**Name of journal: *World Journal of Gastrointestinal Surgery***

**ESPS Manuscript NO: 26906**

**Manuscript Type: Minireviews**

**Minimally invasive management of anastomotic leaks in colorectal surgery**

Sevim Y *et al*. Management of colorectal anastomotic leakage

**Yusuf Sevim, Suleyman UtkuCelik, Hana Yavarifar, Cihangir Akyol**

**Yusuf Sevim**, Department of General Surgery, Ankara Numune Training and Research Hospital, Ankara 06100, Turkey

**Suleyman Utku Celik, Cihangir Akyol, Hana Yavarifar,** Department of General Surgery, Ankara University School of Medicine, Ankara 06100, Turkey

**Author contributions:** Sevim Y and Akyol C contributed equally to this work, generated the figures and wrote the manuscript; Celik SU and Yavarifar H contributed to the writing of the manuscript; Akyol C designed the aim of editorial.

**Conflict-of-interest statement:** The authors declare that there is no conflict of interest.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

**Manuscript source:** Invited manuscript

**Correspondence to: Cihangir Akyol, MD, Associate Professor**, Department of General Surgery, Ankara University School of Medicine, 06100 Sihhiye, Ankara, Turkey.cihangirakyol@gmail.com

**Telephone:** +90-312-5082288

**Received:** April 29, 2016

**Peer-review started:** May 4, 2016

**First decision:** July 4, 2016

**Revised:** July 6, 2016

**Accepted:** July 20, 2016

**Article in press:**

**Published online:**

**Abstract**

Anastomotic leakage is a feared and unfortunate complication of colorectal surgery. This distressed situation can cause severe morbidity and significantly affects quality of life. Additional interventions may cause more morbidity and mortality. Parenteral nutrition and temporary diverting ostomy are standard treatments of anastomotic leak. However, minimally invasive treatment modalities of anastomotic dehiscence have been widely used recently in line with technological developments. These modalities include laparoscopic repair, endoscopic self-expandable metallic stents, endoscopic clip, over the scope clip, endoanal repair, and endoanal sponge. We mainly aimed in this review to provide an overview of the current knowledge on minimally invasive management of anastomotic leaks.

**Key words:** Anastomotic leak; Colorectal surgery; Minimally invasive surgery

**© The Author(s) 2016.** Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** Anastomotic leakage is the most feared complication of colorectal surgery, leading to significant patient morbidity and mortality. Its incidence is 3%-6%, even in experienced hands. Despite the high prevalence of this condition, there is no consensus on proper management of anastomotic leaks. In the review, we summarize and discuss the present knowledge on minimally invasive treatment strategies of anastomotic leakage after colorectal surgery.

Sevim Y, Celik SU, Yavarifar H, Akyol C. Minimally invasive management of anastomotic leaks in colorectal surgery. *World J Gastrointest Surg* 2016; In press

**INTRODUCTION**

Anastomotic leak (AL) following colorectal surgery is a feared complication and its incidence is 3%-6%, even in experienced hands[1]. Anastomotic leaks can cause severe morbidity, cost, and affect quality of life. Moreover, major additional interventions may lead to more morbidity and mortality (rates up to 10-20%)[2]. Today, minimally invasive treatment modalities of ALs have been widely used as a result of technological developments. These modalities include laparoscopic repair, endoscopic self-expandable metallic stents (SEMS), endoscopic clip, over the scope clip (OTSC), endoanal repair, and endoanal sponge.

In this review, we summarize and discuss the present knowledge on minimally invasive treatment strategies of anastomotic leakage after colorectal surgery.

**LAPAROSCOPIC REPAIR AND MANAGEMENT**

In the last two decades there have been significant developments in the field of minimally invasive surgical procedures including laparoscopy. Despite these advances in laparoscopic instrumentation and techniques, laparoscopic management following AL after colorectal surgery is still under debate.

