



Prevention of Anastomotic Leakage in Gastrointestinal Tract: A Brief Literature Review

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Authors' contributions

This work was carried out in collaboration between all authors. Author ETP designed research and wrote the paper. Author MV performed research and analyzed data. Author TEP reviewed and approved the paper.

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ABSTRACT

Anastomotic leakage and its consequences in gastrointestinal tract surgery, especially in low anterior resection, is a day major complication affecting morbidity and mortality rate. Early detection and prevention is crucial in order for sepsis to be avoided. There are well-defined risk factors influencing anastomosis healing. The patient's status and operative conditions including surgical technique have been incriminated for dehiscence. The correct application of conventional operative principles is important. The outcome of anastomosis either handsewn or stapled is deemed to have no major difference. Novel compression anastomotic instruments have been proposed as an alternative option, yet without wide broad application and enough experience. There are innovative staple line reinforcement materials. Some topics such as proximal defunctioning stoma, pelvic tubes or the recently proposed transanal drainage tube are in debate for routine or selective use. Protective transverse colostomy does not affect the risk of leakage, but it reduces the septic consequences. Laparoscopic procedures have similar anastomotic leakage rate with open operations. There is no consensus on whether covering anastomosis with great omentum is necessary as protection or for mechanical bowel preparation. Novel promising perspectives exist as well as commonly accepted aspects. The combination of conventional techniques (handsewn or stapled anastomosis performance) with modern techniques may be proved effective in reducing anastomotic leakage rates.

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1. INTRODUCTION

Anastomotic leakage in gastrointestinal tract surgery, remains the most serious complication, especially regarding low anterior resection, affecting morbidity and mortality rates. Subsequently, its prevention is crucial given that emergency operation is associated with higher risk of dehiscence [1-3].

The incriminating risk factors affecting anastomosis healing are, patient's status and operating conditions, including surgical technique [3,4].

Patient's status includes malnutrition (weight loss, hypoalbuminemia), anemia or hypoxemia, electrolyte disturbances, uremia, steroids, immunosuppressant medication, radiation therapy, smoking, non-steroidal anti-inflammatory drugs and alcohol, leukocytosis, cardiovascular disease and diverticular disease of the colon.

The intraoperative factors, incriminated for higher risk of dehiscence are low anterior resection, prolongation in surgical manipulations (exceeding over 2 hours), intestinal obstruction, insufficient blood supply of anastomosis, perioperative blood transfusion and sepsis. At low anterior resection, factors such as gender (higher rates in males), obesity or patients with ASA score ≥ 3 are incriminated. Neo-adjuvant radiation therapy for rectal cancer is also an aggravating factor.

1.1 Operative Technique

Basic operative principles of sufficient blood supply, free tension in approximating the tips and no extraversion of the mucosa still constitute the fundamental factors for optimal performance of an anastomosis.

Anastomosis can be performed either with sutures of monoclonal absorbable stitches or with titanium clips by special staplers, which are widely endorsed over the last thirty years. The outcome of anastomosis, either handsewn or stapled remains debatable. There is not enough evidence indicating that the use of staplers clearly outweighs the handsewn anastomosis. Technique selection depends on surgeon's

experience, patient's status and availability of equipment [5].

As far as the way handsewn anastomosis performance is concerned, and in particular whether it shall be performed in one or two layers, with continuous or intermittent suture, it remains a controversial matter. A recent large review, though, has shown that anastomosis performed in one layer by continuous suture of slowly absorbable monoclonal stitch and eversion of mucosa, is preferable [6].

A recent meta-analysis in 1,233 patients (Cochrane Collaboration method) revealed the lack of evidence of any superiority of stapler-made colorectal anastomosis compared to handsewn one, regardless the level of anastomosis. The only statistically significant differences observed ($p < 0.05$) were the higher rates of stenosis in stapled anastomosis and the processing time in the handsewn anastomosis [7].

Another recent meta-analysis (Cochrane Collaboration method) for gastroesophageal anastomosis following esophagectomy conducted in 1,407 patients did not indicate any difference in anastomotic leakage and in postoperative mortality between stapler-made and handsewn anastomosis. The only significant difference demonstrated there, was the contribution of the use of circular stapler in the reduction of operating time, but with higher rate in anastomotic stenosis [8].

1.2 Novel Compression Anastomotic Instruments

Novel compression anastomotic instruments have been proposed as an alternative new option [5]. Such instruments are the biofragmental anastomotic ring (Valtrac BAR and AKA-2), the compression anastomotic clip (CAC), the endoluminal compression anastomotic ring (EndoCAR), and the magnetic rings (magnamosis, magnetic anastomosis).

The biofragmental anastomotic ring (Valtrac BAR) consists of two parts (rings) which contain polyglycolic acid (87,5%) and barium sulfate (12,5%). Its range varies (25, 28, 31, 34 mm). Its function is based on placing the rings at the excised tips of intestine enabling their

approximation. Pursestring sutures are placed for safer application of the rings, which are excreted in the feces during the third postoperative week. Since the Valtrac BAR enables the creation of anastomosis without sutures, therefore, it is eligible for the use in anastomosis, both in upper and lower gastrointestinal tract.

The biofragmental anastomotic ring (AKA-2) consists of two rings, one distal and one proximal. Its function simulates that of circular stapler regarding the bowel resection and placement of the rings. The rings and the compressed tips of intestinal wall separate from the rest of anastomosis and they are excreted in the feces during the sixth postoperative day. The advantage of its use is the creation of a lumen with sufficient diameter for the passage of intestinal contents.

