A review of diversionary procedures for distal colorectal anastomosis

S Kumar and Yunus Alif Gul *Department of Surgery, Universiti Putra Malaysia, 43400, Serdang, Selangor. (Correspondence: YA Gul; e-mail: yunus@medic.upm.edu.my)*

Abstract

The morbidity associated with a low colorectal or coloanal anastomotic leak, which can rarely be fatal, is reduced by the use of a defunctioning stoma to divert the proximal faecal stream. Up to the present moment, there has been continuing controversy regarding the optimal method of defunctioning a distal anastomosis, the choice resting between either a loop ileostomy (LI) or loop transverse colostomy (LTC). This review discusses both the above diversionary methods in detail and the resulting outcome following surgery. The collective results from this review indicate an advantage of loop ileostomy over transverse loop colostomy as the preferred method of temporary faecal diversion in low colorectal and coloanal anastomoses.

Key words: loop ileostomy, loop colostomy, defunctioning stoma, faecal diversion.

Introduction

Faecal diversion (Karanjia *et al.*, 1991) is often required for the treatment of diseases affecting the large intestine following low coloanal or colorectal anastomosis (Aitken, 1996), following a restorative proctocolectomy (Dehni *et al.*, 1998), and for Crohn's disease. While options (Popovic *et al.*, 2001) may be limited for technical or therapeutic reasons, in many circumstances the surgeon selects the type of defunctioning stoma according to his or her preference. Preference bias should however rest firmly on available objective data based on the ease of construction and reversal of a stoma, in addition to minimising morbidity rates (Sakai *et al.*, 2001). Equally important are patient's perceptions regarding the ease of stoma use, its subsequent management and associated quality of life.

For left-sided colonic disease and procedures, the two most common stoma options include the formation of a loop transverse colostomy (LTC) or loop ileostomy (LI) (Senapati *et al.*, 1993; Tschmelitsch *et al.*, 1999). Until now, it has remained controversial as to whether a LI or LTC is a better form of faecal diversion. We therefore reviewed the English language medical literatures pertaining to the subject matter incorporating prospective and retrospective, randomized and non- randomized, and case control studies on various aspects concerning loop ileostomy and loop transverse colostomy. Emphasis was placed on the surgical techniques and methods of stoma creation, mode of closure, and complications occurring in the pre- and post-closure period. The advantages and disadvantages of each method in terms of safety and management are also stressed upon in this review.

Indication for Faecal Diversion

Low colorectal and coloanal anastomoses are associated with an anastomotic leak rate approaching 15% (Poon *et al.*, 1999). A significant reduction (leak rates of 4%) in clinically detectable anastomotic leaks has been quoted in various studies in patients in whom a proximal faecal diversion is employed (Aitken, 1996; Eu *et al.*, 1998).

The principal indications of faecal diversion include low colorectal or coloanal anastomosis for primary diseases such as carcinoma of the rectum or sigmoid colon, complicated diverticular disease, ulcerative colitis, Crohn's disease, familial polyposis coli and anorectal trauma (Riesener *et al.*, 1997). The other less common indications include bowel obstruction present at operation due to a distal mass or inflammation (Mann *et al.*, 1991), technical difficulties at surgery, patient related risk factors, proximal to the formation of a J-Pouch (Dehni *et al.*, 1998), enterocutaneous fistulae, severe intra-abdominal sepsis, peritonitis and demonstrable anastamotic leak during intra operative testing (Phang *et al.*, 1999), anal sphincter repairs and surgery for anorectal malformations in infants.

In rare circumstances, the creation of a defunctioning stoma is required in situations such as stapling instrumentation failure (Karanjia *et al.*, 1994), local hypertrophy of bowel (Mann *et al.*, 1991) perforated tumour with faecal contamination, poor bowel preparation, penetrating colonic injury (Gonzalez *et al.*, 1996) and healing of severe perineal injury. The

indications for faecal diversion, both common and infrequent, are summarised in (Table 1).

The optimal mode of faecal diversion is debatable as it can be achieved by either a loop transverse colostomy or loop ileostomy. Several studies have compared loop ileostomy with loop colostomy to defunction colorectal anastomosis and this represents an important issue in abdominal surgery. Both types of stoma are associated with a relatively high complication rate even though both modalities provide satisfactory protection from the morbidity of colorectal or coloanal anastomotic leakage (Karanjia *et al.*, 1994).