A retrospective study by Cucurullo *et al*[3] reported that anastomotic leakage was the most common finding (57.1%) at laparoscopic re-intervention. In this study, 91.7% of cases were managed by anastomotic repair, peritoneal lavage, and temporary diverting ostomy. Only 8.3% of ALs required a Hartmann’s procedure in consequence of gross fecal contamination. Conversion rate was 5.6%, because of extensive colonic ischemia and generalized peritonitis. Lee *et al*[4] also reported 8.2% conversion rate, and all ALs were treated with ileostomy/colostomy with or without anastomotic repair. They compared the results of open and laparoscopic management, and observed significantly shorter hospital stay, lower 30-day postoperative morbidity and complication, and improved stoma closure rate in the laparoscopic group. In other studies by Wind *et al*[5] and Vennix *et al*[6], morbidity rate, hospital stay, ICU admission, and incisional hernia rate were reduced in the laparoscopic re-intervention group. Furthermore, re-laparoscopy can be used a diagnostic tool if clinical concern exists despite an adjunctive diagnostic imaging with reported diagnostic accuracy between 93% and 100%[7].

Laparoscopic re-intervention is a safe, feasible, and effective technique and can be considered as a diagnostic option as well as the first therapeutic approach for evaluating suspected postoperative complications. Today, many studies encourage the use of laparoscopy for the treatment of complications following minimally invasive colorectal surgery in skilled hands.

**ENDOSCOPIC SELF-EXPANDING METALLIC STENT (SEMS), AND OTHER STENTS**

The use of colonic stents has significantly evolved over the last decades as an alternative method of converting emergency surgery for obstructing colorectal cancers to safer definitive elective surgery or as palliative treatment for inoperable malignant colorectal strictures with high success rates[8]. Moreover, the application of colonic stents has gained increasing attention in recent years for postoperative complications following colorectal surgery including ALs, fistulas, and perforations (Figure 1). Especially, smaller ALs not associated with severe sepsis may benefit from colonic stenting after laparoscopic peritoneal lavage and drainage and fashioning of stoma[9]. On the other hand, some authors considered that endoscopic stenting could be utilized in patients with or without a stoma, in combination with percutaneous drainage of infected intraabdominal collections[10].

Several types of intestinal stent are available, such as self-expanding metal stent (SEMS) (uncovered, partially or fully covered), self-expanding plastic stent (SEPS), and biodegradable (BD) stent. Colonic stent-related complications include stent migration, anorectal pain, incontinence, perforation, rectal bleeding, and stent obstruction[9,11]. The stent can only be placed across an end-to-end anastomosis and the distal end of the stent must be no less than 5 cm proximal to the anal verge[10-12]. Stents placed very distally in the rectum may cause more rectal pain, tenesmus, or fecal incontinence[11-13].

The risk of stent migration is high in the lower gastrointestinal tract because of the increased intestinal motility and reported in 25% to 40% of patients[14-16]. This rate is less in uncovered or partially covered stents than biodegradable and fully covered stents[9,10,12]. Migration has been also described when large-diameter stents have been used[11,14]. However, the use of partially covered SEMS prevents migration, but allows for tissue in-growth and its removal results technically difficult[11,12]. Use of clips or endoscopic suturing can be an alternative method to anchor the stent in place and reduce migration risk[14] (Figure 1B). Optimal timing of stent removal is controversial. If possible, stents should be removed after adequate healing of the dehiscence is confirmed by endoscopy and resolution of clinical signs and symptoms[16].

A recent study found that SEMS application was successful in 86% of 22 patients with anastomotic leak following colorectal surgery[13]. In this study, fully covered SEMS were used in 19 patients and uncovered SEMS in 3 patients. Stent migration occurred in only 1 of 22 patients (4.5%); this patient was in covered stent group and stent migrated 6 months after placement. Most of the patients complained of incontinence after placement of the stent, which regressed spontaneously on average 14 wk.

Recent advances and innovations in stent technology have brought up expandable polydioxanone biodegradable stents as an efficacious alternative in the treatment of AL following colorectal surgery. Since the structure of the biodegradable stent does not require any removal procedure, this can decrease mucosal hyperplastic reactions and adverse events associated with stent removal, compared to metal stents[9,10,12,14].

Based on limited data, stent placement appears to be an alternative therapeutic option for selected patients with AL after colorectal surgery when performed by skilled endoscopists. Furthermore, migration is the major problem and the cost of these stents is an important limitation.

**ENDOSCOPIC CLIPS**

Application of clips to approximate the edges of the leaking anastomosis is one of the endoscopic managements. Standard endoclips, which are used to control small perforations and bleeding, may be used for closure of AL, but the usage of these clips with low closure force, especially for more scarred, fibrotic, and irradiated tissues are limited.

First clip was manufactured by the Olympus Corporation from Japan in 1995. Thereafter, a disposable preloaded version of this clip known as Quickclips® (Olympus Ltd., Tokyo, Japan) has gained popularity. Then over-the-scope clips (OTSC) (Ovesco Endoscopy, endoscopy, Tubingen, Germany) were introduced; and in 2011, Cook Medical from US produced instinct endoscopic hemoclip.

