternatively, bowel division can also done with a linear cutting (gastrointestinal anastomosis [GIA]) stapler, which divides and seals two cut ends simultaneously, thereby preventing fecal contamination.

Hand-Sewn Anastomosis

Small-bowel anastomosis

This section describes a double-layer sutured end-to-end small-bowel enteroenterostomy. Two cut ends of the bowel are brought in close apposition. Stay sutures of 3-0 silk are placed between the serosa of the proximal and distal ends of the bowel approximately 5 mm from the cut end.

Interrupted seromuscular sutures (Lembert stitches) of 3-0 silk are placed between these stay sutures with an approximately 3-mm gap between each two sutures. Lembert stitches should incorporate only the seromuscular layer; care must be taken not to incorporate the full thickness of the bowel wall. Sutures are tied sequentially, with care taken

not to apply excessive tension so as to minimize the risk of cut-through of the seromuscular layer. This forms the posterior outer layer.

Next, a Connell stitch is made in both ends. The Connell stitch is achieved by passing the suture from the outside in, then inside out, on one end. The same step is repeated on the other end in the form of a continuous U-shape. The suture is tied so that the knot is outside. The posterior inner layer is completed by taking interrupted full-thickness stitches of 3-0 polyglactin, starting from the near end. The sutures are tied sequentially so that the knot lies inside the lumen.

The needle must be pulled through each edge separately. Trying to include both edges in one pass of the needle can prevent the surgeon from taking a full-thickness bite on both edges. It is necessary to include the submucosa carefully because this is the strongest layer of the bowel wall and gives strength to the anastomosis.

The anterior inner layer is completed in a similar fashion, starting from the far end. The pouting of mucosa is prevented by taking a small amount of mucosa and a large part of the seromuscular layer, which results in inversion of the mucosa.

The anterior outer seromuscular layer is completed by taking interrupted Lembert stitches

Narrowing of the lumen by including too much of the bowel into this layer should be avoided. Patency of the lumen can be confirmed by palpation across the anastomosis with the tips of the thumb and the index finger. The mesenteric defect is closed with interrupted stitches of 3-0 silk. Care should be taken to avoid injuring mesenteric vessels so as to prevent ischemia of the anastomotic site.

Gastrojejunostomy

This section describes the technique of gastrojejunostomy following distal gastrectomy. The first step is to bring up the jejunal loop in an antecolic position

Interrupted Lembertseromuscular stitches of 3-0 silk are placed between the antimesenteric end of the jejunum and the posterior gastric wall. This forms the posterior outer layer. After application of a noncrushing intestinal clamp across the jejunal loop, an incision is made in the jejunum with a knife approximately 5 mm lateral to the seromuscular stitches.

The size of the jejunal opening should be slightly smaller than the gastric opening because the small bowel tends to stretch while taking sutures. Two Babcock clamps are placed (one on each anterior wall) to expose the posterior gastric and jejunal walls.

The posterior inner layer is started by making a Connell stitch at the near end with 3-0 polyglactin. The suture is tied so that the knot lies outside the lumen, and the free end of the thread is kept long and held with a hemostat. After the lumen is entered from the outside in with the needle end of the suture, full-thickness continuous interlocking stitches are taken through both edges. The needle must be pulled through each edge separately to ensure a full-thickness bite on both edges. This forms the posterior inner layer.

Once the far end is reached, a Connell stitch is made, and the anterior inner layer is completed by taking continuous interlocking through-and-through stitches. A loop-on-mucosa suture technique is followed, in which the suture is taken from the inside out of the jejunal wall and outside in through the stomach wall, with the pull on the suture being within the lumen. This ensures good inversion of the mucosa

Good inversion of the mucosa is also ensured by taking a small amount of mucosa and a large part of the seromuscular layer. Once half of the anterior inner layer is completed, clamps are released to ensure the absence of bleeding in the posterior layer. If bleeding points are identified, they are controlled by taking interrupted full-thickness stitches through both edges.

The anterior inner layer is completed by tying the free end of the thread on the near end. The double-layer anastomosis is completed with an anterior seromuscular layer of interrupted 3-0 silk sutures

Colorectal anastomosis

Reconstruction after an anterior resection can be performed in either an end-to-end or a side-to-end fashion. A side-to-end technique (Baker anastomosis) is preferred when there is a size discrepancy between two bowel ends. This section describes the technique of end-to-end hand-sewn colorectal anastomosis following anterior resection.