Techniques of Construction of Loop Ileostomy and Loop Transverse Colostomy

Loop ileostomy

A defunctioning loop ileostomy was originally employed as the sole procedure for the treatment of acute attacks of ulcerative colitis (Lahey, 1951). A loop ileostomy is constructed by the modification of the technique described by Alexander Williams (Carlsen *et al.*, 1999; Williams *et al.*, 1986). The site is selected in the lower right quadrant of the abdomen, 2 to 3 cm above a point midway between the umbilicus and anterior superior iliac spine. A disc of skin together with the subcutaneous fat is incised in a cruciate fashion and after separation of the fibres of the rectus muscle, the posterior rectus sheath and peritoneum are incised. The defect in the abdominal wall is dilated to admit the tip of two fingers and a loop of terminal ileum, approximately 5cm in length, is withdrawn through the opening. The correct orientation of the proximal and distal limb is carefully noted and at least 15-20 cm of ileum proximal to the ileocaecal junction should remain within the peritoneal cavity to prevent tension and facilitate eventual excision of the stoma. The loop is then turned in a clockwise direction so that its proximal end is located inferiorly (Phang *et al.*, 1999). A short plastic rod may be passed through the mesentery close to the intestinal wall to support the bowel at skin level. A transverse incision 1-2 cm long is made in the ante-mesenteric part of the distal limb close to the skin level. The wall of the efferent limb is then everted providing a stoma of 2-3 cm in length. The mucosa is then sutured to the skin using absorbable sutures. A two-piece stoma appliance is immediately fitted.

Loop transverse colostomy

A transverse loop colostomy is constructed proximal to the middle colic artery, perhaps best described originally by Goligher (Khoury *et al.*, 1987) without significant variation. It is constructed in the right upper quadrant of the abdomen through a transverse incision in the rectus abdominis muscle below the costal margin. The mesentery adjacent to the bowel wall is incised for the passage of the rod used to bring the transverse colon out through the pre-marked stoma site. The rod is used to support the colostomy in the early post-operative period and is removed 1 week after surgery. An incision is made along one of the taenia coli and the colostomy matured with interrupted absorbable muco-cutaneous sutures. A stoma appliance is used immediately (Williams *et al.*, 1986).

Complications of Loop Ileostomy and Loop Transverse Colostomy

Complications following the creation of a stoma are experienced by 20-40% of patients. Early complications that include ischaemia, necrosis, haemorrhage, stenosis, infection and retraction are often the result of technical errors (Chen & Stuart, 1996) and can be prevented by meticulous technique and attention to detail.

Prolapse, obstruction, parastomal hernia and skin irritation are usually considered as late complications. These too can be secondary to poorly constructed stomas, or may be related to poor care and management (Dehni *et al.*, 1998). Another factor accounting for complications is recurrent disease, which if unresponsive to medical management, frequently requires reoperation and stoma revision (Dehni *et al.*, 1998; Edwards *et al.*, 2001).

Specific Complications

Stomal Ischaemia

Stomal ischaemia ranges from harmless mucosal sloughing to frank necrosis. This complication is usually due to aggressive stripping of the mesentery, a stenotic aponeurotic fascial defect or excessive tension on the stoma leading to devascularisation (Brooke, 1993).

Haemorrhage

Minor haemorrhage is common and is usually mucosal and self-limiting, often responding to light pressure. Active bleeding usually implies failure of securing haemostasis of the mesenteric vessel (Abacarian *et al.*, 1988; Edwards *et al.*, 1998).