OTSC is the most preferred clips in order to control AL. This clip is made of super-elastic nitinol, which is a biocompatible and MRI-safe material, and has the benefit of a larger clip area with increased compression. Firstly, Kirschniak *et al*[7] published their successful results with OTSC used 11 patients which have bleeding or iatrogenic perforation. Application of OTSC for leaks popularized then. Weiland *et al*[18] reported a general success rate of 84.6%. Arezzo *et al*[19] used OTSC for colorectal surgery, performed on 14 patients with leaks not larger than 15 mm in maximum diameter, and without luminal stenosis and abscess. Similarly, their success rate was 86%. Sometimes, first attempt may fail but repeated attempts will be successful in order to close the dehiscence of AL[20].

Favorable results with OTSC may be obtainable without the presence of fibrotic tissue. Closure of chronic leaks and fistulas seem to be considerably challenging and may decrease the success rate[21]. On the other hand, OTSC have meaningful cost benefits compared with ileostomy, and achieve full-thickness wall closure. Moreover, it is useful in shortening the hospital stay and avoiding temporary ileostomy[19]. OTSC can close defects up to 30 mm[22]. Application of multiple clips may be possible for larger defects; however, there is limited experiences on it[23,24].

**ENDOSCOPIC VACUUM-ASSISTED CLOSURE**

Negative pressure wound therapy or vacuum-assisted closure is now a well-established treatment modality for chronic and difficult healing wounds. Recently, this minimally invasive method has been proposed as an effective approach to manage AL after colorectal surgery with success rates ranging from 56.6% to 100%[25-29]. In the original technique, after the presence of the abscess cavity is confirmed by diagnostic colonoscopy, the enteric and purulent contents are aspirated and then irrigated. Last, an open pored, polyurethane sponge with an attached evacuation tube connected to a drainage system is inserted via an introducer sleeve that is fitted over an endoscope and placed through the dehiscence and into the pelvic cavity[10,12,16,25].

The endo-sponge continuously removes secretion, improves microcirculation, and therefore induces granulation formation in the defect. It also facilitates closure of the pelvic cavity by the application of negative pressure of 125 mm Hg[26] (Figure 2). One of the disadvantage of this method is changing the sponge every 2-4 d until the abscess cavity has regressed[25,28,29]. However, this treatment is more effective at shrinking cavities, especially when used within 6 wk after the AL[10,30]. It should be noted that generalized peritonitis is no indication for endo-sponge therapy[12,25,29]; and the overall complication rates are around 20% mainly, consisting of anastomosis stenosis, recidivate abscess, and fistula[26].

In 2008, a largest series of endoscopic vacuum-assisted closure therapy was reported by Weidenhagen *et al*[25]. In this study, definitive closure of the cavity was achieved in 28 of the 29 patients (96.6%) over a mean treatment period of 34 d (range 4-79 d). In a recent review, Strangio *et al*[26] found that a complete healing of cavity was achieved in near 95% of cases overall, following a median of 30 d of treatment and a median of 11 sessions performed. The authors emphasized that endo-sponge applications might be safely performed in patients with or without a diverting ileostomy. In the series of Weidenhagen *et al*[25], four patients were treated without the construction of a diverting stoma. Similarly, Glitsch*etal*[28] reported on successful endoscopic transanal vacuum-assisted rectal drainage for AL after rectal resection in 16 of 17 patients (94.1%). They also found that the closure time was directly dependent on the cavity size, distance from anastomosis to the anal verge, and the patient’s age. Patients with anastomoses that were 6 cm or less from the anal verge, in elderly patients (aged over 62 years), and the cavity measuring 5 cm × 6 cm or more had considerably longer healing times.

Endoscopic vacuum-assisted closure therapy seems a safe and useful therapeutic option for the local and minimally invasive management of AL after colorectal surgery with high success rates. However, further prospective clinical studies with randomized data and larger numbers of patients are still needed to clarify the beneficial effects of endo-sponge therapy in patients with anastomotic insufficiency.