Two bowel ends with right-angle clamps in situ are brought close by applying lateral seromuscular traction sutures of 3-0 silk. The anastomosis is performed in a single layer with 3-0 silk. Posterior interrupted full-thickness sutures are taken from the distal rectum to the

proximal sigmoid colon. Sutures are not tied but are held long with a hemostat. This ensures accurate placement of full-thickness sutures.

After completion of the posterior layer, sutures are tied in order, starting from one corner. While one suture is being tied, the next suture should be held taut by an assistant to ensure that there is no abnormal gap between the two sutures. Next, full-thickness interrupted anterior-layer sutures are taken, following principles similar to those adopted for the posterior layer.

Sutures are then tied to complete the anastomosis. The integrity of the anastomosis can be checked by filling the pelvis with saline and instilling air through the anus to look for any air bubbles. Transanal anastomosis has also been described after total mesorectal excision.

Esophagogastric anastomosis

The characteristic feature of the esophageal anatomy is the unusually fatty submucosa, which allows greater mobility of the overlying mucosa. In performing an esophageal anastomosis, care should be taken to ensure that every suture transfixes the mucosal edge, which can retract more than 1 cm from the cut esophageal margin. The esophagus also lacks a serosal layer, so that the soft and often tenuous muscle holds sutures poorly. This section describes the technique of two-layer end-to-side esophagogastric anastomosis using 3-0 silk.

The outer posterior layer uses interrupted stitches between the muscular layer of the esophagus and the seromuscular layer of the stomach. Initially, sutures are placed without being tied. During tying, care should be taken to draw the stomach towards the esophagus because the muscular layer of the esophagus holds sutures poorly. Corner ties are left long and held with a hemostat.

The posterior inner layer uses interrupted stitches left long without tying. The mucosa should be identified and included in each stitch to achieve mucosal apposition and avoid anastomotic leak. Sutures are then tied sequentially so that the knot lies inside the lumen. At this stage, the nasogastric tube is passed from the esophagus into the stomach and fixed by the anesthetist to the patient’s nose.

The anterior inner layer is completed in a similar fashion, with care taken to include mucosa. The sutures are tied so that the knot lies outside the lumen.

Anastomosis is completed by taking the anterior outer layer of interrupted stitches between the muscular layer of the esophagus and the seromuscular layer of the stomach.

A single-layer esophagogastric anastomosis also can be fashioned with interrupted silk sutures. Before the anastomosis is performed, the stomach can be hitched to the prevertebral fascia with interrupted silk sutures so that it does not slide down with peristalsis.

Stapled Anastomosis

Small-bowel anastomosis

A stapled small-bowel anastomosis can be performed in either an end-to-end (anatomic or functional) or a side-to-side fashion. True anatomic end-to-end small-bowel anastomosis is performed with a noncutting linear stapler. An important prerequisite for this type of anastomosis is that there should not be any disparity in size between the two bowel ends.

The first step is to triangulate the bowel ends by placing three traction sutures. The linear stapler is placed between two of the sutures and fired. The same process is repeated twice on the other two sides of the triangle by rotating the bowel. Any excess tissue remaining after the firing of the stapler is removed. This technique results in an everting anastomosis. Potential drawbacks of this technique are the possible anastomotic site stricture and ischemic damage secondary to an injury of mesenteric blood vessels when staples are applied close to the mesenteric end.

However, stapled small-bowel anastomosis is commonly performed in a functional end-to-end fashion by using a linear cutting stapler. In this technique, two cut ends of the bowel are placed side to side. The two forks of the stapling device are placed through open bowel ends or an enterotomy (made in the antimesenteric border if the bowel ends are stapled). Care should be taken to avoid inclusion of the mesentery between branches of the stapler. The stapler is fired to create lumen between two bowel segments by dividing the two bowel walls. The bowel ends or enterotomy can be closed by applying a linear stapler or using a hand-sewn technique.

Bleeding from stapled edges is better controlled by taking underrunning sutures. Care should be taken to avoid application of cautery to the stapled edge; doing so can result in transmission of electric current to the rest of the bowel, resulting in thermal damage.

Gastrojejunostomy

This section describes the technique of stapled gastrojejunostomy following subtotal gastrectomy. Resection of the stomach is carried out with a linear cutter so that the cut end is excised and simultaneously stapled.

