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Original article

Internal hernia at Petersen's space after laparoscopic Roux-en-Y gastric bypass: 6.2% incidence without closure—a single surgeon series of 1047 cases

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Abstract

Background: Recent reports describing a gastric bypass technique and the need for closure at Petersen's space using an antecolic antegastric laparoscopic method have differed in the incidence of internal hernia. We report a 6.2% incidence without closure of Petersen's space in a 1047-case, single-surgeon practice.

Methods: The data from 1047 patients undergoing antecolic antegastric gastric bypass between January 2001 and December 2006 were prospectively collected and retrospectively evaluated for formation of an internal hernia at Petersen's space. All cases were performed by a single surgeon using an antecolic antegastric technique without closure of the mesenteric space and with division of 5 cm of small bowel mesentery. The biliopancreatic limb length was created at 50 cm during the first 2 years of the study and then at 50 or 100 cm depending on the patient's body mass index.

Results: Of the 1047 patients, 73 underwent laparoscopic exploration for varying degrees of abdominal pain, unexplained nausea or vomiting, or radiographic evidence of an internal hernia. Of the 73 cases, 65 were Petersen's space hernias, for an incidence of 6.2%, 7 were mesenteric enteroenterostomy hernias, for an incidence of .7%, and 1 was negative for intra-abdominal pathologic findings. A direct relationship was found between the biliopancreatic limb length and the frequency of biliopancreatic internal hernia formation ($P = .0194$), and a high rate of false-negative radiographic reports were noted. Subsequent to these 1047 patients, we have had no internal hernias with space closure in 339 cases.

Conclusion: Closure of Petersen's space is important in preventing the morbidity of reoperation and the incidence of internal hernia. (Surg Obes Relat Dis 2009;5:565–570.)

Keywords: Laparoscopic Roux-en-Y gastric bypass; Internal hernia; Petersen's space hernia

The development and advancement of bariatric surgery has increasingly focused attention on the technique and the resulting efficiency, morbidity, and mortality of these techniques. One of the long-term goals of data collection in the Center of Excellence initiative is to define and collate these techniques. Gastric bypass remains the most popular weight loss surgery in the United States [1]. We noted a relatively high incidence of internal hernias in a single-surgeon set of antecolic antegastric laparoscopic Roux-en-Y gastric bypass patients and a greater proportion of Petersen's space hernias in this patient group compared with that in other reports [2–8].

The technique for gastric bypass varies among surgeons and involves several configurations of pouch construction, position and orientation of the Roux limb, length of the biliopancreatic (BP) limb, length of the resulting BP limb mesentery, and use of the laparoscopic versus open method. The laparoscopic method has been incriminated in resulting in a greater rate of internal hernias [8], supposedly because of the inability to properly identify and close mesenteric defects and the absence of adhesions that normally form more readily with an open technique. Nevertheless, comparable results, reduced intra-abdominal adhesions for subsequent procedures, a lower frequency of wound infection and incisional hernia by some reports, and shorter hospital stays with a more rapid return to normal activity [9,10] have

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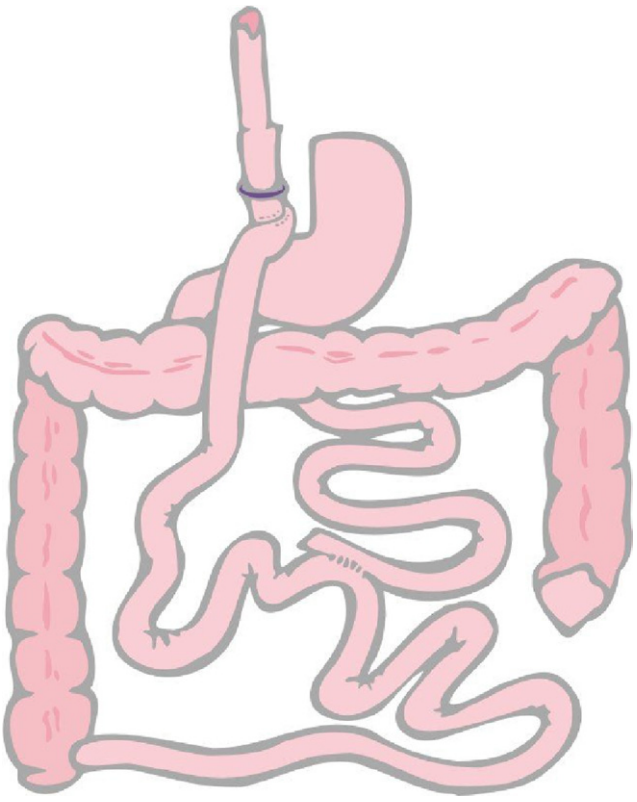