**TRANSANAL REPAIR**

Transanal repair is also another preferred method for treatment of delayed AL. Candidates for this method should have a documented persistent sinus or cavity diagnosed by contrast enema, without any evidence of recurrence and co-morbidity. There is primary repair or repair with flap as transanal repair, especially for sinus formation of AL. The flap should be prepared with skin or mucosa, although there is limited supporting data about it in the literature. Endorectal flap advancement is well described in ileorectal anastomotic sinuses. Blumetti *et al*[31] published their 2-centered study in 2012 and reported 6 transanal repairs for 5 patients with 80% success rate.

In 2015, Brunner *et al*[32] reported two consecutive patients managed by transanal primary repair and irrigation of abdominal cavity for AL after single incision laparoscopic sigmoid resection for stage II/III diverticulitis. They mentioned no residual leaks, no anastomotic strictures, and normal rectal functions.

A summary of some recent successful studies managed minimally invasively after anastomotic leakage and outcomes in SEMS, OTSC, vacuum-assisted closure, and transanal repair at their institutions is shown in Table 1.

**CONCLUSION**

Anastomotic leaks continue to be critical and life-threatening events with considerable morbidity and mortality. Patients with ALs are often critically ill and non-operative management strategies must be preferred first-line approach. Today, minimally invasive treatment options are being a promising alternative to surgical treatment with satisfactory outcomes for the management of ALs. Nevertheless, there is a need for further, large, high quality, randomized, controlled trials on long term outcome, function, and clinical efficacy of these different techniques.

**REFERENCES**

1 **Kingham TP**, Pachter HL. Colonic anastomotic leak: risk factors, diagnosis, and treatment. *J Am Coll Surg* 2009; **208**: 269-278 [PMID: 19228539 DOI: 10.1016/j.jamcollsurg.2008.10.015]

2 **Slieker JC**, Komen N, Mannaerts GH, Karsten TM, Willemsen P, Murawska M, Jeekel J, Lange JF. Long-term and perioperative corticosteroids in anastomotic leakage: a prospective study of 259 left-sided colorectal anastomoses. *Arch Surg* 2012; **147**: 447-452 [PMID: 22249852 DOI: 10.1001/archsurg.2011.1690]

3 **Cuccurullo D**, Pirozzi F, Sciuto A, Bracale U, La Barbera C, Galante F, Corcione F. Relaparoscopy for management of postoperative complications following colorectal surgery: ten years experience in a single center. *Surg Endosc* 2015; **29**: 1795-1803 [PMID: 25294542 DOI: 10.1007/s00464-014-3862-6]

4 **Lee CM**, Huh JW, Yun SH, Kim HC, Lee WY, Park YA, Cho YB, Chun HK. Laparoscopic versus open reintervention for anastomotic leakage following minimally invasive colorectal surgery. *Surg Endosc* 2015; **29**: 931-936 [PMID: 25060688 DOI: 10.1007/s00464-014-3755-8]

5 **Wind J**, Koopman AG, van Berge Henegouwen MI, Slors JF, Gouma DJ, Bemelman WA. Laparoscopic reintervention for anastomotic leakage after primary laparoscopic colorectal surgery. *Br J Surg* 2007; **94**: 1562-1566 [PMID: 17702090 DOI: 10.1002/bjs.5892]

6 **Vennix S**, Abegg R, Bakker OJ, van den Boezem PB, Brokelman WJ, Sietses C, Bosscha K, Lips DJ, Prins HA. Surgical re-interventions following colorectal surgery: open versus laparoscopic management of anastomotic leakage. *J Laparoendosc Adv Surg Tech A* 2013; **23**: 739-744 [PMID: 23859744 DOI: 10.1089/lap.2012.0440]

7 **Kirshtein B**, Domchik S, Mizrahi S, Lantsberg L. Laparoscopic diagnosis and treatment of postoperative complications. *Am J Surg* 2009; **197**: 19-23 [PMID: 18558391 DOI: 10.1016/j.amjsurg.2007.10.019]

8 **van Hooft JE**, van Halsema EE, Vanbiervliet G, Beets-Tan RG, DeWitt JM, Donnellan F, Dumonceau JM, Glynne-Jones RG, Hassan C, Jiménez-Perez J, Meisner S, Muthusamy VR, Parker MC, Regimbeau JM, Sabbagh C, Sagar J, Tanis PJ, Vandervoort J, Webster GJ, Manes G, Barthet MA, Repici A. Self-expandable metal stents for obstructing colonic and extracolonic cancer: European Society of Gastrointestinal Endoscopy (ESGE) Clinical Guideline. *Endoscopy* 2014; **46**: 990-1053 [PMID: 25325682 DOI: 10.1055/s-0034-1390700]

