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Anastomotic Leaks after Laparoscopic Gastric Bypass

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The gastrojejunostomy may be the most technically challenging step when performing laparoscopic Roux-en-Y gastric bypass. Patients who develop anastomotic leaks have increased morbidity and mortality rates. Difficulty in diagnosis is related to nonspecific systemic symptoms and limitations in most radiological studies. Our aim is to evaluate the incidence, etiology, diagnosis, management, and prevention of anastomotic leaks occurring in patients undergoing laparoscopic Roux-en-Y gastric bypass.

Key words: Anastomotic leak, morbid obesity, laparoscopic gastric bypass

Introduction

Many bariatric surgeons have adopted the laparoscopic Roux-en-Y gastric bypass (LRYGBP) to treat patients with clinically severe obesity. Several prospective, randomized clinical trials have demonstrated that LRYGBP results in less estimated blood loss, less pain medication requirements, shorter length of hospitalization, shorter return to daily activities, and fewer complications than the conventional open approach.[1-4] Today, the use of this technique has gained popularity among bariatric surgeons, despite concerns that it may result in higher complication rates compared to the open approach, such as leaks, internal hernias, and bleeding.

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Anastomotic leaks are one of the most dreaded complications following bariatric surgery due to their high rate of morbidity and mortality. Patients who develop anastomotic leaks require multiple additional diagnostic tests, longer hospitalizations, transfers to the Intensive Care Unit, prolonged ventilator support, and many times, a reoperation as a consequence of septic shock, multi-organ system failure, intra-abdominal abscesses, and fistulas.

Our aim is to provide a comprehensive review of the incidence, etiology, diagnosis, management, and prevention of anastomotic leaks occurring after LRYGBP.

Incidence

The incidence of anastomotic leaks in over 6,000 patients who underwent LRYGBP ranges from 0% to 4.3% (Table 1), and does not differ from the incidence in patients who underwent open Roux-en-Y gastric bypass, reported in up to 5.6% of cases.[15] The true incidence of anastomotic leaks is difficult to ascertain because of different operative techniques and different methods of identifying a leak. In addition, leaks that are secondary to staple-line failure in the divided gastric pouch or excluded stomach are commonly reported as "anastomotic leaks". Notwithstanding these shortcomings, the most common site for an anastomotic leak is the gastrojejunostomy.

Table 1. Anastomotic complication rates utilizing different gastrojejunostomy techniques during laparoscopic Roux-en-Y gastric bypass as reported in selected large series from the English literature

Source	Year	No. of patients	Leak rate (%)
Schauer et al[5]	2000	275	3.3
Wittgrove et al[6]	2000	500	2.2
Nguyen et al[3]	2001	79	1.3
Higa et al[7]	2001	1,500	0.9
Oliak et al[8]	2002	300	1.3
Champion et al[9]	2002	743	0.4
Gonzalez et al[10]	2003	108	0
Hamilton et al[11]	2003	210	4.3
Papasavas et al[12]	2003	246	1.6
Gould et al[13]	2004	100	3
Dresel et al[14]	2004	120	0.8
Fernandez et al[15]	2004	554	4.3
Carrasquilla et al[16]	2004	1,000	0.1
TOTAL		**6,135**	**1.4**

Etiology

Anastomotic leaks are secondary to alterations in the normal acute healing process. In such a complex series of events as in the healing process, multiple factors can impede an adequate outcome. The competence of anastomotic healing is dictated by a balance between the amount of collagen deposition and collagen degradation. An imbalance of this process will result in poor healing, and consequently, the load placed across the anastomosis exceeds the resistive capacity of the staple/suture line.

Local factors hindering satisfactory healing of the anastomosis include inadequate blood supply, excessive tension on the anastomosis, infection, and inadequate oxygenation with subsequent ischemia.[17,18] Although hypoxia will stimulate angiogenesis, the healing process will not proceed without tissue O_2 levels of 35 mmHg or greater. Below this level, fibroblasts cannot replicate and collagen production is impaired. Ischemia of the anastomotic region may result from excessive dissection and division of visceral vessels, mechanical tension preventing adequate local perfusion, atherosclerosis, and cardiac failure.[18]

