# THE CAUSES AND PREVENTION OF ANASTOMOTIC LEAK AFTER COLORECTAL SURGERY

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The cause of the leakage may be multifactorial, including contribution from faulty technique, ischemia of the intestine at the suture line, excessive tension across anastomosis and mesentery, the presence of local sepsis, presence of obstruction distal to the anastomosis. The old patient (>80 years), anaemic, malnourished with several coexisting diseases, receiving high doses steroids, after chemio-radiotherapy is more prone to develop the anastomotic leakage. The presence of any of these risk factors calls into question the safety of the planned anastomosis. Anastomotic leakage is the most significant complication after colorectal surgery especially after anterior resection and it is the major cause of postoperative mortality and morbidity. Definition of clinically apparent anastomotic leakage is following: fistula to the skin or vagina, fever above 38°C or septicaemia in patients with radiological or endoscopic leak, with presence of intraperitoneal abscess or symptoms and signs of peritonitis in the presence of an anastomotic leakage [1]. (Fig. 1) Its frequency is higher after anterior resection. In 60% of cases leakage heals under the conservative treatment. If re-laparotomy is necessary the mortality related to this complication is very high. The leak incidence varies from 3.4% to 40% (the larger figures include subclinical radiological diagnoses) [5]. In the series published after 1990 in the group of 1318 patients the rate of clinically detected anastomotic leak was 4.7%, varying between 2.7 and 10.5%. In an addition 5.7%-10.7% of patients had subclinical leaks discovered by routine postoperative radiological examination [2,3]. Goligher in 1970 found radiological leak in 69% of patients with low colorectal anastomosis diagnosed by means of routinely performed barium enema on 5-7-th day after surgery [4]. Our personal leak rate is 5.7% among 263 patients who underwent colorectal resection and primary anastomosis.

The consequences of anastomotic leak are peritonitis, fistula formation or abscess.

The principles of the good and reliable colorectal anastomosis are as follows: (Fig. 2)

- 1. good exposure and access to large bowel (long enough incision)
- 2. adequate blood supply of anastomosed stumps
- 3. prevent sepsis or gross faecal contamination
- 4. sutures or staplers should be properly placed assuring good approximation of all layers of bowel wall (most important is submucosa)
- 5. no tension of the anastomosis (always release the splenic flexure in left colorectal surgery)
- 6. prevent distal obstruction
- 7. the patient should be well nourished and large bowel should be mechanically well prepared (no faecal contamination) (Keighly1993)[17].'

**Good exposure includes:** long incision, adequate bowel mobilisation, appropriate illumination, correct positioning of assistants and retractors.

**Blood supply** is essential for the healing of anastomosis. The cut ends of bowel should bleed. To assess the adequate blood supply of the bowel stump the routine measurement of tissue oxygen and laser Doppler flowmetry are currently being eva-

## Definition of anastomotic leak

## 1. Faecal fistulas to the skin or vagina

- 2. Fever > 38 °C or septicaemia
- 3. Radiological or endoscopis signs of anastomotic leakage
- Also an intraperitoneal abscess or peritonitis in the presence of an anastomotic leak

Müller, 1994

luated in many centres. To achieve a good blood supply some important operative precautions should be followed, namely: adequate mobilisation, no tension on anastomosis, sutures must not be placed too deep or too tight (extramucosal sutures are the best in this aspect) used bowel clamps should be non-crushing and should be lightly applied without including the mesentery since that may compromise the blood supply.

#### Manual sutured anastomosis.

Since Czerny (1880) recommendation a two layer technique of colorectal anastomosis was commonly used. The first layer was an inner through-and-through suture which was either continuous or interrupted and the second layer (usually interrupted) was an outer serosomuscular Lambert stitch.

Halsted (1887) and Gambee (1951) showed that the submucosa was the strongest layer of the bowel wall and they supported the single layer technique with moderate inversion. Currently generally accepted view is that for colorectal anastomosis the inversion techniques should be employed.

Dunn and other authors stated that everted anastomosis should not be performed in patients with abdominal infections, after radiotherapy, with inflammatory bowel diseases [6]. These are risk factors for anastomotic leakage especially after stapling technique employed.

Kusunoki showed no significant differences in anastomotic dehiscence (5-7%) or recurrence of Crohn's disease between the stapling and hand-sewn procedures [7].

These results indicate that stapling technique producing an everted anastomosis is a safe procedure for Crohn's disease. Still exists controversy about the need for a one or two layer anastomosis. Theoretically the two layer anastomosis produces more ischemia, the tissue necrosis and more narrowing of the bowel lumen than one layer technique.