9 **Kabul Gürbulak E**, Akgün İE, Öz A, Ömeroğlu S, Battal M, Celayir F, Mihmanlı M. Minimal invasive management of anastomosis leakage after colon resection. *Case Rep Med* 2015; **2015**: 374072 [PMID: 25861277 DOI: 10.1155/2015/374072]

10 **Blumetti J**, Abcarian H. Management of low colorectal anastomotic leak: Preserving the anastomosis. *World J Gastrointest Surg* 2015; **7**: 378-383 [PMID: 26730283 DOI: 10.4240/wjgs.v7.i12.378]

11 **DiMaio CJ**, Dorfman MP, Gardner GJ, Nash GM, Schattner MA, Markowitz AJ, Chi DS, Gerdes H. Covered esophageal self-expandable metal stents in the nonoperative management of postoperative colorectal anastomotic leaks. *Gastrointest Endosc* 2012; **76**: 431-435 [PMID: 22817797 DOI: 10.1016/j.gie.2012.03.1393]

12 **Smallwood N**, Mutch MG, Fleshman JW. The failed anastomosis. In: Steele SR, Maykel JA, Champagne BJ, Orangio GR. Complexities in colorectal surgery: Decision-making and management. New York: Springer, 2014: 277-304 [DOI: 10.1007/978-1-4614-9022-7]

13 **Lamazza A**, Sterpetti AV, De Cesare A, Schillaci A, Antoniozzi A, Fiori E. Endoscopic placement of self-expanding stents in patients with symptomatic anastomotic leakage after colorectal resection for cancer: long-term results. *Endoscopy* 2015; **47**: 270-272 [PMID: 25668426 DOI: 10.1055/s-0034-1391403]

14 **Dabizzi E**, De Ceglie A, Kyanam Kabir Baig KR, Baron TH, Conio M, Wallace MB. Endoscopic "rescue" treatment for gastrointestinal perforations, anastomotic dehiscence and fistula. *Clin Res Hepatol Gastroenterol* 2016; **40**: 28-40 [PMID: 26209869 DOI: 10.1016/j.clinre.2015.04.006]

15 **Manta R**, Caruso A, Cellini C, Sica M, Zullo A, Mirante VG, Bertani H, Frazzoni M, Mutignani M, Galloro G, Conigliaro R. Endoscopic management of patients with post-surgical leaks involving the gastrointestinal tract: A large case series. *Unit Euro Gastroenterol J* 2016; 1-8 [DOI: 10.1177/2050640615626051]

16 **Rogalski P**, Daniluk J, Baniukiewicz A, Wroblewski E, Dabrowski A. Endoscopic management of gastrointestinal perforations, leaks and fistulas. *World J Gastroenterol* 2015; **21**: 10542-10552 [PMID: 26457014 DOI: 10.3748/wjg.v21.i37.10542]

17 **Kirschniak A**, Kratt T, Stüker D, Braun A, Schurr MO, Königsrainer A. A new endoscopic over-the-scope clip system for treatment of lesions and bleeding in the GI tract: first clinical experiences. *Gastrointest Endosc* 2007; **66**: 162-167 [PMID: 17591492 DOI: 10.1016/j.gie.2007.01.034]

18 **Weiland T**, Fehlker M, Gottwald T, Schurr MO. Performance of the OTSC System in the endoscopic closure of gastrointestinal fistulae--a meta-analysis. *Minim Invasive Ther Allied Technol* 2012; **21**: 249-258 [PMID: 22694247 DOI: 10.3109/13645706.2012.694367]

19 **Arezzo A**, Verra M, Reddavid R, Cravero F, Bonino MA, Morino M. Efficacy of the over-the-scope clip (OTSC) for treatment of colorectal postsurgical leaks and fistulas. *Surg Endosc* 2012; **26**: 3330-3333 [PMID: 22580885 DOI: 10.1007/s00464-012-2340-2]

20 **Sulz MC**, Bertolini R, Frei R, Semadeni GM, Borovicka J, Meyenberger C. Multipurpose use of the over-the-scope-clip system ("Bear claw") in the gastrointestinal tract: Swiss experience in a tertiary center. *World J Gastroenterol* 2014; **20**: 16287-16292 [PMID: 25473185 DOI: 10.3748/wjg.v20.i43.16287]