Systemic factors that can affect healing are chemotherapy, glucocorticoids, radiation therapy, diabetes mellitus, cardiac failure, renal failure, and peripheral arterial occlusive disease.[17-20] Bone marrow suppression as a consequence of chemotherapy results in lymphocyte and monocyte deficiency and dysfunction that impairs cellular proliferation in the inflammatory phase of wound healing. Glucocorticoids inhibit arachidonic acid metabolism, impair macrophage migration, alter neutrophil function, and inhibit the synthesis of procollagen by fibroblasts, thus delaying wound contraction. Radiation injury leads to progressive arteriolar fibrosis and impaired oxygen delivery in addition to limiting the proliferative potential of fibroblasts. Although diabetes is often associated with decreased healing and increased susceptibility to infection, healing is not impaired in a well-controlled diabetic with adequate local tissue perfusion. Cardiac failure, renal failure, and peripheral arterial occlusive disease secondary to atherosclerosis can be a primary cause of impaired healing and may also be a cofactor with other conditions.

Although Vitamins A, C, and E are known to influence certain aspects of wound healing, their use in humans is not supported by rigorous evidence. Zinc and copper are also important co-factors for many enzyme systems involved in wound healing and their deficiency seems to hinder normal tissue healing.[17-20]

Clinical studies have identified technical factors and patient characteristics to be the most important factors that influence outcomes of anastomotic healing. Risk factors for anastomotic leaks in patients undergoing esophagectomy include ischemia, neoadjuvant therapy, and co-morbid conditions.[21] Of these, ischemia is the most important factor (odds ratio 5.5). Interestingly, although weight is not a risk factor for ischemia or leak, the risk of stricture rises with increasing weight.

Factors that Increase the Risk of Developing Anastomotic Leaks

Patient Demographics and Co-morbidities

Several studies have been undertaken with the purpose of identifying factors associated with poor operative outcomes in patients undergoing LRYGBP. Identification of patients who have a

higher possibility of developing leaks is crucial because it is an independent risk factor associated with perioperative death.[22]

Male gender, revisional surgery, increasing age, and increasing weight were found to be the most influential factors for predicting major complications after open Roux-en-Y gastric bypass.[23] Similarly, BMI >50 kg/m^2, FEV_1 <80 % predicted, previous abdominal procedures, and an abnormal electrocardiogram were found to increase the likelihood of a complicated postoperative management.[24] In another study, operative experience of the surgeon of less than 75 cases, older, and male patients were found to negatively influence operative outcomes after LRYGBP.[25]

A recently published study of both laparoscopic and open Roux-en-Y gastric bypass identified older, heavier male patients with multiple co-morbid conditions to be at increased risk for developing anastomotic leaks and subsequent mortality.[15] Consequently, the authors recommended that surgeons should avoid these high-risk patients during their learning curve.

Technical Considerations

The integrity of the gastrojejunostomy is totally dependent on the sutures or staples used until tissue healing acquires sufficient strength to offset the increased loads placed across the anastomosis. Additionally, several studies have suggested that the technique utilized to create the gastrojejunostomy may play an important role in the development of postoperative complications, such as strictures and leaks.

Constructing the gastrojejunostomy is one of the most challenging steps during LRYGBP. Consequently, different techniques have been devised in order to facilitate performing this step. The circular stapled anastomosis is the most commonly used technique; other techniques include using a linear stapler or handsewing the anastomosis. In LRYGBP, the handsewn and linear stapled techniques have been associated with lower stricture rates than the circular stapled technique.[11,26] Similarly, in open Roux-en-Y gastric bypass, the handsewn gastrojejunostomy technique has lower stricture and leak rates compared with the circular stapled technique.[27] However, similar findings have not been reported for anastomotic leaks following the laparoscopic approach.

In drawing correlates from colorectal surgery, the bursting pressure is considered to be the most important factor in assessing the quality of a newly created intestinal suture or staple line. Earlier animal data demonstrated that the biofragmentable anastomotic ring (BAR) has the greatest bursting pressure on the day of surgery, sutured anastomosis is the strongest on the third day of surgery, and there is no significant difference by the seventh postoperative day between those two techniques and stapling.[28] In another study, handsewn anastomoses had larger diameter, higher burst pressure, lower collagen content, less inflammation, and a more complete epithelialization than circular stapled anastomoses, resulting in a lower tendency to stricture and leakage.[29]

However, more contemporary studies demonstrated no difference between BAR, circular stapled, and two-layered handsewn anastomoses in human colon,[30] and a prospective, randomized trial comparing circular stapled, linear stapled, and handsewn anastomoses in emergency intestinal surgery found no difference in anastomotic leak rates, morbidity, or postoperative mortality.[31]