Currently for low colorectal extraperitoneal anastomosis one layer manual anastomosis is recommended. A two layer anastomosis is performed in more proximal colon whenever it is reasonable to do so. In many centres most surgeons opt to use the circular staplers.

To perform a two layer anastomosis the absorbable material is used for inner layer and non-absorbable material for an outer layer.

A single layer anastomosis is accomplished using a non-absorbable material usually monofilament, which causes less tissue reaction. New developed long-resorbable materials, like vicryl, PDS, maxon, are recommended for one layer colorectal anastomosis. The size or gauge of the suture material is usually 00 or 000 for adult intestinal anastomosis and the needle is of the round type.

There are numerous variations in technique to perform anastomosis. Most common are: end-to-end anastomosis (double layer, single layer full thickness, single layer extramucosal) end-to-side anastomosis, side-to-side anastomosis.

End-to-side anastomosis many surgeons prefer to perform following right hemicolectomy or after low rectal anterior resection. Most essential is to secure the mesenteric and antimesenteric corners by using the Connell stitches. Personally, I prefer to anastomose short distal rectal stump to side of proximal colon employing end-to-side technique (so called Baker technique).

- 1. Good access and exposure
- 2. Adequate the blood supply of two ends of bowel (no clamps)
- 3. Sutures or staples should be properly and meticulously placed (layers appproximation, the role of the submucosa)
- 4. No tension on the anastomosis (relase of the splenic flexure)
- 5. No faecal contamination (ideally empty the large bowel)
- 6. Prevent distal obstruction
- 7. The patient should be well nourished

An alternative to manual techniques is the use of staplers. Staplers have allowed colonic or rectal closure and anastomosis is performed more quickly than manually.

There are three types of stapling instrument which are applied in colorectal surgery. These are linear staplers (TA or RL), the linear cutters (GIA or PLC) and the circular instrument (EEA or 1LS).

Whether stapled anastomosis is more tight and reliable than conventional hand-sewn is open to debate. Reported leak rates after stapled and hand-sewn anastomosis were 8% and 27% respectively.

Thirteen randomised, controlled trials showed a little or no differences between hand-sewn vs. stapled anastomoses in outcome variables including mortality, technical problems, leak rates, wound infections, strictures and cancer recurrences [8].

Strictures and intraoperative technical problems were more common with stapled than hand-sewn anastomosis. Thus both techniques are effective, stapled technique is a little bit quicker but the choice may be based on the personal preference. Hashemi showed, that side-to-side stapled anastomosis is associated with lower incidence of recurrence in Crohn's disease requiring reoperation (2%) at 46 months with comparison to the end-to-end hand-sewn anastomosis (43%) [28].

However longer follow-up is required to evaluate this technique in randomised prospective study.

Docherty and co-workers in randomised, controlled trial evaluated 732 patients who had had any form of elective or emergency colorectal resection or reconstruction. In patients having suturing or stapling of anastomoses was equally effective. In patients who had colorectal anastomoses, incidence of radiological leak were lower when staplers were used [29].

## Factors influencing anastomotic healing.

The morbidity and mortality related to anastomotic breakdown in colorectum is considerable. Fielding (1980) in his study showed, that among 1466 patients who underwent large bowel anastomosis there were 191 patients with an anastomotic leak with 22% of hospital mortality compared with 7.1% of 1275 patients without a leak [9].

Anastomotic leak can only be prevented if the causes are understood. Many factors may play a pathological causative role, including: (Fig. 3)

- 1. poor surgical technique
- 2. wrong intraoperative judgement
- local complications (sepsis, bowel preparation, drains, role of omentum and peritoneum, anaesthetic drugs, protective stoma)
- 4. systemic complications (nutritional status, blood loss)
- 5. surgeon-related factors, which are of the most important causes of an anastomotic leakage.

## Local sepsis

The presence of local sepsis (e.g. perforated diverticulitis, a perforated colorectal cancer, colorectal trauma, faecal contamination during colorectal surgery) causes the reduction in collagen at the colonic anastomosis. This may result in higher anastomotic dehiscence rate.