After completion of the gastrectomy, the jejunal loop is brought up in an antecolic or retrocolic fashion. Seromuscular interrupted stay sutures of 3-0 silk are placed between the posterior gastric wall close to the greater curvature and the jejunal wall to bring them in apposition. A small gastrotomy and enterotomy are made to facilitate the passage of a 55-mm linear cutting (GIA) stapler.

The two limbs of the GIA stapler are placed simultaneously into the stomach, with the cartridge fork of the linear cutter inside the stomach. Care should be taken not to include part of the small-bowel mesentery. The stapler is fired so that the common wall between the stomach and the jejunum is divided and the gastrojejunostomy created.

The nasogastric tube can be either placed in the stomach or advanced into the efferent jejunal loop if early enteral feeding is planned. The enterotomy and gastrotomy can be closed with an appropriately sized linear stapler or in two layers, with the inner continuous layer using 3-0 polyglactin and the outer interrupted layer using 3-0 silk.

Colorectal anastomosis

A stapled colorectal anastomosis following anterior or lower anterior resection for carcinoma of the rectum can be performed in either an end-to-end or an end-to-side fashion. This section describes the technique of an end-to-end double-stapled colorectal anastomosis.

After mobilization of the splenic flexure, proximal division of colon is performed at the junction of the sigmoid and descending colon. Bowel division can be performed by using a 55-mm linear transverse anastomosis (TA) stapler or cutting with a knife after applying a bowel clamp.

After complete mobilization of the rectum, a right-angle clamp is applied distal to the tumor, and the distal rectum is divided with a linear stapler (30-mm or 45-mm contour device or roticulator) applied distal to the right-angle clamp. An adequate distal mural margin (2 cm) is necessary to prevent recurrence. The distal rectal stump can be washed with saline or

dilute povidone-iodine to destroy exfoliated tumor cells shed in the distal rectum before a clamp or stapler is applied.

After division of the distal rectum, the bowel ends are prepared for a double-stapled anastomosis using a circular stapler (31-mm or 33-mm end-to-end anastomosis [EEA] stapler). The proximal bowel is prepared by applying full-thickness purse-string stitches of 3-0 silk or polypropylene. The anvil head is placed in the proximal colon, and the purse-string suture is tied above the tying notch.

After gentle dilatation of the anus, the shaft of the circular EEA stapler is advanced through the anal canal under the guidance of the abdominal surgeon and placed close to the staple line with the trocar fully retracted inside. The trocar is then fully extended so as to pierce the tissue and advance through the rectal wall, either anterior or posterior to the staple line. The detachable head assembly is then reattached by sliding the anvil shaft over the trocar and pushing until the detachable head assembly snaps with the trocar into its fully seated position.

The ends of the circular stapler are closed, with care taken to confirm that there is no twist in the mesentery of the proximal colon. The stapler is tightened completely, fired, and then gently removed by rotating it counterclockwise for half a turn before removal. The presence of two intact donuts should be confirmed.

The integrity of the anastomosis should be checked by filling the pelvis with saline, instilling air in the distal rectum, and looking for air bubbles. If donuts are not complete, additional sutures should be made. In some cases, proximal diversion with proximal colostomy or ileostomy may be considered.

Cervical esophagogastric anastomosis

This section describes the technique of stapled cervical esophagogastric anastomosis popularized by Orringer .After removal of the tumor-bearing segment of the esophagus and division of the proximal esophagus, the gastric tube is brought into the neck. A 1.5- to 2-cm-long anterior vertical gastrotomy is made for passage of stapler.

The site for the gastrotomy is selected by approximating the divided end of the esophagus against the anterior gastric wall. It should be low enough to facilitate subsequent placement of a 3-cm-long stapler cartridge.

The esophagus is aligned to the stomach by placing two stay sutures. The first suture is the full-thickness stitch through the anterior corner of the esophagus. The second is the full-thickness stitch through the upper end of the gastrotomy (inside out) to the posterior corner of the divided esophagus (outside in). A GIA stapler (30 mm) is inserted simultaneously into the stomach and esophagus while downward traction on the sutures is maintained, with the thicker staple-bearing portion of cartridge inside the esophagus.

Two stay sutures are placed between the anterior gastric wall and the adjacent esophagus on either side of the stapler to take tension off the anastomosis. The stapler is fired so that the common wall formed by the posterior esophageal wall and anterior gastric wall is divided, creating a large esophagogastric anastomosis.

A 16-French nasogastric tube is inserted by the anesthetist and advanced across the anastomosis into the intrathoracic stomach.