Surgeon's Experience

Surgical skills (i.e., dissection, identification of tissue planes, knot tying, and clipping) are more difficult to learn in laparoscopic than in open surgery, requiring additional training to decrease operative time and complications.[32] The learning curve for LRYGBP is one of the longest in laparoscopic surgery and is estimated to be between 75 and 100 cases.[33-35] However, a significant reduction in anastomotic leak rates with increasing experience has not been clearly documented. Schauer et al[33] reported a learning curve of LRYGBP of 100 cases, defined as the point at which postoperative complications became comparable to those of open gastric bypass. Although the incidence of gastrojejunostomy leaks decreased, it did not reach statistical significance. Similar results were recently reported by other authors.[34,35]

From previous experience with other types of gastrointestinal operations, we believe that the occurrence of staple-line leaks after LRYGBP cannot be

completely eliminated. As surgeons gain experience, they become more confident and undertake LRYGBP in higher risk patients, such as men and patients with increased weight, age, incidence of comorbidities, and previous abdominal operations.[33]

Intraoperative Evaluation of Anastomotic Integrity

Notwithstanding the lack of comparative studies validating the use of intraoperative tests to detect leaks, it is a common practice in bariatric surgery to perform some type of test to evaluate for leaks after completing the gastrojejunostomy. One of the most frequently used techniques involves clamping the Roux limb distal to the gastrojejunostomy and forcefully injecting air under water seal (Figure 1). Another technique involves instillation of methylene blue through a nasogastric tube and evaluating for extravasation at the level of the anastomosis. Intraoperative upper gastrointestinal series performed by instillation of Gastrografin® through a nasogastric tube under fluoroscopy is reported to detect anastomotic defects in 1.25% of patients and to decrease the postoperative leak rate to 0.4%.[36]

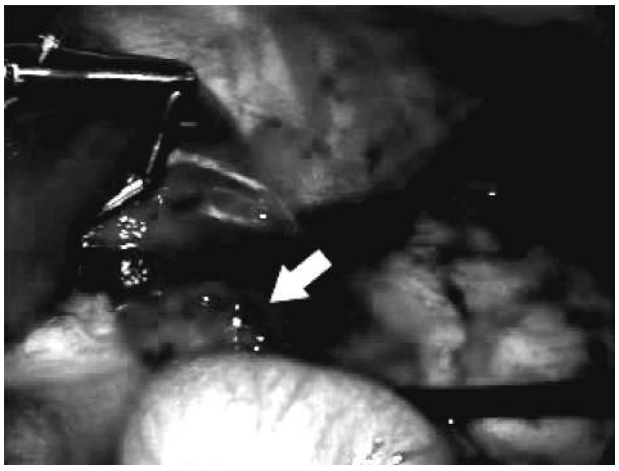

Figure 1. Intraoperative leak test. The Roux limb is carefully clamped distal to the gastrojejunostomy; saline is used to submerge the anastomotic region. Then, air is forcefully injected into the Roux limb using a specially adapted long laparoscopic needle and 60 cc syringe. The presence of bubbles (arrow) indicates a defect in the staple-line. The defect is closed with interrupted sutures and the anastomosis retested until no more bubbles are seen.

Insufflation of oxygen at 2 L/min into the gastric pouch through a nasogastric tube connected to a non-rebreather line of the ventilator is reported to be a fast, inexpensive, and reliable method for detecting anastomotic leaks.[37] Finally, air insufflation by intraoperative upper endoscopy with saline solution submersion is reported to correlate with postoperative barium swallow findings,[38] and has been reported to document 4.1% of intraoperative technical errors including suture and staple line leaks, allowing intraoperative repair and reduction of the incidence of leaks to 0.36%.[9] Many of the techniques described herein may require additional equipment, can be cumbersome, and increase significantly operative time and costs.

Routine Use of Drains

The routine use of drains in LRYGBP is thought to help in the early diagnosis of bleeding and leaks. Increased bleeding through the drain and changes in the characteristics of its output have been described to diagnose internal bleeding and leaks in 33% and 50% of patients with these complications, respectively.[39] In another series, 72% of leaks occurring after the first postoperative day were detected by anomalous drain output and avoided reoperation and readmission in all patients.[40] In our experience, purulent discharge from the drains has supported the diagnosis of a leak in two-thirds of patients and precluded further interventions in hemodynamically stable patients.[41]