## **Factors Affecting Anastomotic Healing**

- 1. Poor surgical technique
- 2. Wrong or lack of intraoperative judgement
- 3. Local complications (sepsis, bowel preparation, drains, role of peritoneum and omentum, drugs used during anaesthesia)
- 4. Systemic factors (nutritionale state, bloods loss)
- 5. Surgeon-related factors, which are of the most important causes of an anastomotic leak

## **Bowel preparation**

Most surgeons use mechanical bowel preparation before colorectal surgery as essential in preventing complications. It is generally accepted that faecal loading has an adverse effect on the healing of large bowel anastomosis. A meta-analysis conducted by Platted showed that there is a limited evidence in literature to support the use of mechanical bowel preparation in patients undergoing colorectal surgery [10]. (Fig. 4) Three clinical trials showed a significant greater incidence of wound infection and anastomotic leak in patients who received a mechanical bowel preparation (10.8% and 8.1% respectively) comparing with patients without preparation (7.1% and 4% respectively) (fig 1). Remembering mentioned above there is a little doubt that is safer to leak from an empty bowel than from one that is loaded with faeces. (Fig. 5)

Recently again Miettinen and co-workers demonstrated, that preoperative bowel preparation seems to offer no benefit in elective open colorectal surgery in regard of mortality, wound infections and anastomotic leakage rate [11].

#### Protective stoma

Some surgeons advised to create a defunctioning stoma in order to prevent faecal contamination of an anastomosis and when anastomotic leak appears.

The decision whether to create a protective colostomy or ileostomy is often not a matter of objective reason but one of emotion like feeling that operation was technically difficult to perform, there was considerable blood loss, the tumour was stuck in the pelvis, the patient had many medical problems, the anastomosis looked tenuous, there was some tension across the anastomosis, I didn't feel good about it, I'll sleep better tonight. All those are reasons for protecting the anastomosis with a proximal stoma.

Probably the most common reason for a subsequent anastomotic complications is tension in suture line (distraction, vascular insufficiency). If the above precautions are taken a protective colostomy is usually unnecessary. There are relative indications for protecting the anastomosis which are following: pelvic sepsis, excessive blood loss and arterial hypotension, poor nutritional status and ultralow anastomosis (below 6 cm from the anal verge).

It is generally believed that a temporary defunctioning colostomy is avoided more often if a stapled anastomosis is performed than if a hand-sewn technique is used.

Fig. 5

## Colorectal surgery

	wound	infection	death
only mechanical preparation	36%		11.2%
mechanical preparation with antibiotic prophylaxis	22	2%	4.5%

## The Principles Of Large Bowel Anastomosis

	(+)	(-)
anastomotic leak	8.1%	4%
wound infection	1.0.8%	7.4%

Plattel, Dis. C Red. 1998, 41, 875

However recent experimental evidence in rats demonstrates, that a proximal diverting colostomy may reduce of collagen metabolism, anastomotic protein level and delay of the development of anastomotic strength [12,13,14].

There is no evidence that protective stoma prevents the anastomotic leak. On the other hand all surgeons know, that if leak does take a place in patient with diverting stoma, the septic complications resulting from the anastomotic dehiscence are significantly reduced.

Wessex (Grabham) colorectal audit showed, that a defunctioning colostomy reduced the frequency of anastomotic leak from 11.4% to 6.5% [15]. Reoperation was needed more frequently where there was no protective stoma (7.3% vs. 3.0%). Postoperative mortality was greater following a leak, where no diversion was performed (10.4% vs. 4.1%). (Fig. 6)

Presented data showed, that diverting colostomy decreases both the frequency and consequences of anastomotic leakage following anterior resection. More experienced surgeons use more frequently defunctioning colostomy performing low rectal anastomosis.

Tube caecostomy as a mean of protecting the low rectal anastomosis is advocated to facilitate postoperative management and to avoid the need for defunctioning stoma requiring formal closure having own morbidity and mortality [16].

However, intraluminar intracolonic bypass technique using coloshield or condom is a very safe, cost-effective and easily available alternative for coloanal anastomosis [19,20].

Hirsch et al. stated, that removing completely blood, serum, cellular debris from pelvis following resection of rectum and mesorectum minimises the risk of anastomotic breakdown. They believe that with this, routine defunctioning colostomy is no longer required for most patients undergoing low anterior resection with total mesorectal incision [26].

Drains which are situated in direct and close distance from anastomosis may contribute to anastomotic leakage and sepsis [17,18]. This must be considered when surgeon decides to drain abdominal cavity. Abdomino-perineal resection is the only colorectal procedure for routine drainage.

It is difficult to assess the role of peritoneum and of the omentum in prevention of anastomotic breakdown. There is no controlled trial in man, which support the technique of wrapping an anastomosis with omentum or peritoneum as the prevention of leak. However several surgeons do this manoeuvre whenever [17].