The esophagotomy and gastrotomy are closed with sutures in two layers (an inner continuous layer using 3-0 or 4-0 polyglactin and an outer interrupted layer using 3-0 silk).

Technique in Children

The bowel loop with the pathologic finding is isolated. Gentle bowel handling throughout the procedure is very important. Noncrushing intestinal clamps may be used for isolating the loop to be excised. The mesenteric vessels supplying the part to be excised are identified and divided after ligation with silk ligatures.

The intestinal loop is excised, and the cut edges are examined for bleeding and viability. If viability is doubtful, more bowel is excised. The adequacy of the lumen is ensured, and the anastomosis is performed with interrupted sutures in a single layer. The most commonly used suture material is polyglactin 910. Intraluminal staplers have been used for intestinal anastomosis and are said to reduce the operating time of most surgeons.

With intestinal atresia, it is necessary to reduce the size of the proximal atretic end by excising the dilated end portion or performed a tapering enteroplasty to facilitate performance of the anastomosis. This is necessary to avoid prolonged functional obstruction that may occur.

For multiple intestinal atresias present in a neonate, it may be necessary to perform multiple anastomoses as a single-stage procedure.

For meconium ileus, a chimney procedure (eg, Mikulicz procedure, Bishop-Koop procedure, or Santullienterostomy) may be done.

Necrotizing enterocolitis may necessitate different procedures (eg, primary resection and anastomosis, resection and enterostomy, or relook surgery after a "clip-and-drop procedure"), depending upon the condition of the intestine and the extent of the disease.

Complications

Important complications following intestinal anastomosis include the following:

- Anastomotic leak
- Bleeding
- Wound infection
- Anastomotic stricture
- Prolonged functional ileus, especially in children

Anastomotic leak

Anastomotic leak is the most feared early complication of intestinal anastomosis. The healing of an intestinal anastomosis is broadly divided into three phases, as follows:

- Inflammatory phase
- Fibroplasia phase
- Remodeling phase

During the inflammatory phase, the integrity of the anastomosis is dependent on mechanical strength provided by sutures. The inflammatory phase is followed by the fibroplasia phase around postoperative days 5-7; this phase is characterized by a switch from collagen degradation to collagen deposition, which gives strength to the anastomosis. Any systemic or local factor that causes delay in the transition from the inflammatory phase to the fibroplasia phase can result in poor healing and anastomotic leak.

Systemic conditions that increase the risk of anastomotic leak are anemia, diabetes mellitus, malnutrition with hypoalbuminemia, vitamin deficiencies, and steroid therapy. Local factors such as the presence of irradiated bowel, anastomosis involving disease-affected bowel, and inadequate blood flow are associated with poor healing and anastomotic leak.

In a 2012 prospective study of 616 patients who underwent colorectal resection, anastomoses less than 10 cm from the anal verge, a Charlson Comorbidity Index of 3 or more, high ligation of the inferior mesenteric artery, male sex (possibly by reason of the narrower pelvis), and intraoperative complications or adverse events that were either surgical or anesthesia-related were found to be independent risk factors for anastomotic leak after large-bowel surgery.

Anastomotic leak presenting on postoperative day 1 or 2 is invariably due to technical reasons. Anastomotic leak secondary to interference in the normal healing mechanism usually presents around the end of postoperative week 1. Anastomotic leak can present either as frank peritonitis when the leak is uncontrolled or as localized intra-abdominal collection/abscess if the leak is controlled.

An uncontrolled leak with diffuse peritonitis is associated with high morbidity and mortality and necessitates reexploration. During repeat laparotomy, a thorough lavage of the peritoneal cavity should be carried out. In most circumstances, it is better to dismantle the anastomosis and bring out the bowel loops as a stoma. A controlled leak presenting with a localized intra-abdominal abscess can be managed conservatively with percutaneous drainage of the abscess under imaging guidance and antibiotics.

In a study of 452 consecutive patients undergoing bowel resection with anastomosis, Erb et al found that abnormal vital signs were common after surgery and did not accurately predict the presence of anastomotic leaks.In postoperative week 1, fever, tachycardia, tachypnea, hypotension, and leukocytosis occurred daily in approximately 70% of patients who did not have anastomotic leaks and in more than 90% of those who did. The positive predictive values for fever, hypotension, and tachypnea were 11%, 4%, and 4%, respectively.

Bleeding:

Bleeding-related complications after intestinal anastomosis are common in patients with sepsis and deranged coagulopathy. Bleeding may

manifest in the immediate postoperative period as hemorrhagic aspirate from the nasogastric tube, hematemesis, melena, or bleeding from an intra-abdominal drain.