Diagnosis

Clinical Signs and Symptoms

Clinical signs and symptoms in patients who develop leaks are similar to those of any other intraabdominal infection. Sustained tachycardia, tachypnea, and fever are among the signs frequently present in the early clinical course of patients with leaks, even before patients develop abdominal pain, leukocytosis, decreased urinary output, or hemodynamic instability. However, because many of the early signs are rather non-specific, diagnostic stud-

ies may be utilized in hemodynamically stable patients to determine the nature of the underlying etiology and to direct therapeutic interventions. A multivariate logistic regression analysis of clinical signs in patients undergoing LRYGBP indicated that tachycardia exceeding 120 beats per minute (odds ratio of 23) and respiratory distress (odds ratio of 6) are the two most sensitive indicators of gastrointestinal anastomotic leaks.[11]

Methylene Blue Swallow

This test was originally described for evaluation of leaks following gastrectomy, and consists of oral administration of methylene blue and observing its effluence through the drains. It can be performed at the bedside and has been reported to be 100% sensitive and to have no side-effects.[42] Its usefulness is limited to patients in whom leaks communicate with the surgically placed drains.

Upper Gastrointestinal Series

Upper gastrointestinal series are frequently used either routinely or electively for the evaluation of the gastrojejunostomy. It typically involves the use of Gastrografin® and evaluation under fluoroscopy of the integrity of the anastomosis and esophageal emptying. Since that does not require a large amount of contrast, Gastrografin® should be administered right before the patient lies down on the fluoroscopy table to avoid its rapid emptying from the gastric pouch into the Roux limb and to increase the sensitivity of the study. In our practice, we follow Gastrografin® with dilute barium because its greater density allows for detection of smaller leaks. On occasion, patients who exceed the weight limitations of the fluoroscopy table or could not be transferred to the table were examined standing, with an optimal projection obtained with a 25° rotation to the left[41] (Figure 2).

Routine postoperative examination is reported to detect radiological abnormalities in up to 10% of patients, including leaks (2.9%), delayed gastric pouch emptying (4.6%), gastrogastric fistulas (1.7%), and gastric pouch outlet obstruction (1%).[43] However, it is reported to have a low sensitivity, because it detects only 22% of documented leaks.[11] Nevertheless, it is important to remember that upper gastrointestinal series may not detect leaks derived from the jejunojenunostomy or from the excluded stomach. In our experience, routine use of upper gastrointestinal series within 24 hours postoperatively has allowed us to initiate early management decisions (i.e., withholding early oral intake, administration of antibiotics, keeping drains in place, and use of total parenteral nutrition) in patients who otherwise had equivocal clinical findings of leaks.

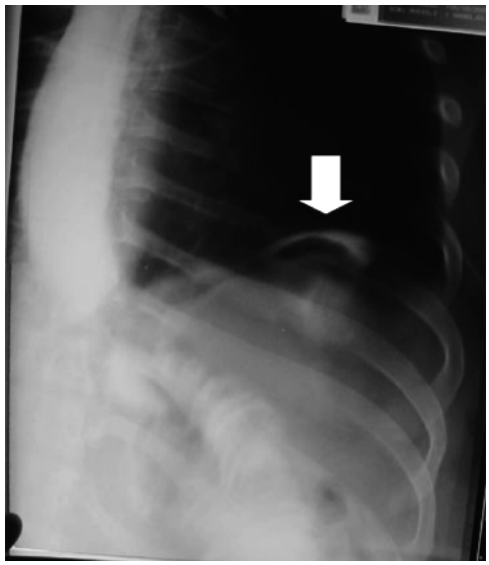

Figure 2. Upper gastrointestinal series can be used routinely or in patients suspected of having a leak. Extravasation of contrast material from the gastrointestinal tract (arrow) gives the diagnosis of a leak.

Computed Tomography Scan

Computed tomography (CT)-scans should be done with the administration of both intravenous and oral contrast materials. Patients do not require an extensive bowel preparation as for other abdominal CT-scans, because the proximal gastrointestinal tract is the most important part to be evaluated. As for the upper gastrointestinal series, in order to increase the sensitivity of the study, patients should take 30 to 60 cc of oral contrast material immediately before the study to opacify the gastric pouch and its connection to the Roux limb. Helical CT is useful for identifying normal postoperative anatomy and complications after gastric bypass surgery.[44] Findings suggestive of an anastomotic leak include loculated collections adjacent to the gastric pouch, diffuse

abdominal fluid, and trace amount of oral contrast material in the drainage tract (Figure 3). On the other hand, oral contrast material in the excluded stomach, but not in the duodenum or the remaining afferent loop, is suggestive of gastric staple-line dehiscence or incomplete division of the stomach.