21 **Dişibeyaz S**, Köksal AŞ, Parlak E, Torun S, Şaşmaz N. Endoscopic closure of gastrointestinal defects with an over-the-scope clip device. A case series and review of the literature. *Clin Res Hepatol Gastroenterol* 2012; **36**: 614-621 [PMID: 22704818 DOI: 10.1016/j.clinre.2012.04.015]

22 **von Renteln D**, Schmidt A, Vassiliou MC, Rudolph HU, Caca K. Endoscopic full-thickness resection and defect closure in the colon. *Gastrointest Endosc* 2010; **71**: 1267-1273 [PMID: 20598252 DOI: 10.1016/j.gie.2009.12.056]

23 **Seebach L**, Bauerfeind P, Gubler C. "Sparing the surgeon": clinical experience with over-the-scope clips for gastrointestinal perforation. *Endoscopy* 2010; **42**: 1108-1111 [PMID: 21120779 DOI: 10.1055/s-0030-1255924]

24 **Manta R**, Manno M, Bertani H, Barbera C, Pigò F, Mirante V, Longinotti E, Bassotti G, Conigliaro R. Endoscopic treatment of gastrointestinal fistulas using an over-the-scope clip (OTSC) device: case series from a tertiary referral center. *Endoscopy* 2011; **43**: 545-548 [PMID: 21409741 DOI: 10.1055/s-0030-1256196]

25 **Weidenhagen R**, Gruetzner KU, Wiecken T, Spelsberg F, Jauch KW. Endoscopic vacuum-assisted closure of anastomotic leakage following anterior resection of the rectum: a new method. *Surg Endosc* 2008; **22**: 1818-1825 [PMID: 18095024 DOI: 10.1007/s00464-007-9706-x]

26 **Strangio G**, Zullo A, Ferrara EC, Anderloni A, Carlino A, Jovani M, Ciscato C, Hassan C, Repici A. Endo-sponge therapy for management of anastomotic leakages after colorectal surgery: A case series and review of literature. *Dig Liver Dis* 2015; **47**: 465-469 [PMID: 25769505 DOI: 10.1016/j.dld.2015.02.007]

27 **Riss S**, Stift A, Kienbacher C, Dauser B, Haunold I, Kriwanek S, Radlsboek W, Bergmann M. Recurrent abscess after primary successful endo-sponge treatment of anastomotic leakage following rectal surgery. *World J Gastroenterol* 2010; **16**: 4570-4574 [PMID: 20857528 DOI: 10.3748/wjg.v16.i36.4570]

28 **Glitsch A**, von Bernstorff W, Seltrecht U, Partecke I, Paul H, Heidecke CD. Endoscopic transanal vacuum-assisted rectal drainage (ETVARD): an optimized therapy for major leaks from extraperitoneal rectal anastomoses. *Endoscopy* 2008; **40**: 192-199 [PMID: 18189215 DOI: 10.1055/s-2007-995384]