Fig. 1. Antecolic antegastric Roux-en-Y gastric bypass.

encouraged patient and surgeon enthusiasm. Earlier antecolic techniques favored a slightly broader based and shorter length pouch, and concern was present regarding the anastomotic tension that was created. A longer length, narrower width pouch was advocated by some surgeons to alleviate the degree of tension at the anastomosis and to include more of the lesser curvature, which, in theory, offered a more muscular and less distensible segment of the stomach [11,12]. A long BP limb has been advocated by some surgeons to increase malabsorption. Creating a longer Roux limb has been incriminated as potentiating herniation at Petersen's space [13]. The magnitude of the division of the small bowel mesentery at the gastrojejunostomy site and the resulting position of the jejunojejunostomy site has been thought by some to influence the frequency of Petersen's space hernia [8]. To our knowledge, Petersen's space hernias have not been previously differentiated by which segment of bowel lay within the space. The question of whether these modifications increase the potential for Petersen's space herniation motivated our review.

Methods

We retrospectively reviewed the charts for 1047 antecolic antegastric gastric bypass patients from a single operating surgeon (R.B.) from February 2001 to December 2006. All procedures were performed at Carolina Medical Center NorthEast (Concord, NC). The technique used remained relatively unchanged throughout the study until the frequency of internal hernias precipitated a change to routine closure of Petersen's space.

Our technique involved a 6–7-cm pouch created along the lesser curvature of the stomach with the use of a 28F Ewald tube as a stent. This resulted in a pouch diameter of approximately 1–1.2 cm (Fig. 1). The gastrojejunostomy was a linear stapled anastomosis and included a stapled closure of the anastomotic aperture. The afferent segment lay to the left of the gastrojejunal anastomosis and the efferent limb would lead caudad. The afferent limb (proximal to the anastomosis) was then divided with a linear stapler immediately adjacent to the pouch, such that very little redundant small bowel resulted proximal to the anastomosis. Its antimesenteric edge was sutured to the pouch along the left side of the pouch in a pseudo "Fobi pouch" fashion [11]. The resulting BP limb, therefore, would lay to the left of the Roux limb and was either 50 or 100 cm. In the first 2 years of the study, the BP limb length was 50 cm. Thereafter, the decision regarding the BP limb length was determined by the patient's body mass index (BMI). Patients with a BMI >45 kg/m^2 generally received a 100-cm BP limb length, although this criterion was not strictly adhered to. The small bowel mesentery was divided with a harmonic scalpel such that any tension at the anastomosis was minimized, usually a distance of 5 cm. A resulting Petersen's space was thus created posterior to the Roux limb, extending from the root of the Roux limb mesentery to the level of the transverse colon (Fig. 2). For closure purposes, we excluded the area cephalad to the colon, because we believe that small bowel herniation superior to the mesocolon is unlikely. No such herniation has occurred as yet in 339 subsequent patients whose spaces were closed.

The remainder of the procedure involved the creation of a Roux limb, varying in length from 75 to 250 cm, depend-

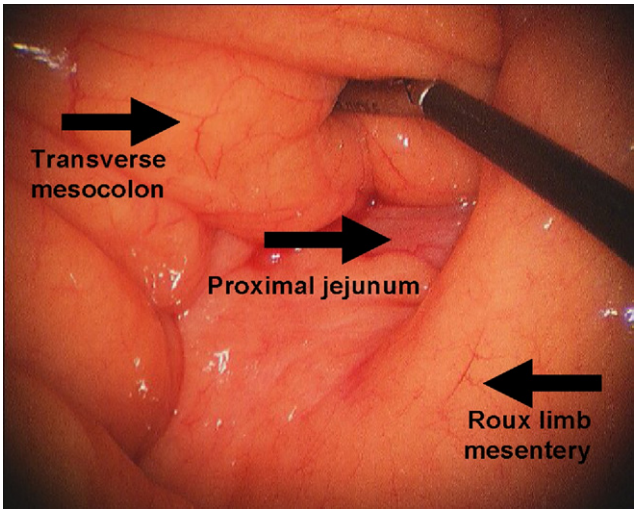

Fig. 2. Petersen's space (right lateral view).

ing on the patient's BMI. The enteroenterostomy was created as a linear side-to-side stapled anastomosis of the Roux limb in an antiperistaltic fashion with the BP limb. Closure of the mesentery at the jejunojejunostomy was performed with running 2-0 braided nonabsorbable polyethylene suture.