Nonetheless, sensitivity and specificity is observer-dependant and the radiologist evaluating the CT-scan should be familiarized with postoperative anatomical changes after a Roux-en-Y gastric bypass. The CT-scan renders a better assessment of the proximal portion (excluded stomach [100%], proximal efferent Roux limb [99%], and gastric pouch [96%]) than the distal portion (jejunojejunostomy [67%]) of the Roux-en-Y gastric bypass anatomy.[44] Further studies on the role of the CT-scan in hemodynamically stable patients suspected of having an anastomotic leak are necessary.

Management of Leaks

Patients who exhibit hemodynamic instability should undergo operative treatment. Surgical exploration is also warranted in patients with complicated leaks and/or signs of sepsis. Furthermore, surgeons should have a low threshold for operative management in patients who exceed weight limitations for adequate radiological evaluation. In patients in whom the diagnosis is unclear, a diagnostic celiotomy or laparoscopy is an integral part of the treatment algorithm of suspected anastomotic leaks.

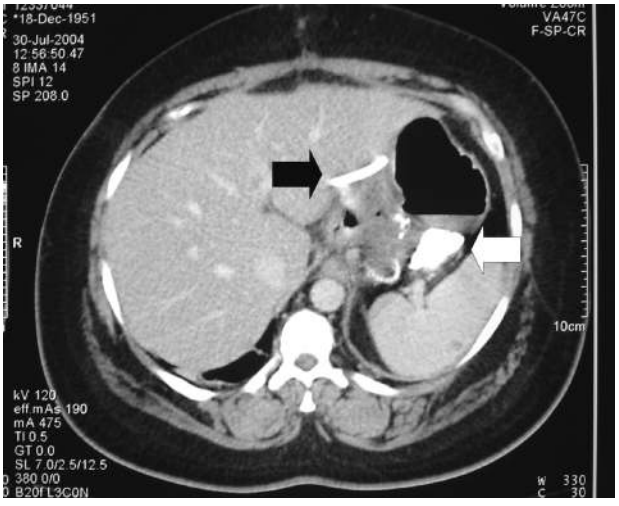

Figure 3. Computed tomography scans can be used not only to diagnose leaks, but also to differentiate between localized and diffuse intra-abdominal collections. The white arrow points to a localized collection of contrast material outside the bypassed stomach, suggestive of an anastomotic leak. The black arrow points to the surgically placed drain that in this case is not in contact with the collection.

The mainstay of treatment of leaks is operative, with the specific goals of achieving wide and adequate drainage, correcting the underlying defect and accessing the excluded stomach. Wide drainage can be achieved by utilizing closed suction drains in most patients. The second goal of repairing the anastomotic defect can be significantly hampered by dense inflammatory changes around the gastrojejunostomy and the excluded stomach. We proceed with primary repair if the defect can be easily identified and if the local tissues are not severely inflamed. Otherwise, as in longstanding leaks, closure of the defect may not be possible and wide drainage of the sub-diaphragmatic space is the best option. Anastomotic defects in the jejunojejunostomy may be more easily repaired, and a complete revision of the anastomosis is rarely needed. Decompression of the excluded stomach via a gastrostomy tube is recommended in patients with a complicated course and extensive leaks, to prevent gastric dilatation from the ensuing ileus and to access the stomach later for enteral nutrition. Primary abdominal closure may not be feasible in patients with extensive bowel wall edema and intra-abdominal fluid sequestration; adjuncts for fascial closure such as synthetic mesh may be used to avoid evisceration which can be difficult to control in obese patients. In addition to operative treatment, patients who develop signs of sepsis should be monitored in the Intensive Care Unit. Adjuncts to treatment of leaks are systemic antibiotics, total parenteral nutrition, and prophylaxis against deep venous thrombosis. Ventilator support is often required in patients with sepsis or postoperative respiratory failure.

Leaks from the gastrojejunal anastomosis may be found in a small subset of patients with minimal clinical findings by means of a routine upper gastrointestinal series done 24 hours postoperatively. Many of these patients require further diagnostic testing including CT-scans to determine if the leaks

are controlled by the drains or if there are any abdominal collections that require percutaneous drainage. These patients may be treated non-operatively with antibiotics, maintenance of the surgical drains, withholding oral intake, and administration of total parenteral nutrition. In our experience, these leaks have resolved within 1 week and none of the patients have required operative intervention.