Patients with bleeding should be aggressively managed with correction of coagulopathy (if present) and blood transfusion. If the bleeding results in hemodynamic instability with a significant decrease in hemoglobin, urgent reexploration should be performed. Intraoperative anastomotic site bleeding is characterized by blood in the intestinal lumen distal to the anastomosis. In such circumstances, the anterior layer of the sutures is opened and both layers are examined for evidence of any bleeding.

Once the bleeding site is identified, it can be controlled with hemostatic sutures. The decision to reanastomose or to convert into a stoma depends on the general condition of the patient. Conversion to a stoma is preferred in patients who are hemodynamically unstable.

Wound infection

Wound infection occurs when there is uncontrolled spillage of intestinal contents during anastomosis. It is managed by removing a few skin sutures and ensuring proper drainage of pus. Superficial surgical site infection does not require treatment with systemic antibiotics.

Anastomotic stricture

Anastomotic stricture is a late complication of intestinal anastomosis. The risk of anastomotic stricture is marginally increased after end-to-end anastomosis, especially when the anastomosis is performed with a stapled technique.

The most important risk factor for anastomotic stricture is a controlled anastomotic leak managed conservatively. This scenario is more common after cervical esophageal and colorectal anastomotic leak. Anastomotic strictures occurring in these areas can be conservatively managed with endoscopic or colonoscopic dilatation. If this fails, surgical revision might be required.

Single-layer vs double-layer anastomosis:

Intestinal anastomosis is traditionally performed in two layers. The shortcoming of the two-layer technique is that it is somewhat tedious and time-consuming to perform. Potential advantages of the single-layer technique are that it takes less time to perform and that it costs less, though safety may be a concern. However, randomized trials and meta-analyses comparing the two techniques of intestinal anastomosis did not find increases in the rate of anastomotic leak, the incidence of perioperative complications, mortality, or the length of hospital stay with the single-layer technique.

-Shikata el al. (2006) BMC Surgery
Compared single versus two layer intestinal anastomosis
Meta-analysis of randomized controlled trials
No difference in leak rates

-Burch et al (2000) Annals of Surgery
Compared single-layer continuous technique with two layer interrupted technique
Prospective randomized trial
No difference in leak rates
Lower cost
Less time

Continuous vs interrupted sutures:

An intestinal anastomosis can be fashioned by using either simple (continuous) or interrupted sutures. A continuous suture is less time-consuming to place, and the suture line is more watertight with better hemostasis. However, the entire suture line is based on a single stitch.

Animal studies have shown that anastomotic blood flow and perianastomotic oxygen tension is low after a continuous suture, resulting in impaired healing and increased complication rates.However, prospective randomized trials have failed to show any difference in complication rates between the two techniques.

Hand-sewn vs stapled anastomosis:

The introduction of reliable disposable instruments has led to an increase in the use of stapling devices for intestinal anastomosis. A meta-analysis comparing stapled and hand-sewn anastomoses in colorectal surgery included nine studies involving 1233 patients (622 stapled and 611 hand-sewn); the authors did not find any significant difference in the incidence of anastomotic leak between the two techniques.Another meta-analysis included 13 trials comparing hand-sewn with stapled colorectal anastomosis and found a high incidence of stricture and intraoperative problems in the stapled group.Animal studies have found that a stapled anastomosis heals by secondary intention, whereas a sutured anastomosis heals by primary intention; this may account for the high rate of stricture.

Another systematic review compared hand-sewn and stapled techniques of ileocolic anastomosis in six trials and 955 patients (357 stapled, 598 hand-sewn). The authors found a significantly lower leak rate in stapled anastomosis.

Important advantages of the stapled technique are the shorter operating time and the greater ease of performing the procedure, especially in low pelvic anastomoses.

Inverting vseverting anastomosis

A 1966 comparison of inverted and everted techniques for anastomosis in experimental animals concluded that an inverted anastomosis had a weaker union than an everted anastomosis. The authors stated that the use of interrupted silk sutures used to evert the anastomosis was better than the conventional two-layer inverting technique.

However, these early findings were contradicted by Goligher et al.In a randomized trial comparing these two techniques of colorectal anastomosis, the everted suture anastomosis group had a substantially higher rate of fecal fistula (43%) than the inverted suture anastomosis group (8%). Currently, inverted anastomosis is the most widely used technique worldwide.

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