Patients presenting with abdominal pain, nausea, or vague unremitting discomfort were assessed clinically and early on with computed tomography (CT). Patients with positive findings on CT scan and or a clinical picture consistent with intra-abdominal pathologic features underwent laparoscopic exploration. Some patients required conversion to an open technique because of poor visualization and/or inadequate access to the affected area. The presenting physical examinations findings remained nonspecific, ranging from a generalized vague tenderness to palpation and "fullness" in the left upper quadrant to diffuse pain on moderate palpation. A number of patients reported surgical treatment for an internal hernia at outside facilities, but this information could not be confirmed. Patients who had undergone their initial surgery elsewhere and any of our patients who had been treated surgically for abdominal pain at another facility were not included in the present study. Also, hernias resulting from trocar hernias were excluded from the present study.

The repair for both Roux limb and BP limb herniation through Petersen's space consisted of reduction of the offending limb and closure of the space from the right side of the space with running 2-0 nonabsorbable braided polyethylene beginning in the crease formed by the Roux limb mesentery and the mesocolon and continuing to a point just inferior to the transverse colon.

Results

Of the 1047 patients reviewed, 73 had undergone surgical intervention for abdominal pain (Table 1). The indications for surgery varied and ranged from thorough diagnostic testing and negative results, to positive CT findings, to a clinical impression only. On 16 occasions, the finding of cholelithiasis on evaluation was used as justification for cholecystectomy and concomitant diagnostic laparoscopy. Patients presenting with complaints consistent with ulcer diathesis underwent endoscopy and, if positive for ulcer, were not included in this review.

Of the 73 patients, 65 were found to have entrapped small bowel within Petersen's space. Of these hernias, 7 were mesenteric hernias at the enteroenterostomy. The laparoscopic findings for 1 patient were negative. Of the 1047 patients treated during the study period, 85% were women, and the age range was 18–67 years (mean 43). This average age and female predominance corresponded with the age and frequency of the 72 patients with an internal hernia. The interval to reoperation ranged from 8 days to 76 months (average 22 months). Four of these cases occurred within the first postoperative month. Excluding these 4 cases, the average interval from the original operation was 25 months.

Of the 72 hernias, 58 (80.6%) involved the BP limb entrapped within Petersen's space, traveling posterior to the Roux limb and from left to right. The remaining 7 Petersen's space hernias (9.7%) traveled right to left and contained the Roux limb. The patients with these hernias usually presented in more dramatic fashion. In some instances, the entire small bowel and proximal cecum were found to have herniated through Petersen's space. This type of hernia resulted in more lymphatic occlusion and compromised bowel, although no bowel resections were necessary for nonviable tissue. The length of the Roux limb in the right to left Peterson's space hernia cases was 100 cm in 5 cases, 110 cm in 1, and 180 cm in 1. At presentation, the average percentage of excess weight loss was 84% for the hernia population, corresponding to the average value seen at 2 years postoperatively in our nonhernia patients. Excluding 4 reoperations that were conducted within 60 days, the range of the percentage of excess weight loss was 59–126%. The incidence of leak in the entire series of patients was .29 (2 from the proximal pouch staple line and 1 from the jejunojejunostomy). To our knowledge, no patient has died of any reason since the inception of the program.

We noted that 8 BP Petersen's space hernias occurred when the BP limb length was 50 cm and 50 occurred when the limb length was 100 cm. To determine whether a statistically significant relationship was present between the incidence of BP limb Petersen's space hernias and BP limb length, Fisher's exact test was used. The test compared the total number of hernias that occurred in cases performed

Table 1
Incidence, interval to presentation, %EWL, and limb length of Petersen's space and jejunojejunostomy mesenteric space internal hernias (n = 1047)

Hernia type	Incidence (%)	Average interval from initial bypass (mo)	%EWL at reoperation (%)	BP limb length (cm)	
				50	100
Enteroenterostomy hernia (n = 7)	.7	29	84	NA	NA
Petersen BP limb hernia (n = 58)	5.5	23	83	8 (.76)	50 (4.78)*
Petersen Roux limb hernia (n = 7)	.7	26	91	1	6

%EWL = percentage of excess weight loss; BP = biliopancreatic; NA = not applicable.
Data in parentheses are percentages.
* $P = .0194$.

with short BP limbs and the number of hernias that occurred in cases performed with long BP limbs. The result was highly significant at $P = .0194$. The P value suggests that shorter limbs were less likely to result in hernia formation in this population.

The interval from the original operation to patient presentation varied, as did the percentage of excess weight loss, suggesting that the risk could be independent of these variables.