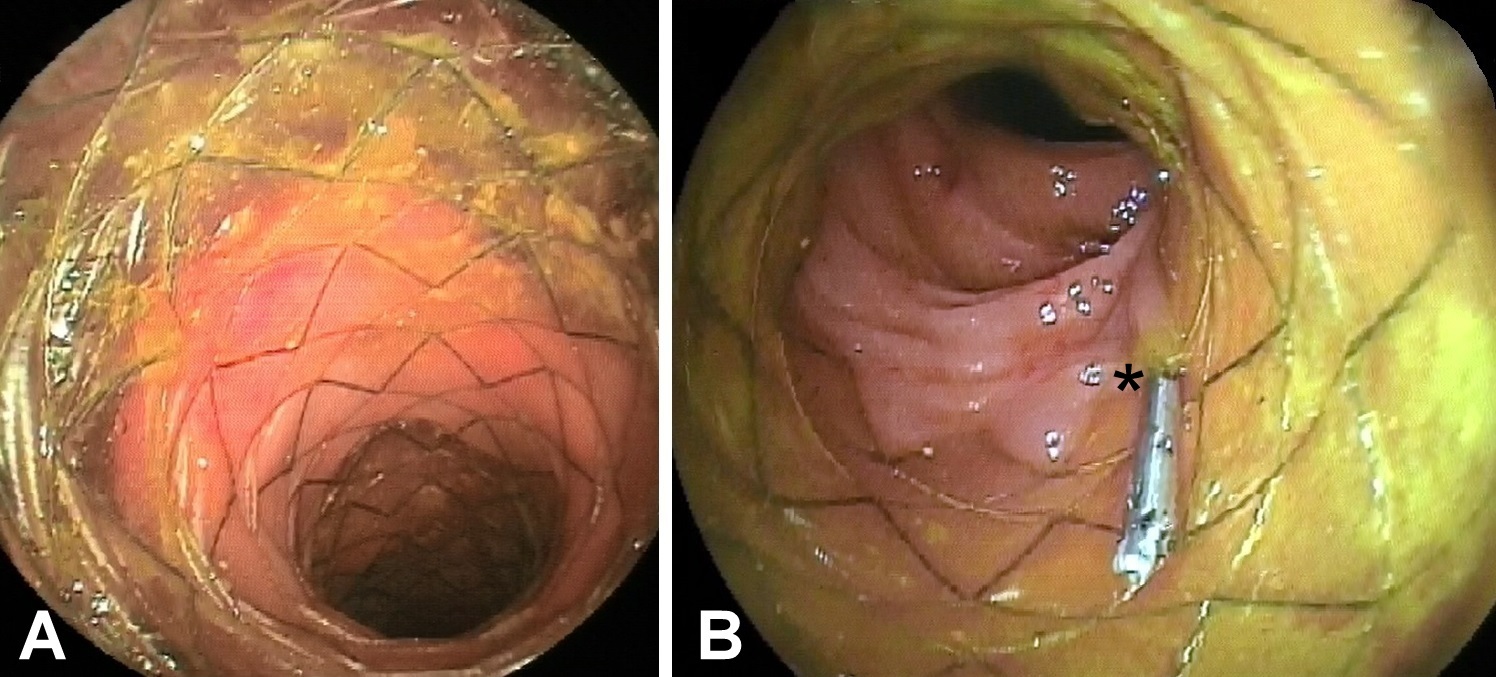
29 **Kuehn F**, Janisch F, Schwandner F, Alsfasser G, Schiffmann L, Gock M,Klar E. Endoscopic Vacuum Therapy in Colorectal Surgery. *J Gastrointest Surg* 2016; **20**: 328-334 [DOI: 10.1007/s11605-015-3017-7]

30 **Srinivasamurthy D**, Wood C, Slater R, Garner J. An initial experience using transanal vacuum therapy in pelvic anastomotic leakage. *Tech Coloproctol* 2013; **17**: 275-281 [PMID: 23111399 DOI: 10.1007/s10151-012-0911-9]

31 **Blumetti J**, Chaudhry V, Prasad L, Abcarian H. Delayed transanal repair of persistent coloanal anastomotic leak in diverted patients after resection for rectal cancer. *Colorectal Dis* 2012; **14**: 1238-1241 [PMID: 22229958 DOI: 10.1111/j.1463-1318.2012.02932.x]

32 **Brunner W**, Rossetti A, Vines LC, Kalak N, Bischofberger SA. Anastomotic leakage after laparoscopic single-port sigmoid resection: combined transanal and transabdominal minimal invasive management. *Surg Endosc* 2015; **29**: 3803-3805 [PMID: 25783831 DOI: 10.1007/s00464-015-4138-5]

**P-Reviewer:** Segre D, Tebala GD, Virk JS **S-Editor:** Qi Y **L-Editor: E-Editor:**

Figure 1 Self-expanding metal stent for anastomosis leakage. A: Endoscopic image after deployment of the stent; B: Stent with clip (\*) at the proximal end.

