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EDITORIAL

# Anastomotic leakage in rectal cancer surgery: The role of blood perfusion

Martin Rutegård, Jörgen Rutegård

Martin Rutegård, Jörgen Rutegård, Department of Surgical and Perioperative Sciences, Umeå University, S-90187 Umeå, Sweden

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Correspondence to: Martin Rutegård, MD, PhD, Department of Surgical and Perioperative Sciences, Umeå University, SE-901-87, S-90187 Umeå, Sweden. martin.rutegard@surgery.umu.se
Telephone: +46-90-7858628
Fax: +46-90-7851156

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## Abstract

Anastomotic leakage after anterior resection for rectal cancer remains a common and often devastating complication. Preoperative risk factors for anastomotic leakage have been studied extensively and are used for patient selection, especially whether to perform a diverting stoma or not. From the current literature, data suggest that perfusion in the rectal stump rather than in the colonic limb may be more important for the integrity of the colorectal anastomosis. Moreover, available research suggests that the mid and upper rectum is considerably more vascularized than the lower part, in which the posterior compartment seems most vulnerable. These data fit neatly with the observation that anastomotic leaks are far more frequent in patients undergoing total compared to partial mesorectal excision, and also that most leaks occur dorsally. Clinical judgment has been shown to ineffectively assess anastomotic viability, while promising methods to measure blood perfusion are evolving. Much interest has recently been turned to near-infrared light technology, enhanced with fluorescent agents, which enables intraoperative perfusion assessment. Preliminary data are promising, but large-scale controlled trials are lacking. With maturation of such technology, perfusion measurements may in the future inform the surgeon whether anastomoses are at risk. In high colorectal anastomoses, anastomotic revision might be feasible, while a diverting stoma could be fashioned selectively instead of routinely for low anastomoses.

**Key words:** Anastomotic leakage; Blood perfusion; Rectal cancer; Anterior resection; Diverting stoma



**Core tip:** Anastomotic leakage after anterior resection for rectal cancer is still common. Several preoperative risk factors may inform the surgeon of the leakage risk. The surgeon might choose to perform a diverting stoma to mitigate this risk, or to construct an end colostomy and thus avoid an anastomosis altogether. Intraoperatively, clinical judgment of the viability of the anastomosis is not reliable. However, research using blood perfusion measurement technology has evolved in recent years; technology using near-infra red light seems to be promising, allowing assessment

of the bowel perfusion. In the future, such technology may aid in the decision-making concerning colorectal anastomoses.

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## INTRODUCTION

Anterior resection is considered standard procedure for patients with cancer in the mid and high rectum. With the advent of the total mesorectal excision (TME) technique, complications such as anastomotic leakage have been increasing in frequency[1]; current population-based studies indicate rates of around 10%-11%[2,3]. The impact of anastomotic leakage is considerable, leading to major morbidity and mortality[4]. Anastomotic breakdown is a multifactorial event, influenced by patient factors as well as surgical technique[5,6], although the pathogenesis has not been clearly elucidated. Axiomatically, the fundamental principles of a successful anastomosis entail anastomosing two ends of healthy bowel with adequate blood supply and lack of tension after union. The former aspect has been the subject of considerable debate but perhaps less investigation. Surgeons' ability to predict anastomotic leakage by judging the appearance of the serosa has been shown to be highly unreliable[7]; in current practice, only risk factor appraisal is available to guide the surgeon when making decisions whether to, *e.g.*, perform a diverting stoma, revise the anastomosis, or fashion an end colostomy. However, the advent of new studies and technologies may soon provide surgeons with effective means of assessing anastomotic viability.

### *Blood flow measurement technology*

A plethora of methods has been used to determine blood flow or oxygenation in general surgery[8]. The most commonly used method has been laser-Doppler flowmetry (LDF), the principle of which is to measure the Doppler shift - the frequency change that light waves undergo when reflected by moving objects, *e.g.*, red blood cells. Laser light is emitted and the backscattered light is collected, producing an output signal that is proportional to the number and velocity of the moving blood cells in the measured volume. The method has proven to be reproducible and has been correlated with other flow measurements, but LDF measurements are easily perturbed by motion artefacts and require direct tissue contact, which may disturb local blood flow. In order to measure oxygenation, visible light spectrophotometry offers shallow penetration of tissue at the capillary level, while near-infrared (NIR) light goes deeper and allows for a global oxygenation assessment. Spectrophotometry systems employ devices that emit light on or near the bowel wall - this light penetrates, diffuses and is subsequently analysed as it re-emerges variably coloured, according to the oxygenation level. In combination with injection of fluorescent agents, perfusion may also be evaluated by the NIR technique, which has lately been introduced into clinical studies[8].

