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ORIGINAL ARTICLE

TECHNICAL CHALLENGE IN BARIATRIC SURGERY

Concomitant hiatal hernia repair during bariatric surgery: does the reinforcement make the difference?

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ABSTRACT

BACKGROUND: Hiatal hernia repair (HHR) is still controversial during bariatric procedures, especially in case of laparoscopic sleeve gastrectomy (LSG). Aims: to report the long-term results of concomitant HHR, evaluating the safety and efficacy of posterior cruroplasty (PC), simple or reinforced with biosynthetic, absorbable Bio-A® mesh (Gore, Flagstaff, AZ, USA). Primary endpoint: PC's failure, defined as symptomatic HH recurrence, nonresponding to medical treatment and requiring revisional surgery.

METHODS: The prospective database of 1876 bariatric operations performed in a center of excellence between 2011-2019 was searched for concomitant HHR. Intraoperative measurement of the hiatal surface area (HSA) was performed routinely.

RESULTS: A total of 250 patients undergone bariatric surgery and concomitant HHR (13%). Simple PC (group A, 151 patients) was performed during 130 LSG, 5 re-sleeves and 16 gastric bypasses; mean BMI 43.4±5.8 kg/m², HSA mean size 3.4±2 cm². Reinforced PC (group B) was performed in 99 cases: 62 primary LSG, 22 LGB and 15 revisions of LSG; mean BMI 44.6±7.7 kg/m2, HSA mean size 6.7±2 cm². PC's failure, with intrathoracic migration (ITM) of the LSG was encountered in 12 cases (8%) of simple vs. only 4 cases (4%) of reinforced PC (P=0.23); hence, a repeat, reinforced PC and R-en-Y gastric bypass (LRYGB) was performed laparoscopically in all cases. No mesh-related complications were registered perioperatively or after long-term follow-up (mean 50 months). One case of cardiac metaplasia without goblet cells was detected 4 years postoperatively; conversion to LRYGB, with reinforced redo of the PC was performed. The Cox hazard analysis showed that the use of more than four stitches for cruroplasty represents a negative factor on recurrence (HR=8; P<0.05).

CONCLUSIONS: An aggressive search for and repair of HH during any bariatric procedure seems advisable, allowing a low HH recurrence rates. Additional measures, like mesh reinforcement of crural closure with biosynthetic, absorbable mesh, seem to improve results on long term follow-up, especially in case of larger hiatal defects. In our experience, reinforcement of even smaller defects seems advisable in obese population.

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KEYWORDS: HERNIA, hiatal; Bariatric surgery; Laparoscopy.

Incidence of symptomatic hiatal hernia (HH) ranges between 10-20% in the general, adult population. While its implications and indications for repair differ between the different types of HH, the common incidence of gastroesophageal reflux disease (GERD) advocates for antireflux surgery.[1] The incompetence of the antireflux barriers and of the crural diaphragm ensues a vicious cycle of symptoms that accentuates and maintains GERD.[2] Obesity is an independent risk factor for HH and GERD.[3-5] Increase of body mass index (BMI) will upsurge the risk of HH's incidence, GERD symptoms and erosive esophagitis (EE), regardless of demographic features and dietary intake.[2] The prevalence of GERD in patients with obesity ranges from 37% to 72%, especially in morbid obese patients' candidate to bariatric surgery.[2-5]

Concomitant HHR during bariatric surgery is gaining worldwide popularity,[4] following international guidelines of SAGES recommending the repair of all hiatus defects during any bariatric procedure,[5] especially during laparoscopic sleeve gastrectomy (LSG). LSG has higher reported GERD rates and proton pump inhibitor (PPI) use; other indications for concomitant treatment are prevention of postoperative acid/biliary gastroesophageal reflux and of the intrathoracic migrations (ITM) of the operated stomach, even in asymptomatic patients, especially with large HH. Even if concomitant HHR during LSG, particularly in patients with GERD, is safe in the long term without higher mortality risk[6, 7] this issue still remains controversial. Additionally, there is no consensus concerning the preferred surgical option in patients with large HH and no GERD symptoms or endoscopic evidence for reflux.[8]

Crura's closure, in case of a widened diaphragmatic hiatus, is performed with simple interrupted sutures in primary posterior cruroplasty (PC). However, inadequate PC or postoperative disruption of sutures with subsequent intrathoracic migration was observed to be the primary cause of anatomical failure in HHR, HH recurrence and revisional surgeries.[9] This led to the technique, among many others, of reinforcing the hiatal closure with prosthetic mesh[10] in order to decrease recurrence; there are conflictive opinions on mesh use, composition, shape, fixation techniques and associated long-term complications. There is also no consensus on the exact hernia size that should be repaired with a mesh as the definition of hernia size varies across studies. Pre- or intraoperative assessment of the hiatal surface area (HSA) was recently proposed,[11] due to a positive association between increasing HSA, increasing recurrence risk and therefore a higher need for mesh. A simplified, already established calculation of the HSA as a rhombus area was introduced, measuring the major horizontal distance between the two crura (d1) and the vertical distance between the pillars' decussation and the hiatus' superior edge (d2); HSA=d1Xd2/2[12] (Figure 1).