Table 1. Indications for faecal diversion

Common Indications	Infrequent Indications
Obstructing colorectal cancers	Technical difficulties at surgery
To protect a low colorectal or coloanal anastomosis.	Patient related risk factors
Inflammatory bowel diseases	Enterocutaneous fistula
Proximal to the formation of a J-Pouch	Demonstrable anastomotic leak (intra-operative testing)
Healing of severe perineal or perianal injury	Stapling instrument failure
Perforated tumour with faecal contamination	Local hypertrophy of bowel
Severe intra -abdominal sepsis and peritonitis	Poor bowel preparation
Anal operations like complicated fissures and sphincter repairs	Penetrating colonic injury
Anorectal malformation and short segment aganglionosis in the paediatric age group	

Table 2. Randomised controlled studies of complications occurring prior to and following stoma closure

Studies	Pre-closure of Stoma			Post-closure of Stoma		
	Type of stoma	Number	Complications (%)	Type of stoma	Number	Complications (%)
Williams *et al.* (1986)	LI	23	3 (13)	LI	20	1 (5)
	LTC	24	11 (46)	LTC	20	6 (30)
Khoury *et al.* (1987)	LI	32	11 (34)	LI	32	1 (3)
	LTC	29	18 (62)	LTC	29	1 (3)
Gooszen *et al.* (1998)	LI	37	4 (11)	LI	29	8 (28)
	LTC	39	0 (0)	LTC	32	3 (9)
Edwards *et al.* (2001)	LI	34	1 (3)	LI	32	1 (3)
	LTC	36	10 (28)	LTC	31	3 (10)
Law *et al.* (2002)	LI	39	6 (15)	LI	35	4 (11)
	LTC	38	11 (29)	LTC	38	3 (8)

Table 3. Specific complications of loop ileostomy and loop transverse colostomy.

Studies	Stoma Type	No.	Bowel Obstruction	*Wound Related	Prolapse/ Retraction	€ Skin	**Others	Total (%)
Fasth *et al.* (1980)	LI	21	2	1	NS	4	0	7 (37)
	LTC	21	1	6	NS	5	0	12 (63)
Williams *et al.* (1986)	LI	23	2	12	1	8	12	35 (38)
	LTC	24	2	20	4	17	13	56 (62)
Khoury *et al.* (1987)	LI	32	2	8	NS	2	1	12 (39)
	LTC	29	3	12	NS	1	3	19 (61)
Gooszen *et al.* (1998)	LI	32	2	17	5	14	26	64 (40)
	LTC	38	1	25	17	18	36	97 (60)
Edwards *et al.* (2001)	LI	34	0	1	0	NS	4	5 (26)
	LTC	36	1	3	2	NS	8	14 (74)
Rullier *et al.* (2001)	LI	107	14	5	4	2	11	36 (41)
	LTC	60	6	18	9	4	15	52 (59)
Sakai *et al.* (2001)	LI	63	4	15	0	2	12	33 (37)
	LTC	63	4	24	2	10	15	55 (63)
Law *et al.* (2002)	LI	42	6	2	0	4	2	14 (47)
	LTC	38	1	2	3	7	3	16 (53)

* includes wound infection, fistula and wound haematoma; ** includes parastomal hernia, incisional hernia and high output stoma; € skin excoriations; NS = not stated

Table 4. Studies reporting gut recovery and hospital stay following stoma closure

Studies	Loop ileostomy		Loop colostomy	
	First bowel movement (Days)	Hospital Stay (Days)	First bowel movement (Days)	Hospital Stay (Days)
Williams *et al.* (1986)	3	6	4	6
Khoury *et al.* (1987)	2	NS	4.5	NS
Sakai *et al.* (2001)	3	7	4	8
Law *et al.* (2002)	2	5	3	6

NS = not stated

Mucocutaneous separation

Undue tension or separation of sutures used to construct the stoma will cause separation along the mucocutaneous border. Gross separation, though rare can lead to eventual stricture and stenosis (Brooke, 1993).

Infection / fistula

Parastomal abscess or infection is often related to an infected haematoma or fistula formation. Beyond the immediate postoperative period, fistula formation or infection may signal recurrent Crohn's disease (Van de Pavoordt *et al.*, 1987; Williams *et al.*, 1986).

Stomal Retraction

Retraction, particularly of an ileostomy can lead to leakage and severe skin problems. Retraction is the most common reason for reoperation and can usually be prevented by minimising tension (Mann *et al.*, 1991).

Prolapse

This is most frequently seen with loop colostomy and can be managed with reduction and supportive care until revision surgery is planned (Torkington *et al.*, 1998).