The symptoms at presentation varied widely in quality, location, intensity, and duration of complaints, ranging from vague intermittent discomfort of gradual onset to severe abdominal acute pain. The pain was most often localized to the epigastrium and left upper quadrant but could also present as diffuse abdominal pain and was often exacerbated with deep palpation. With additional questioning, the patients often reported similar quality symptoms of lesser intensity that they had thought was gas pain.

The setting of their presentation varied as well, including intermittent visits during follow-up in our office, referral from primary care physicians after varying periods, and referral from other general surgeons after cholecystectomy failed to relieve their discomfort. Emergency room referrals occurred in our office after workup with supposed negative findings and in their department in the acute setting. Workups before bariatric surgeon consultations often included CT with urogram protocols, ultrasonography, upper gastrointestinal studies, and intravenous contrast only enhanced CT scans. In some cases, full-contrast CT scans were obtained. With time, a review of these studies with the radiology staff postoperatively increased the sensitivity somewhat such that a heightened level of suspicion resulted in some readings when mesenteric "swirls" were noted (Fig. 3). Viewing sequential slices of the abdominal contents was the most effective method to demonstrate the rotation of the mesentery. In some of the early patients who underwent CT with the scan findings read as "normal," nonopacified bowel loops were present to the right of the Roux limb, immediately adjacent to the duodenum, making differentiation from this segment difficult (Fig. 4).

Fig. 3. CT scan image with mesenteric "swirl" or "mushroom" appearance.

Fig. 4. CT scan image with redundant small bowel loop adjacent to duodenum (2 segments of unopacified bowel present representing duodenum and herniated BP limb anterior to right kidney).

Seven cases were converted from laparoscopy to an open technique because of inadequate visualization or level of acuity or an inability to reduce the hernia. Three of these were for Roux limb herniation through Petersen's space and one was an enteroenterostomy mesenteric defect.

Since December 2006 and the institution of closure at Petersen's space, no subsequent patients have developed an internal hernia.

Discussion

We have presented the data from 1047 consecutive single-surgeon antecolic antegastric gastric bypass cases that resulted in ≥65 Petersen' space hernias (6.2% incidence) when this space remained unclosed. The technique varied only in BP limb length, suggesting a significant risk of morbidity, as well as an apparent relationship between the BP limb length and the incidence of hernia formation.

We have also presented our findings regarding the different segments of small bowel entrapped in Petersen's space; findings that help explain the different presentations possible with small bowel obstruction. The resolution of symptoms after closure of this space was universal, regardless of the length of entrapped bowel. In the patient with intermittent discomfort, short segments of small bowel that

have traversed Petersen's space on a sliding basis could account for this discomfort and should be considered as a possible etiology. In further defining the segment of bowel residing within Petersen's space, it is worth identifying how the position of these small bowel loops are different than the position originally described by Petersen in 1900. His description was that of the space immediately caudal/inferior to a gastrojejunostomy and thus at a level cephalad/superior to the transverse colon. For the purposes of our report and most reports referring to gastric bypass, the usage implies a position caudal or inferior to the transverse colon bordered by the colon, mesocolon, and Roux limb and its mesentery.

Some reports have stated the risk of hernia to range from .2% [5] to 8.8% [4]. The risk has also varied depending on the antecolic versus retrocolic technique [14–16]. Enteroenterostomy mesenteric hernia has occurred in as many as 2.6% [17]. We encountered 7 cases (.7 %) in our series and that might have been a result of a different closure technique. We believe the mechanism for enteroenterostomy mesenteric hernia in this setting might result from mesenteric adipose tissue loss rather than at Petersen's space, where the omission of a closure technique appeared to be responsible for its high occurrence rate. In the present study, varying the length of Roux limb appeared to have no influence on the incidence of Petersen's space hernia that involved the Roux limb, because the incidence of this hernia was only .7%.

An apparent, but not testable, relationship was present between the length of the BP limb and the frequency of the Roux limb Petersen's space hernia because 6 of the 7 patients with a Roux limb Petersen's space hernia had had a longer length BP limb. An explanation for this is not readily apparent, however. The BP limb is a fixed segment of bowel originating at the ligament of Treitz and ending at a relatively fixed point in the jejunojejunostomy. Varying this length should not influence the potential for the Roux limb to slide from the right to left through Petersen's space unless traveling a greater distance down the small bowel mesentery to create the BP limb causes a greater gap from the root of the small bowel mesentery to the transverse colon and thus a larger Petersen's space.