Intraoperative Techniques to Prevent Leaks

Technique to Preserve Blood Supply to the Gastric Pouch

Preservation of adequate blood supply is crucial for the prevention of ischemia, necrosis, and subsequent anastomotic failure. Branches of the left gastric artery to the pouch should be preserved. Excessive dissection of the neuro-vascular bundle from the lesser curvature and the phreno-esophageal ligament may compromise blood supply to the divided gastric pouch, especially in revisional bariatric surgery.

Technique to Reduce Tension at the Gastrojejunostomy

In preparing a Roux limb, the proximal jejunum is run distally to identify a point of maximal mobility in the mesentery of the proximal jejunum, giving the surgeon an accurate estimate of the reach of the Roux limb. We select the location to divide the jejunum based on mobility of its mesentery and not the distance from the ligament of Treitz. The mesentery of the jejunum is divided using a linear stapler: the first application to the level of the first arcade and the second application parallel to the longitudinal axis of the Roux limb to lengthen the reach of its mesentery.

In patients with excessive intraabdominal fat, the greater omentum can be divided to within one inch (2.5 cm) from the transverse colon. From this point further, the omentum can be divided parallel to the transverse colon as needed. The Roux limb is then brought to the upper abdomen in an antecolic position to verify its reach to the gastric pouch without tension. If the Roux is under tension, it should be placed in a retrocolic position. The anastomotic staple-line can be also be reinforced with sutures.

Reinforcing Staple-Lines

One of the commonly used techniques is oversewing the staple-lines with a continuous suture. This requires advanced laparoscopic skills and often increases operative times significantly. This technique has been reported to provide approximately a 10-fold reduction of the risk of developing gastro-gastric fistulas;[45] however, similar findings have not been reported for leaks.

Treated bovine pericardial strips have been used in pulmonary resections to reduce the incidence and duration of postoperative air leaks. Animal studies have demonstrated that their use for reinforcing suture lines results in decreased operative times, intraoperative bleeding, and burst pressure similar to suture lines without reinforcement.[46] In a recently published study, there were three gastro-gastric fistulas and no anastomotic leaks after using this type of staple-line reinforcement in 250 patients undergoing a circular stapled LRYGBP.[47] A recent prospective randomized trial found no leaks in the group that received bovine pericardial strips during LRYGBP.[48] Nonetheless, there is concern about recent reports of erosion of the pericardial strips with subsequent intraluminal migration and obstruction of the gastrointestinal tract in up to 2% of patients.[49]

Another technique involves the application of fibrin sealant to the staple-line (Figure 4). This sealant forms an insoluble polymerized matrix that stabilizes as it adheres to the edges of the gastric pouch and jejunum, resulting in an aprotinin-containing gel, which retards fibrinolysis by inhibiting the plasminogen-plasmin cascade, theoretically creating an impermeable and lasting anastomotic seal. Two series involving over 850 patients in whom fibrin sealant was used at the gastrojejunostomy have reported leaks in only two patients (leak rate of 0.2%).[50,51] Additionally, animal data supports the use of fibrin sealant.[52] In our experience, leaks in patients in whom fibrin sealant was used are apparently less severe and do not require re-operation as often.

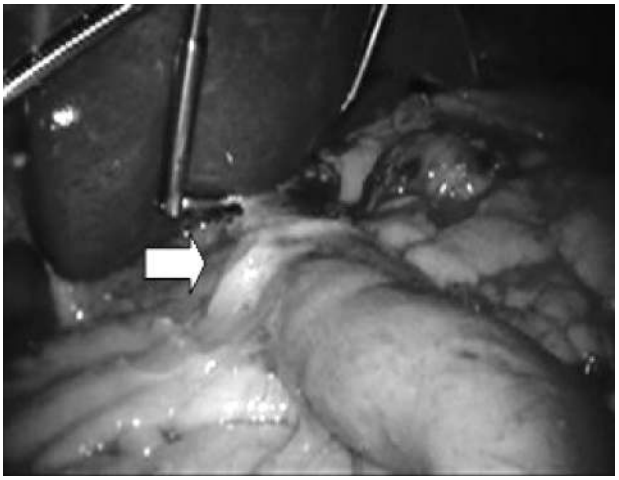

Figure 4. Within a minute of its application, a fibrin sealant creates an impermeable seal around the anastomotic region (arrow). The sealant is applied circumferentially around the gastrojejunostomy using a special laparoscopic applicator.

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