Parastomal hernia

This is a common complication and has been reported in as many as 50% of patients. Predisposing factors include stoma placement lateral to the rectus sheath, a large stoma aperture, obesity, poor abdominal incision, malnutrition and wound infection (Van de Pavoordt *et al.*, 1987).

Skin complications

Contact dermatitis is the most common disorder associated with stomas. This is either secondary to an allergic reaction to certain components of stoma appliances or exposure to ostomy effluent. Additional anatomic factors may predispose a patient to leakage and dermatitis (Spencer & *et al.*, 1997)

Advantages and Disadvantages of Loop Ileostomy

A frequent advantage cited in favour of a loop ileostomy as a defunctioning stoma of choice relates to its ease of construction and reversal. Patients often find it easier to adapt to an ileostomy as it is associated with less complicated stoma care, requiring less appliance changes. It is also associated with significantly less odour. Morbidity after construction and closure of stoma such as prolapse, peristomal skin excoriation and leakage around the stoma site (Rullier *et al.*, 2001; Fasth *et al.*,1980) are also comparatively less in comparison to a transverse loop colostomy. It is hence often considered to be a more reliable option of faecal diversion (Edwards *et al.*, 2001).

The major disadvantage of loop ileostomy is a higher rate of severe dehydration and bowel obstruction leading to relaparotomy (Gooszen *et al.*, 1998). Intestinal obstruction subsequent to LI closure following an ileoanal anastomosis has been reported to range between 13% to 15% with a lesser risk (less than 5%) following elective colorectal anastomosis. Since loop ileostomy closure is frequently associated with local or segmental resection prior to re-establishing bowel continuity, the operative time required is longer (Law *et al.*, 2002). Patients are often advised to adhere to strict dietary guidelines to avoid unnecessary metabolic complications secondary to ileostomy diarrhoea. Loop ileostomy tends to be associated with higher incidence of adhesions and obstructions following total colectomy and an ileoanal pouch (Mann *et al.*, 1991; Francois *et al.*, 1989) even though this complication is reported to be less frequent after distal colorectal resection.

Advantages and Disadvantages of Loop Colostomy

Loop colostomy may provide better defunctioning in a poorly prepared bowel or where large bowel intestinal leakage has occurred as it prevents residual faecal content within the proximal large bowel from continually soiling the distal field (Gooszen *et al.*, 1998). The operative time required for construction and closure of stoma is reported to be shorter than loop ileostomy (Law *et al.*, 2002). Bowel obstruction and dehydration is comparatively less common than in loop ileostomy and strict dietary guidelines are not usually necessary in loop colostomy even though patients often have to refrain from certain foods associated with increased flatus discharge.

The disadvantages of loop colostomy are numerous, notably stomal prolapse and parastomal hernias. Skin related complications, which include leak and excoriations, are significantly more common after colostomy (Rullier *et al.*, 2001). Clothing adjustments are needed more often in the presence of a colostomy, which is also associated with a greater degree of unpleasant odour. Apart from difficulty in managing the stoma appliance, wound infection, incisional hernia, anastamotic leaks and enterocutaneous fistula are reported to be more common after colostomy closure (Rullier *et al.*, 2001).

Comparative Studies of Loop Ileostomy and Loop Transverse Colostomy.

This review on the preferred method of faecal diversion to defunction the distal bowel primarily focuses on procedural related complications as the main factor in determining the advantage of one procedure over another. Secondary factors that contribute in the decision-making process include gut function returning to normal and length of hospital stay.

The frequency of complications occurring prior to and following stoma closure (Table 2), specific complications of loop ileostomy and colostomy (Table 3) and gut recovery together with hospital stay following stoma closure (Table 4) were tabulated and only studies with more than 20 patients undergoing each procedure were scrutinised. A total of 5 randomised clinical trials, 1 retrospective and 2 case matched studies met the criteria for this review. A total of 6 studies recommended loop ileostomy while the remaining 2 studies recommended loop transverse colostomy as the defunctioning stoma of choice.