The compression anastomotic clip (CAC) consists of heat sensitive material, which becomes in low temperatures (0°C) flexible, while its shape is stabilized at room temperatures. It has been mainly used in vascular prostheses, intramedullary fracture repairs and in dental acts. The device consists of a double ring, which at low temperature (0°C) has a diameter of 30mm and a maximum opening angle of 30°. In human body temperatures, the rings take solid shape holding the interfering intestinal tissue and exerting force with constant pressure. The pressure exerted on the intestinal walls causes ischemia, which triggers the healing process and the creation of anastomosis.

The endoluminal compression anastomotic ring (EndoCAR) consists of two separate synthetic rings, which are placed in a device similar to circular stapler. One end is placed on the tip of proximal stump and the other through the rectum. The device is secured and the rings are locked, exerting force with constant pressure in the interfering intestinal tissue. As a result transient ischemia and necrosis are caused, which trigger the healing process. The rings fall into the lumen and are excreted in 7-10 days.

There is another sutureless method applied to an experimental study in pigs by the Department of Surgery, University of California, San Francisco, USA, consisting in the use of two magnetic rings for anastomosis (magnamosis), which are exerted later. The study's results appear promising.

1.3 Innovative Staple Line Reinforcement Materials

The application of staple line reinforcement material on anastomosis constitutes a new innovative effort, widely used in the upper gastrointestinal tract, but recently also used in the colon. It can be applied on the stapler or later on the anastomosis. The materials are divided into non-absorbable, semi-absorbable and absorbable. The selection criterion of the material depends on surgeon's view; however, absorbable materials' benefits outweigh due to their composition. Namely, while non absorbable materials contain PTFE, and semi-absorbable contain bovine pericardium or porcine submucosa of small intestine, absorbable materials consist of polyglycolic acid/trimethylene carbonate or cellulose, that do not cause reactions and as result are considered safer [4,9,10].

There are promising new techniques for enhancing the anastomosis but without sufficient experience yet. They consist of fibrin glue, biofragmental drainage of polyurethane, which applies on circular stapler on low anastomosis (C-seal) and biosynthetic absorbable cellulose [3,11]. Fibrin glue has a protective effect for prevention of anastomotic leakage [12].

1.4 Debatable Applications

The use of proximal defunctioning (prophylactic) colostomy in low anterior resection (≤ 7 cm) is still controversial [1]. A Swedish multicenter study conducted in 234 patients showed that prophylactic stoma contributed to the reduction of anastomotic leakage from 28% to 10.3% ($p < 0.001$) [13], which was also confirmed by another meta-analysis [14]. A randomized controlled multicenter study has evaluated an evidence based new technique for the prevention of low colorectal anastomosis, temporary percutaneous ileostomy by exclusion probe (jejunal probe introduced in the distal ileum) [15].

The application of pelvic drains is another controversial issue. The recent guidelines for rectal cancer include bowel preparation, pelvic drains and defunctioning stoma [2].

Additionally, the use of transanal drainage for avoiding defunctioning stoma is controversial as well [16]. A recent prospective study in 158 patients with anterior rectal-sigmoidectomy for rectal cancer, showed that placement of

transanal tube for the prevention of leakage and bleeding is an effective method; it reduces the leakage rates (2.5% instead of 7.8%) and bleeding (0% instead of 2.6%) [17]. The effectiveness for transanal tube has also been evaluated [18].

Regarding the intraoperative angiography (laser fluorescence), a prospective study in 402 patients revealed that it reduces anastomotic leakage, in total 3.5% instead of 7.5%; in elective operations 3.1% instead of 7.7% in emergency operations, for patients >70 years old 4.3% instead of 11.9% and in handsewn anastomosis 1.2% instead of 8.5% [19].

1.5 Novel Promising Perspectives

There are experimental applications that show some potential, but they are still in early stages and include the use of bipolar diathermy by high frequency current, sutures coated by doxycycline and mesenchymal stem cells [5].

The perioperative oxygen administration after gastrectomy reduces the leakage from esophagojejunal anastomosis [20]. A recent prospective randomized study in 171 patients showed that the administration of FiO₂ 80% during the first 6 hours had statistically significant decrease (p<0.05) to 9.3% of anastomotic leakage in contrary to 20%, which was observed with FiO₂ 30% administration [21].

A recent prospective randomized trial for bowel preparation in colorectal cancer surgery has recommended oral antibiotics instead of probiotics to prevent infection [22].

1.6 Commonly Accepted Assumptions

The following ascertainments can be drawn based on literature data:

- a. Laparoscopic colectomies have similar leakage rates with open procedures, as well as handsewn anastomosis compared with stapled.
- b. The proximal defunctioning colostomy does not affect the probability of leakage in high-risk anastomosis of the left colon and especially of the low ones, but certainly mitigates the adverse consequences of leakage.
- c. The intraoperative test of the integrity of low recto-sigmoid anastomosis is beneficial and is considered indispensable.

- d. There are no sufficient data and documented consensus, but different views, related to the covering of anastomosis with circular fit of the great omentum, use of drainage tubes at low anastomosis or mechanical bowel preparation.

2. CONCLUSION

While several modern techniques, beyond the conventional ones, have been used in colonic anastomosis, however, they are not broadly accepted by the surgical community. The combination of classical techniques (handsewn anastomoses, use of staplers) with new techniques may be approved sufficient for the reduction of anastomotic leakage rates.

CONSENT

Not applicable.

ETHICAL APPROVAL

Not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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