### *Vascular anatomy and the anastomosis*

The importance of the knowledge of gross vascular anatomy cannot be overstated. Much attention has been directed at the colonic limb of the colorectal anastomosis, as evidenced by the controversy surrounding high ligation of the inferior mesenteric artery - high arterial ligation may compromise blood supply to the oral part of the anastomosis, if the sigmoid or descending colon is used and the marginal artery is not present or patent.

A Japanese group performed LDF on patients operated for cancer of the rectum and the sigmoid colon; colonic measurements were made before and after clamping, and showed marked reductions in perfusion after clamping, particularly for high tie patients[9]. Similar methodology was used by a Dutch group, but these authors compared measurements made immediately after laparotomy to measurements made before fashioning the anastomosis, and found that there were blood flow reductions in high tie patients; however, low tie patients displayed an increase in blood flow, a difference between groups that was statistically significant[10].

Observational studies on the clinical impact of high ligation have not consistently shown that this is a risk factor for anastomotic leakage[3,11,12], while no randomized clinical trial data are available. It is entirely possible that any perfusion compromise is uncommon due to collateral networks and also that surgeons adjust the colonic resection margins when faced with perfusion loss; thus, any perfusion disadvantage rendered by the high tie on the oral part of the anastomosis might be mitigated.

Using the TME technique, dissection at the level of the pelvic floor is sometimes extensive. The rectal blood supply after anterior resection is dependent on the inferior and the variable medial rectal arteries, but perfusion to the different parts of the rectum is not equally distributed. Angiographic findings suggest that the lower rectum has a sparse network of intramural collaterals, in contrast to the more vascularized upper and mid rectum[13]; this might explain the lower leak rate when performing partial mesorectal excision (PME), an oncologically feasible alternative for tumours in the upper rectum[14]. Moreover, the dorsocaudal aspect of the rectum is sparsely perfused[15], lending biological rationale to the clinical experience that most anastomotic leaks are located in the posterior aspect of the rectum[16]. Furthermore, laser-Doppler blood flow measurements recently made by our group have indicated that TME surgery, as compared to PME, markedly reduces perfusion in the posterior quadrant of the rectum[17].

An Italian group considered both the proximal and distal circulations in surgery for rectosigmoid cancers, where TME surgery was performed for cancers in the middle and lower rectum. Low tie was routinely performed, and measurements were made at the colonic serosa in and at the rectal mucosa, after division of the artery and before fashioning the anastomosis. The authors noted that most patients displayed colonic as well as rectal blood flow reduction, but the latter was more predictive of anastomotic leaks[18].

More recently, there have been several studies on NIR with fluorescent agents in the setting of colorectal surgery in general, including anterior resection. In a large series of open colorectal procedures, imaging of the bowel serosa prompted surgeons to revise transection margins in 16% of cases; reoperation for anastomotic leakage was decidedly less common in the group using this technique, compared to matched but historical controls[19]. As the bowel wall is difficult to assess aborally to the anastomosis in particularly low anterior resection, mucosal evaluation might be more important. Initial experiences have shown that reliable imaging of the perianastomotic region could be achieved[20], and suggested that revision of anastomoses, which displayed questionable perfusion, decreased leak rates[21]; in another study on NIR, the perceived imaging results provided confidence to avoid a diverting stoma in low anterior resection cases[22]. These studies all share small sample sizes and results cannot be validly extrapolated. However, the largest and most recent study to date on NIR included 139 laparoscopic colorectal resections, where all anastomoses were evaluated; in eleven patients, poor perfusion changed operative strategy, in most cases leading to an altered transection margin. In these patients, no leaks were detected[23]. However, no control group was enrolled and most anastomoses were high, making even this study difficult to apply to low rectal cancer. Arguably, the very low anastomoses may be challenging to revise, as any attempt may lead to a short and possibly damaged rectal stump; this would subsequently demand a purse string suture, hand-sewn under pressure, in order to be able to insert another circular stapler.

### *Future implications*

Preoperative risk factors for anastomotic leakage have been identified[24], and serve as a means to select patients to either anterior resection or operation with end colostomy. The unselected use of a diverting stoma in low anterior resections seem to reduce anastomotic leakage in a trial setting[25], while recent audits provide data that favour more selective use, tailored to the individual patient risk factor profile[26].

Ideally, the experimental data on rectal perfusion above could be translated into clinical practice. First, the anatomical knowledge on rectal vasculature may inform the surgeon that deep extensive dissection in the posterior aspect of the rectal stump may be potentially harmful. Second, blood flow measurements before and after the construction of the anastomosis could inform the surgeon that this particular anastomosis is at risk, and subsequently the case for anastomotic revision (for high anastomoses) or a diverting stoma (for low anastomoses) could be stronger. Presently, it seems that the evolving NIR methodology may offer such an opportunity in the near future. Naturally, such a strategy would need extensive support from more experimental and clinical data, but would provide a valuable tool for the colorectal surgeon.

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