Khoury *et al.* (1987) in their randomised study recruited 61 patients, 32 of whom underwent loop ileostomy and 29 had a loop transverse colostomy fashioned. Fifty-two patients had their stomas closed. They found no significant difference between the groups except that LI functioned earlier than LTC. The authors recommended loop ileostomy as the procedure of choice based on this factor. The management of stomas was not deemed as a significant problem and skin excoriations rarely occurred even in the presence of leaks from the appliance. The absence of prolapse, retraction or serious skin problems may be due to the skilled and intensive stoma care available within the authors' institution and the policy of early restoration of bowel continuity. In this study rods or absorbable bridges were not used to support a loop ileostomy to avoid unnecessary fibrosis at the base of the stoma, which may increase the difficulty associated with early stoma closure.

A retrospective study by Rullier *et al.* (2001) demonstrated that LTC was associated with a significantly greater degree of morbidity and higher risk of surgical re-intervention than LI. Reported complications after colostomy formation in this series included parastomal hernias, prolapse, retraction, wound infection after stoma closure and incisional hernias. These complications have also been cited in other series performing loop colostomy with a frequency ranging from 5-40%, the most frequent being wound abscess and the most serious, fistula formation. The large sample size in this series added significance to the results in comparison to other similar studies apart from the fact that a sizeable number of patients recruited included those with rectal cancers. However no data was provided regarding the overall hospital stay and costs, performance of pre-closure contrast studies and patient satisfaction. The reported development of wound infections and incisional hernias following stoma closure may be attributed to the employment of primary wound closure and wound drainage techniques, which were not standardized.

Sakai *et al.* (2001) in a retrospective case matched study, reported mostly skin related complications and leakage around the stoma site following the formation of a loop colostomy. The operative time of loop ileostomy closure in this study was longer in comparison to other studies as bowel resection was commonly

performed prior to restoring intestinal continuity. The superiority of the results were however demonstrated through intensive stoma management related to comprehensive pre-operative stoma therapy and patient education by a certified enterostomal nurse which was most likely responsible for the positive outcome. The authors added significance to the study by reporting on a large sample of patients who were well matched even though the analysis was retrospective in nature. The authors also recommended that closure of stomas should be performed after 3 months to limit complications.

One of the earliest studies indicating the superiority of LI over LTC was by Fasth *et al.* (1980). Wound infection rates in subjects who had a LTC were reported to be higher in their non-randomised study. Stoma related skin problems were also reported to be associated with a greater difficulty in managing colostomy patients. According to the authors, the anatomical siting and fashioning of colostomy flush to the skin contributed greatly to this difficulty. Loop ileostomy and colostomy closure in this study was accomplished by a local procedure without requiring bowel resection except for one case in the LTC group, which required limited resection due to florid inflammatory fibrotic reaction in the surrounding wound. Four patients developed wound sepsis and one patient developed a fistula in the LTC group. Closure of ileostomy was uneventful in all patients except for one who developed wound sepsis.

Williams *et al.* (1986) in their randomised controlled trial incorporating 47 patients (LI: 23, LTC: 24) undergoing elective colorectal surgery found significant differences in favour of LI. The advantages of LI were primarily due to less odour and frequent appliance change. Furthermore eleven patients (58%) with LTC experienced stoma related problems compared to 3 patients (18%) with LI. The authors claimed that the techniques of stoma closure had a significant impact in reducing wound sepsis in the LI group. The surgical procedure was performed by all grades of surgeons in this study and there was no correlation between the surgeon's level of experience and complication rate. This finding is in conflict with the common speculation amongst the surgical fraternity that stoma construction is often left to junior surgeons to complete and is therefore associated with a higher complication rate.

Edwards *et al.* (2001) reported no significant difference in the ease of construction and the time taken to fashion LI and LTC. On the other hand, Khoury *et al.* (1987) showed that LI appeared to be more difficult to construct in obese patients (Mann *et al.*, 1991). In contrast to the findings of Williams *et al.* (1986), Edwards *et al.* (2001) reported no difference in complications of stoma management due to improvements in stomal appliances and accessories. Senior consultants and senior trainees performed stoma closure with no observed differences in the ease and time taken to close the stoma. Loop ileostomy appeared to be more difficult than LTC because of the need to reduce or resect the spout of the ileostomy (6 LI versus 2 LTC). The larger fascial defect used to create LTC in comparison to LI improves the access into the peritoneal cavity for stomal mobilization and hence tends to be associated with a greater degree of ease during closure. The size of the fascial opening and the relative bulkiness of LTC were most likely responsible for two prolapses and hernias observed in the LTC group. The high incisional hernia rate in this study associated with LTC formation is probably related to the higher bacterial concentration of effluent from loop colostomies which results in greater contamination of the wounds at the time of closure and concomitantly increases the risk of deep wound dehiscence.