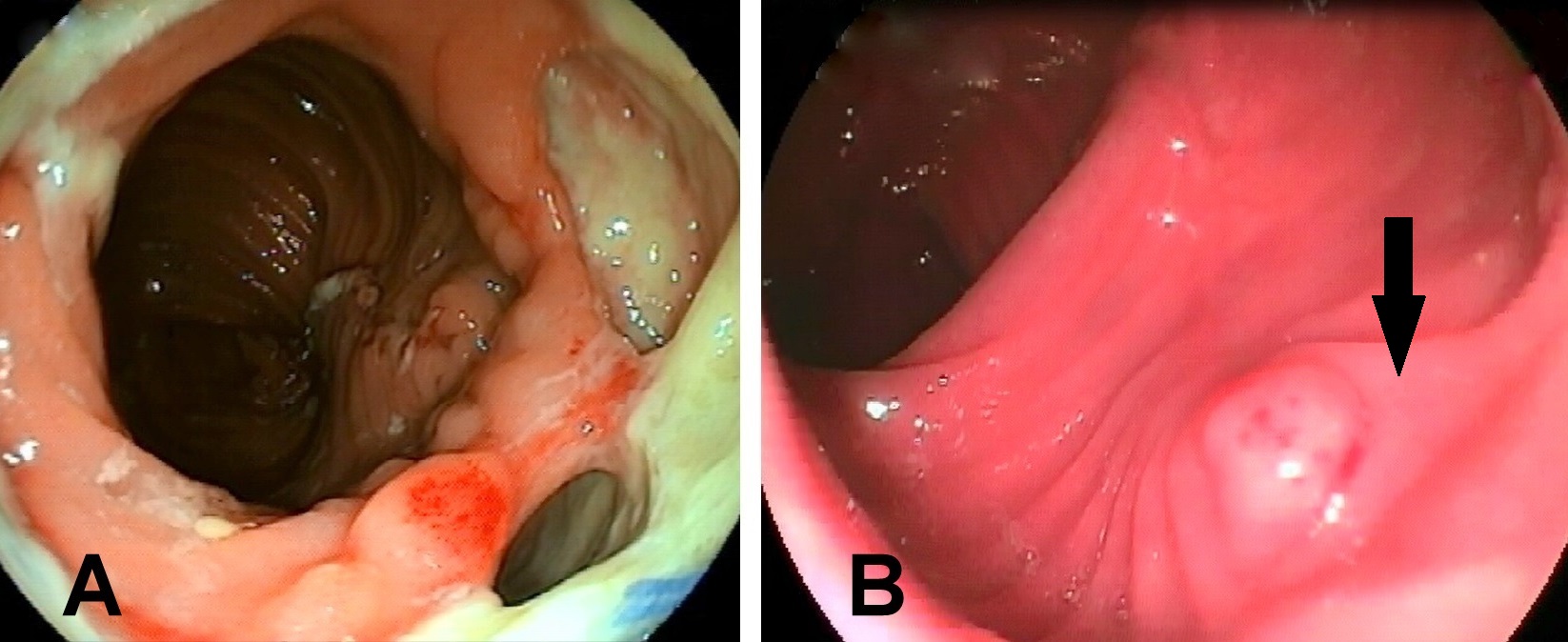
Figure 2 Endoscopic appearance of anastomotic leakage. A: Anastomotic leak with cavity before endoscopic vacuum-assisted closure therapy; B: Same cavity covered with granulation tissue (black arrow) three weeks after vacuum therapy was initiated.

Table 1 Results of some recent successful studies managed minimally invasively after acute or chronic anastomotic leak

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ref.** | **Year** | **Cases** | **Procedure** | **Gender**  **(F/M)** | **Age**  **(yr)** | **Previous diagnose or treatment** | **Success**  ***n* (%)** | **Failure or complications**  ***n* (%)** | **Follow-up** |
| Lamazza *et al*[13] | 2015 | 22 | SEMS | 11/11 | 68 | Anterior resection (all)  Neoadjuvant (21) | 19 (86.4) | Failure: 3 (13.6)  Stent migration: 1 (4.5) | 18-42 mo |
| Arezzo *et al*[19] | 2012 | 14 | OTSC | 8/6 | 68.5 | Anterior resection (12)  Colostomy closure (1)  Right hemicolectomy (1) | 12 (85.7) | 1 patient need further surgery | 4 mo |
| Sulz *et al*[20] | 2014 | 6 | OTSC | 1/5 | 66.5 | Colorectal resection | 5 (83.3) | Failure: 1  (Succeeded with 2nd OTSC) | N/A |
| Weidenhagen *et al*[25] | 2008 | 29 | VAC | 5/24 | 66.7 | Rectal cancer (22)  Rectosigmoidal cancer (3)  Large rectal adenoma (2)  Diverticulitis (1)  Endometrial cancer infiltration (1) | 28 (96.6) | 1 (Hartmann’s procedure) | VAC duration: 34.4 ± 19.4 d |
| Blumetti *et al*[31] | 2011 | 5 | Transanal repair | N/A | 52 | Coloanal anastomose (4)  Colorectal anastomose (1) | 4 (80) | Failure: 1 (20) | Time to repair:  8-15 months |

F/M: Female/male; SEMS: Self-expandable metallic stent; OTSC: Over the scope clip; N/A: Data not available; VAC: Vacuum-assisted closure.