#### Fig. 6

#### 1996 - Wessex Colorectal Audit: Anastomotic Leak After LAR

	diverting colostomy no	o diverting colostomy
frequency of the leak	6,5% (p=0.043)	11.4%
need of reoperation	3.0% (p=0.0024)	7.3%
postoperative mortality	4.1%(p<0.05)	10.00%
more experienced surgeon	leak<6.9%	, proximal
(> 10 operation	ns/year) colostomy	r in 49.6%
less experienced surgeon	leak >14.19	6, proximal
(<10 operations/year)	colostom	y in 30 %

## Intraoperative Air Text To Asses The Anastomotic Tingtness

Test performed - in 23% of cases air leak, additional sutures, on 10th day after operation the radiological leak in 7.5% of cases, mortality 2%

Test not performed - on 10th day postoperatively the radiological leak in 23.5% with mortality 10%

We are concerned about the integrity of an anastomosis, about anastomotic blood supply, particularly in elderly patients and these with severe atherosclerosis or cardio-respiratory insufficiency. It is important from the practical point of view to assess the anastomotic integrity by using intraoperative air test (cycle tire puncture manoeuvre).

Once anastomosis is performed the pelvic cavity is filled with saline, intestinal clamp is applied proximal to the anastomosis and 50-100 ml of air is slowly and gently injected through the anus. No bubbles means anastomotic tightness. In case when bubbles appear an additional suture on the anastomotic line is required [12]. In the group of patients to whom intraoperative air test was performed in 23% of cases air leak was observed. This was an indication for additional stitches to secure anastomosis. On 10-th postoperative day the radiological leak in 7.5% of cases was showed and overall mortality in this group was 2%. In the contrast, in group of patients to whom intraoperative air test was not performed, postoperative radiological leak was found in 23.5% of cases with 10% mortality [12]. (Fig. 7)

#### Anaesthetic drugs

Neostigmine which reverses the effect of the curare-type relaxants might evoke active contraction of the intestine after completion of the anastomosis and subsequently might result in its disruption.

Current evidence suggests, that neostigmine should be avoided during colorectal surgery even with combination with atropine. Halothane anaesthesia, however, abolished this neostigmine adverse effect [17].

It is widely accepted that corticosteroids have a deleterious effect on healing of skin wounds. Little is known about effect of steroids on the healing of colonic anastomosis.

Schrock et al. (1973) found that administration of corticosteroids did not increase significantly incidence of clinical anastomosis leakage (retrospective study) [21].

From experimental study Furst et al. reported that steroids do have an adverse effect on colonic anastomotic healing [22]. It requires further clinical as well as experimental investigations. Antineoplasmatic drugs can potentially adversely affect the healing process of large bowel anastomosis via several mechanisms like impairment of the synthesis and maturation of collagen, retardation of production and function of the cellular mediators of the healing process (macrophages, fibroblasts, leukocytes,





## Risk factors for development of an anastomotic leak (1726 pts)

- 1. LAR vs. other procedures (leak 4.4% vs. 1.4%, p<0.001)
- 2. Pre-existing sepsis vs. no-sepsis (5.0% vs. 1.5%,p<0.005)
- 3. Heavy intraoperative faecal contamination vs. minimal
- contamination (11.3% vs. 23%, p<0.001)
- 4. Perianastomotic drains vs. no drain (6.3% vs. 1.9%, p < 0.001) 5. Proximal diverting stoma vs. no stoma (9.8% vs. 1.9%,p < 0.001)
- 5. FTOXITIAL diverting stories as no stories (9.6% vs. 1.9%, p > 0.0
- 6. Emergency vs. elective surgery (4.1% vs. 1.9%, p ns)

epithelium). Hananel and Gordon in their experimental study demonstrated the 5-fluorouracil and leucovorin introduced in several regimens have no effect on the colonic anastomosis healing process [23]. Surgery, at least in experimental animals, can be performed safely during and shortly after chemotherapy.

#### Systemic factors

The role of systemic factors in aetiology of anastomotic leak is not yet completely defined. Among systemic factors at least three of them do seem to play a significant role and they are: 1. malnutrition (serum albumin level below 3.0 g/dl)

- 2. anaemia Hb below 11g% and hematocrit below 33%
- 3. excessive blood loss and advanced malignancy.

Excessive blood loss results in reduction of colonic blood flow with subsequent tissue necrosis. Blood loss inevitably leads to the need of transfusion, which in turn has been shown to decrease the patientis immunocompetence.