One of the studies that supported the use of LTC as a defunctioning stoma was a multicentre randomised controlled study conducted in 5 centres over a period of 6 years incorporating 76 patients, 37 of who had a LI (Gooszen *et al.*, 1998). Statistically lower complication rates were reported with LTC especially in the post-stoma closure period. In the period between stoma construction and closure, significant complications were however more common following LTC in the form of prolapse rate, need for temporary adaptation of clothing, and dietary adjustments. Following stoma closure 27.5% of the LI group had complications with two mortalities compared to 9% complications in the LTC group with no deaths. The trial however included patients presenting with emergency left-sided colonic obstruction as well as benign elective colorectal surgical procedures in the form of sigmoid diverticular resection. The higher than usual morbidity and mortality rate was in relatively older patients in whom the impact of a stoma, even though temporary, is potentially enormous.

Law *et al.* (2002) only included patients who had anterior resection and total mesorectal excision for rectal cancers requiring defunctioning stomas in their study with results favouring LTC. Even though the gut function in the LI group started to function earlier than LTC, this did not translate into earlier resumption of solid diet or a shorter hospital stay following stoma closure. Post-operative intestinal obstruction and prolonged ileus were also reported to be more common in patients with loop ileostomy. The presence of a loop ileostomy in the infra colic compartment is more likely to lead to the formation of adhesions, twisting or herniation of the small bowel which explains the high reported rates of post-operative obstruction. The authors' cohort of patients also had loop ileostomy closure approximately 6 months longer than the normal expected duration of 2 months following construction.

A few remaining studies have collectively recommended LI as a better alternative to LTC in terms of patient satisfaction and the lower frequency of wound infection associated with its closure (Raimes *et al.*, 1984; Senapati *et al.*, 1993; Berry *et al.*, 1997; Torkington *et al.*, 1998; O' Leary *et al.*, 2001)

Complications of loop ileostomy and loop transverse colostomy prior to and following stoma closure are summarised in Table 3. The results clearly demonstrates the higher association of loop colostomy with complications such as prolapse, retraction, parastomal hernia, incisional hernia, wound infections, wound hematomas, faecal fistulas, anastomotic leakage, and severe skin complications that require clothing adaptation. The incidence of other minor complications like fever, haemorrhage and general complications like pulmonary, cardiac, urinary and deep venous thrombosis have also been reported to be more common in patients with loop colostomy (Khoury *et al.*, 1987). In contrast, LI dominates morbidity associated with bowel obstruction and adhesions even though the total complication rate of LI is reported to be lower than LTC.

The reported major or minor complications that have been discussed can be attributed to certain risk factors which include surgeons experience, primary disease, site of the stoma, operative technique, and time interval between the primary operation and stoma closure. Furthermore, a complete preoperative bowel preparation in combination with peri-operative antibiotic treatment has been recommended to reduce stoma related complications (Riesener *et al.*, 1997).

Recovery phase (Table 4) from stoma closure in terms of first bowel movement and resumption of fluid diet is also reported to be more rapid in patients with loop ileostomy. The overall length of hospital stay (Table 4) further confirms the superiority of loop ileostomy over loop transverse colostomy (Khoury *et al.*, 1987).

Conclusions

Stoma surgery has a great influence on a patients' daily life. Both LI and LTC are methods that provide effective defunctioning of a distal high-risk anastomosis. This review suggests that LI is associated with low rates of serious stoma related complications and faster recovery and its use is therefore recommended as an optimal diversionary procedure for patients who need defunctioning of a distal anastomosis following low anterior resection and total mesorectal excision with adequate bowel preparation. The employment of a stoma should be carefully planned and performed on a selective basis considering the significant complications that occur with both types of stoma and that at least 15% of temporary stomas will turn out to be permanent. Loop colostomy appears to be a better alternative in defunctioning poorly prepared bowel or in an emergency situation where leakage has occurred and diversion is required.