The V that comprises Petersen's space involves the root of the small bowel mesentery and the junction of the transverse mesocolon (Fig. 2) and is performed with a running nonabsobable suture, closing these 2 mesenteries to the level of the transverse colon. This has proved to be an effective approach when kept superficial to the vasculature, and the infrequent result of bleeding at this site has been controlled with completion and firm seating of this stitch.

The magnitude of the division of small bowel mesentery near the gastrojejunostomy should have no influence on the potential the size of Petersen's space, because this size is determined solely by the distance from the root of the small bowel mesentery to the bowel itself (the V), not by the defect created in the mesentery (Fig. 2). We have been able to clearly identify all mesenteric defects and propose that appropriately placed access ports offer excellent visualization such that an open technique should confer no advantage.

The diagnosis of internal hernia and, in particular, a hernia at Petersen's space can be difficult to discern on CT scan [18,19], and obstruction of the BP limb has traditionally been difficult to diagnose because contrast studies cannot demonstrate patency of this segment. Dilation of the gastric remnant can be an inconsistent finding in a BP limb that slides, is not fixed in the hernia space, or is only partially obstructed. Because undiagnosed obstruction can have significant consequences and partial obstruction can lead to an indolent course, negative findings should not necessarily exclude the diagnosis of hernia.

The mesenteric "swirl" and the presence of an unopacified loop of small bowel in the region between the transverse colon and the third and fourth portions of the duodenum as shown in Figs. 3 and 4 demonstrate elements that were missed in our series. The "swirl" is consistent with the vasculature of the herniated segment of bowel as it winds around the vessels of the Roux limb that track to the gastrojejunostomy. By definition, this finding could be considered a volvulus because it is a twisting of the small bowel on itself; however, the etiology is dependent on the existence of Petersen's space and therefore has historically been referred to as an internal hernia.

In some cases, emergency room and primary care physicians referred these patients to general surgeons unfamiliar with postbypass anatomy. As a result, either a delay in diagnosis or cholecystectomy occurred without resolution of the symptoms, and a second laparoscopy was required. As the frequency of hernias became more apparent, we eventually refrained from obtaining CT scans because of the inaccuracy. Laparoscopy was subsequently performed on clinical suspicion only and resulted in 1 patient with negative findings of 73 who underwent laparoscopy. We advocate diagnostic laparoscopy as the modality of choice in patients who have undergone gastric bypass and who have unexplained abdominal pain.

Our study had a number of shortcomings. One of these was the lack of consistency in the selection of BP length. In the early portion of the study, a standard length of 50 cm was chosen based on convention and the notion that the length of the Roux mesentery was longest at this point. As it became clear that mesentery length was not at issue due to pouch configuration, an effort to increase the bypassed length of the first portion of the jejunum was made for patients with a greater BMI. Although the selection process was inconsistent during the study period, the results remain suggestive of a greater risk of herniation with a longer BP length. Our expectation is that closure of Petersen's space will obviate the risk of choosing a longer BP limb length.

The consistent and reproducible collection of preoperative studies for abdominal pain in this group of patients

would be valuable in the prediction of positive findings at laparoscopy, although a very reliable element in this study proved to be clinical suspicion. In future data collection, careful attention must be paid to the workup algorithm. An explanation of the greater incidence of Roux limb hernias in the 100-cm BP limb patients will probably remain unanswered, because a trial comparing the incidence of these limb lengths in the unclosed Petersen space would be unethical given our results.

Conclusion

As the popularity of bypass techniques increases, strict attention must be paid to eliminating the morbidity associated with internal hernia formation. After adjusting our technique to include closure of Petersen's space, we noted the absence of internal hernia occurrence in 339 cases spanning 19 months. Because the average time to presentation of an internal hernia was ≥23 months and the interval since we began closing this space has not yet reached that point, we might yet experience a significant occurrence of hernias despite closure. Although the configuration of the BP limb in this technique might lend itself to Petersen's space hernia formation when the space is not closed, future bypass techniques might find value in noting the reduced risk if this space is closed. The opinion that closure of this space is important is not new [16]; however, descriptions from other surgical groups and personal observations of other programs have confirmed that this approach is not universal. Our data suggest that routine closure of the Petersen defect could prevent the occurrence of internal hernias through Petersen's space, and we have adopted a policy of routine closure at our institution. We anticipate a continued trend in the dramatically decreased frequency of internal hernias in our practice and endorse prospective comparative studies to evaluate the merit of this closure. It is our expectation that the inclusion of this brief and simple step could result in a significant reduction in complication rates and improve long-term patient outcomes.

Disclosures

The authors claim no commercial associations that might be a conflict of interest in relation to this article.

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