#### Other risk factors

Averbach et co-workers published very interesting results of an analysis of risk factors for anastomotic leak after double-stapled low colorectal resection. The incidence of anastomotic leak was directly related to extent of proximal colon resection [24]. Standard colon resection for sigmoid colon-to-rectum anastomosis was associated with 1 % leak rate compared with 29% leak after transverse colon-to rectum anastomosis. Averbach presents also a risk factors list of anastomotic leak after low anterior resection [Table 1]. The most important factor for prevention of anastomosis breakdown is a good surgical technique that can improve with experience. The mobilisation of splenic flexure (with high ligation of the inferior mesenteric vein) is essential to decrease the tension across the anastomotic line and subsequently to prevent anastomotic dehiscence. In case of the narrow pelvis of small male patients or in patients with a bulky tumour a triple stapling technique (TST) is advocated in which a proximate linear stapler is used twice for transverse occlusion of the rectum. Staplers are fired from both sides of the rectum. The centre of the rectum with crossed staples is removed by a further procedure that is as the same as the standard double stapling technique [25].

Anterior resection for rectal cancer is associated with higher incidence of anastomotic leak. Total mesorectal excision (TME) reduced the incidence of local recurrence of the tumour but inc-

## Fig. 10

## LAR - functional outcome

median anastomotic height above anal verge -6 cm

"neorectal" volume at distention, pressure of 40 and 50 cm H,0	present reduced	absent 114 ml
compliance at sensation of filling	reduced	~ 4 ml/cm H $_2$ 0
urge to defecate	reduced	$\sim 3.5 \text{ ml/cm H}_20$
maximum tolerated volume	reduced	$\sim 3$ ml/cm H <sub>2</sub> 0

## Fig. 11

Multifactorial Index Risk Factors in Colon Resection (Ondrula et al., Dis. Col. Rect. 1992)			
Risk factor	FunctionCoefficient	Clinical Index	
Emergent	0.590	6	
Age ≥ 75 years	0.420	4	
CHF	0.363	4	
Prior radiation	0.292	3	
Albumin > $2.7 \text{ g/dl}$	0.227	2	
Prior MI	0.206	2	
COPD	0.142	1	
Diabetes	0.121	1	
Steroids	0.084	1	
All risk factors have a significat CHF – congestive heart faluire;	nce level of p=0.031 COPD – chronic obstructive pulm	onary disease	

reased the rate of anastomotic dehiscence. Karanjia reported 11% of major anastomotic leaks associated with peritonitis and 6.4% of asymptomatic leaks detected by contrast enema.

All major leaks occurred at an anastomosis situated below 6 cm from anal verge. Defunctioning stoma reduces the incidence of major leak and protects against the development of peritonitis. It has been considered it prudent to defunction the low rectal anastomosis below 6 cm from anal verge, particularly after total mesorectal excision [27].

With meticulous attention to the technical issues described below anastomotic complications can be kept to less than 5% of the bowel resections.

#### Technique

- a) Conventional suturing suture s, interrupted or continuous, should take deeper muscularis and minimal mucosa, good approximation all layers of bowel wall; the floor of the pelvis is not reconstituted but is vigorously irrigated with saline; no drains are advised
- b) Stapled anastomosis various stapling technique can permit a secure anastomosis. Following principles are essential for minimising complications related to the use of staplers:
  - I. Use the largest calibre of stapler the anastomosis can accommodate
  - II. After placing of the purse-string the excessive bulk of tissue should not appear around shaft
  - III. The purse-string can be snagged up close to the shaft
  - IV. Reinforce the purse-string if one is concerned about the possibility of a gap
  - V. Repair any identified defect
  - VI. Non-satisfactory anastomosis (e.g. incomplete doughnuts) mandates a diverting colostomy or evidence of primary anastomosis.

Most common factors leading to anastomotic leak are: disease of the bowel itself, inadequate blood supply and diseases that affect local blood flow particularly in distal stump, tension on the suture line, inaccurate suture placement, trauma and failure to obtain a watertight seal.

The implementation of intraoperative air testing or direct visualisation of anastomosis by means of the sigmoidoscope can reduce the leak rates from 14% ("no test" group) to 4% ("test" group).

The presence of drains is associated with an increased incidence of anastomotic leakage. Drains may adversely affect an anastomotic healing. Selectively used protective colostomy does not prevent the development of anastomotic leak but when it happens colostomy reduces the mortality and morbidity.