With the advent of stapled anastomosis for closure, adhesion barrier agents, modern stoma appliances, meticulous surgical techniques and patient management, the complication rate associated with loop ileostomy can be reduced to a greater extent, hence reinforcing our recommendation for this method to be considered as the defunctioning stoma of choice.

References

Abacarian H, Pearl RK. Stomas. *Surg Clin North Am* 1988; 68: 1295-305.

Aitken RJ. Mesorectal excision for rectal cancer. *Br J Surg* 1996; 83: 214-6.

Anderson DN, Driver CP, Park KG, Davidson AI, Keenan RA. Loop ileostomy fixation - a simple technique to minimize the risk of stomal volvulus. *Int J Colorectal Dis* 1994; 9: 138-40.

Berry DP, Scholefield JH. Closure of loop ileostomy. *Br J Surg* 1997; 84: 524.

Brooke BN. The management of an ileostomy including its complications. *Dis Colon & Rectum* 1993; 36: 512-6.

Carlsen E, Bergan AB. Loop ileostomy-technical aspects and complications. *Eur J Surg* 1999; 165: 140-4.

Chen F, Stuart M. The morbidity of defunctioning stoma. *Aust N Z J Surg* 1996; 66: 218-21.

Dehni N, Schlegel RD, Cunningham C, Guiguet M, Tiret E, Parc R. Influence of a defunctioning stoma on leakage rates after low colorectal anastomosis and colonic J pouch-anal anastomosis. *Br J Surg* 1998; 85: 1114-17.

Edwards DP, Chisholm EM, Donaldson DR. Closure of transverse loop colostomy and loop ileostomy. *Ann R Coll Surg Eng* 1998; 80: 33-5.

Edwards DP, Leppington CA, Sexton R, Heald RJ, Moran BJ. Stoma-related complications are more frequent after transverse colostomy than loop ileostomy - a prospective randomized clinical trial. *Br J Surg* 2001; 88: 360-3.

Eu KW, Seow CF, Ho JMS, Ho YH, Leong PK. Local recurrence following rectal resection for cancer. *J R Coll Surg Edin* 1998; 43: 393-6.

Fasth S, Hulten L, Palselius I. Loop ileostomy - an attractive alternative to a temporary transverse colostomy. *Acta ChirScand* 1980; 146: 203-7.

Feinberg SM, McLeod RS, Cohen Z. Complications of loop ileostomy. *Am J Surg* 1987; 153: 102-7.

Francois Y, Dozois RR, Kelly KA, Beart RW, Wolff BG, Pemberton JH, Ilstrup DM. Small intestinal obstruction complicating ileal pouch-anal anastomosis. *Ann Surg* 1989; 209: 46-50.

Gonzalez RP, Falimirski ME, Holevar MR. Further evaluation of colostomy in penetrating colon injury. *Southeastern Surgical Congress* 1999; 42: 1-11.

Gooszen AW, Geelkerken RH, Hermans J, Lagaay MB, Gooszen HG. Temporary decompression after colorectal surgery- Randomised comparison of loop ileostomy and loop colostomy. *Br J Surg* 1998; 85: 76-9.

Gooszen AW, Geelkerken RH, Hermans J, Lagaay MB, Gooszen HG. Quality of life with a temporary stoma- ileostomy vs colostomy. *Dis Colon Rectum* 2000; 43: 650-5.

Hasegawa H, Radley S, Morton DG, Keiggley MR. Stapled versus sutured closure of loop ileostomy-A randomized controlled trial. *Ann Surg* 2000; 231: 202-4.

Karanjia ND, Corder AP, Beam P, Heald RJ. Leakage from stapled low anastomosis after total mesorectal excision for carcinoma of the rectum. *Br J Surg* 1994; 81: 1224-6.

Karanjia ND, Corder AP, Holdsworth PJ, Heald RJ. Risk of peritonitis and fatal septicaemia and the need to defunction the low anastomosis. *Br J Surg* 1991; 78: 196-8.

Khoury GA, Lewis MC, Meleagros L, Lewis AA. Colostomy or ileostomy after colorectal anastamosis? :Randomised trial. *Ann R Coll Surg Engl* 1987; 69: 5-7.

Kockerling F, Parth R, Meissner M, Hohenberger W. Ileostomy-caecal fistula-colostomy-which is the most suitable faecal diversion method with reference to technique, function, complications and reversal?. *Zentralbl Chir* 1997; 122: 34-8.

Lahey FH. Indications for surgical intervention in ulcerative colitis. *Ann Surg* 1951; 133: 726-42.

Law WL, Chu KW, Choi HK. Randomized clinical trial comparing loop ileostomy and loop transverse colostomy for faecal diversion following total mesorectal excision. *Br J Sur* 2002; 89: 704-8.

Mann LJ, Steward PJ, Goodwin Chapuis, Bokey. Complications following closure of loop ileostomy. *Aust N Z J Surg* 1991; 61: 493-6.

O'Leary DP, Fide CJ , Foy C, Lucarotti ME. Quality of life after low anterior resection with total mesorectal excision and temporary loop ileostomy for rectal carcinoma. *Br J Surg* 2001; 88: 1216-20.

Phang PT, Hain JM, Perez-Ramirez JJ, Madoff RD, Gemlo BT. Techniques and complications of ileostomy takedown. *Am J Surg* 1999; 177: 463-6.

Poon RT, Chu KW, Ho JW, Chan CW, Law WL, Wong J. Prospective evaluation of selective defunctioning stoma for low anterior resection with total mesorectal excision. *World J Surg* 1999; 23: 463-7.

Popovic M, Petrovic M, Matic S, Milovanovic A. Protective colostomy or ileostomy?. *Acta Chir Iugosl* 2001; 48: 39-42.

Raimes SA, Mathew VV, Devlin HB. Temporary loop ileostomy. *J R Soc Med* 1984; 77: 738-41.

Reasbeck PG, Smithers BM. Construction and Management of Ileostomies and Colostomies. *Digestive Dis* 1989; 7: 265-80.

Richard JH, Brendan JM, Roger DH, Rosemary S, John KM. Rectal cancer: The Basingstoke experience of total mesorectal excision. *Arch Surg* 1998; 133: 894-9.

Riesener KP, Lehnen W, Hofer M , Kasperk R , Braun JC, Schumpelick V. Morbidity of ileostomy and colostomy closure-impact of surgical technique and perioperative treatment. *World J Surg* 1997; 21: 103-105.

Rullier E, Letoux N, Laurent C, Garrelon JL, Parneix M, Saric J. Loop ileostomy vs Loop Colostomy for defunctioning low anastamosis during rectal cancer surgery. *World J Surg* 2001; 25: 274-7.

Rutegard J, Dahlgren S. Transverse colostomy or loop ileostomy as diverting stoma in colorectal surgery. *Acta Chir Scand* 1987; 153: 229-32.

Sakai Y, Nelson H, Larson D, Maidl L, Young F, Ilstrup D. Temporary transverse colostomy vs loop ileostomy in diversion-a case-matched study. *Arch Surg* 2001; 136: 338-42.

Senapati A, Nicholls RJ, Ritchie JK. Temporary loop ileostomy for restorative proctocolectomy. *Br J Surg* 1993; 80: 628-30.

Spencer MP. Ostomies and stomal therapy. *Am Soc Colon and Rectal Surgeons* 1999; 42: 1-5.

Torkington J, Khetan N, Jamison MH. Temporary decompression after colorectal surgery- randomized

comparison of loop ileostomy and loop colostomy. *Br J Surg* 1998; 85: 1452.

Tschmelitsch J, Wykypiel H, Prommegger R, Bodner E. Colostomy vs tube cecostomy for protection of a low anastomosis in rectal cancer. *Arch Surg* 1999; 134: 1385-8.

Vande Pavoordt HD, Fazio VW, Jagelman DG, Lavery IC, Weakley. The outcome of loop ileostomy closure in 293 cases. *Int J Colorectal Dis* 1987; 2: 214-7.

Williams NS, Nasmyth DG, Joned D, Smith AH. Defunctioning stomas-a prospective controlled trial comparing loop ileostomy with loop transverse colostomy. *Br J Surg* 1986; 73: 566-70.