Low anterior resection, pre-existing sepsis (before operation), heavy faecal contamination during operation, perianastomotic drainage, proximal diverting stoma, emergency operation, cardio-respiratory insufficiency and less experienced surgeon: these are most essential risk factors for the incidence of an anastomotic leak. (Fig. 8)

The prompt diagnosis of anastomosis leak has a paramount value for the patient. Contrast enema with either uropolin or gastrographine enables early diagnosis of anastomotic leak.



Determination of lysozyme content in the wound or in the effluent from pelvic drains might be useful in early diagnosis of anastomotic dehiscence.

Lysozyme is a component of local defence and is produced in macrophages. In patients with impending anastomotic leak, lysozyme activity is significantly increased as early as the first postoperative day in contrast to patients without any anastomotic complications [30].

Total parental nutrition, broad spectrum antibiotics, treatment of the septic shock and prompt surgery (depends on patient status and diameter of fistula) are essential for the patient.

Disconnection of breakdown anastomosis followed by Hartman procedure is a treatment of the choice in anastomotic dehiscence bigger than 1 cm. (Fig. 9)

Long-term functional outcome after LAR may be impaired by anastomotic leakage [31]. In patients with leak as the results of pelvic sepsis, the fibrosis may develop with subsequent narrowing of the distal bowel or stricture formation. (Fig. 10)

"Neorectal" volume at distension pressures of 40 and 50 cm H2O and compliance at sensation of filling urgency maximum tolerated volume were significantly reduced in patients with anastomotic leak. The impaired anorectal function is measured by:

- 1. increased frequency of bowel movements
- 2. increased urgency
- 3. increased incontinence score and
- 4. impaired evacuation.

In addition anastomotic leak may increase the risk of locoregional neoplastic recurrence [32].

## Summary

Several systemic and local factors play significant role in aetiology of anastomotic leak.

*Systemic factors* are: shock, sepsis, advanced age of patient (above 75 y.), coagulopathy, steroids, advanced malignant disease,

## Table 1

Risk Factors of Anastomotic Leak after Low Anterior Resection of the Rectum (Surgical Treatment Only)

<b>Demonstrated in randomised trials</b> Low (below peritonea reflexion) vs. high anastomosis	al de la composition de la composition Composition de la composition de la comp
<b>implicated</b> Inadequate blood supply; tension on suture line Septic conditions or undrained pelvic collection Preoperative radiotherapy, chemotherapy, steroid therapy Patients condition (concurrent disease), age Inadequate bowel cleaning or emergency or palliative surg Shock during surgery, coagulopathy Vitamin C, iron, zinc, methionine and cysteine deficiency collagen lysis/synthesis)	gery (unbalanced
Implicated especially to double-stapled technique Mucosal tears caused by anvil or staple gun insertion Excessive upward traction of rectal stump during insertion an instrument Forceful extraction of an instrument Failure of staples closure	or closing of

Adapted from A.M. Averbach et al. Dis. Colon Rectum 1996, 39, 780

radio- and chemo-therapy, diabetes, uraemia, anaemia, iron, zinc, cystein, vitamin C depletion, malnutrition with hypoalbuminemia, congestive heart failure and chronic obstructive pulmonary disease. (Fig. 11)

Local factors are: intraabdominal sepsis, bowel preparation, defunctioning stoma, peritoneum, omentum, drains, anaesthetic drugs. It seems to me that local factors and particularly surgeon-related variables are far more important. Fielding in 1980 clearly showed, that the leak rates amongst 84 surgeons in 23 hospitals who performed 1466 colorectal anastomoses varied from 0.5% to 30% [9]. This means that some surgeons perform anastomosis badly. It might be related to individual surgical technique, lack of judgement and low case-load.

Having some risk factors, which might impair the healing process of performed anastomosis I recommend the following procedures:

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- 1. to avoid primary anastomosis and two-stages operation (Hartman or Hartman-like operation) should be performed
- 2. one-stage colorectal resection with primary anastomosis with anastomosis protection using intracolonic bypass tubes like biodegradable tubes, coloshield, condom (Wan-Hee, Ger, Ravo) [19,20].
- 3. Intraoperative air test for the assessment of tightness of the anastomosis
- 4. the proximal ileostomy or colostomy routinely performed in ultra-low coloanal or colorectal anastomosis particularly in patients presenting risk factors

Minimal local tissue necrosis, minimal collagenase activity, minimal "foreign body" reaction and ideal apposition of all layers of bowel wall of both anastomosed stumps (particularly submucosa) warrant that minimal risk of anastomotic dehiscence will take place. (Fig. 12)

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