Moreover, the lack of long-term follow up delineating the effectiveness of mesh reinforcement is compounded by the fact that in addition to surgical techniques, factors contributing to the

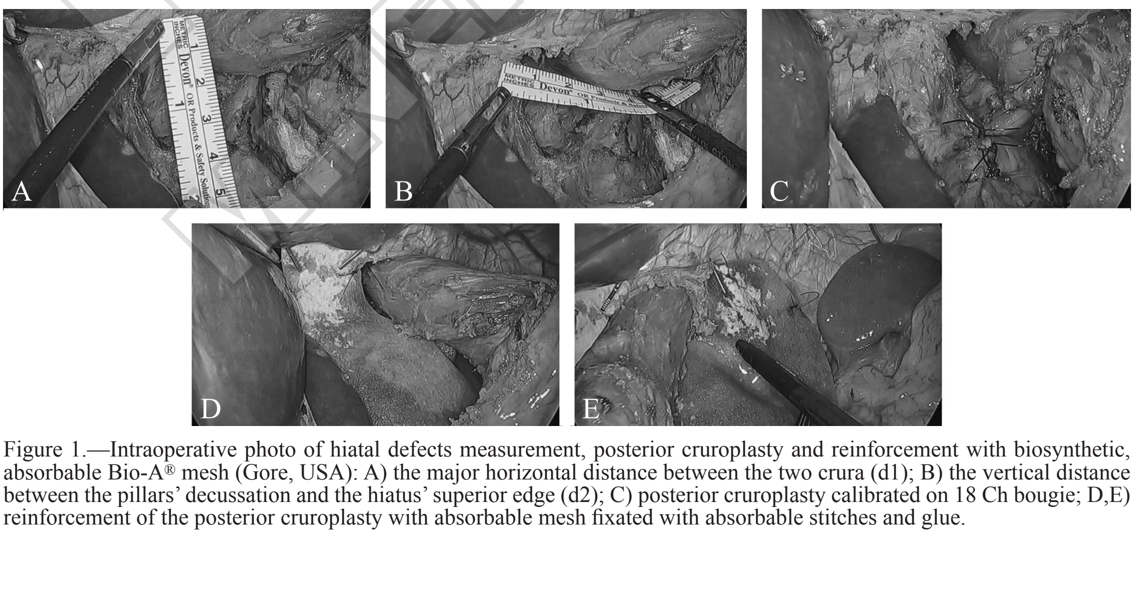

Figure 1.—Intraoperative photo of hiatal defects measurement, posterior cruroplasty and reinforcement with biosynthetic, absorbable Bio-A® mesh (Gore, USA): A) the major horizontal distance between the two crura (d1); B) the vertical distance between the pillars' decussation and the hiatus' superior edge (d2); C) posterior cruroplasty calibrated on 18 Ch bougie; D,E) reinforcement of the posterior cruroplasty with absorbable mesh fixated with absorbable stitches and glue.

etiology of HH, such as ultrastructural changes of the crura[12] or pharyngoesophageal ligament can lead to hiatoplasty disruption.[13]

Mesh available for HHR are non-absorbable synthetic, biological and biosynthetic absorbable. Non-absorbable synthetic have a major concern due to related complications, like erosions, local infections, dysphagia, fibrosis, stenosis of the esophago-gastric junction;[14, 15] the biological, absorbable scaffolds made from decellularized human, bovine or porcine tissues rich in collagen, but their high cost, difficulty in handling and fixation and the possibility of immunological reactions are also reasons for concern.[15] The absorbable biosynthetic scaffolds are hybrid meshes that exploit the advantages, while minimizing the disadvantages of synthetic and biological prosthesis. Gore® Bio-A® Tissue Reinforcement (Gore, Flagstaff, AZ, USA)is currently the only biosynthetic, absorbable mesh with CE mark (since 2008) and Food and Drug Administration's (FDA, USA) approval (since 2017) for hiatal use, showing good technical results,[16] with no local or general complications and apparently efficient in reducing postoperative recurrence on medium and long-term.[6, 7, 17] Bio-A® is composed of a 3-dimensional web of copolymer of polyglycolic acid (67%) and trimethylene carbonate (33%), providing a temporary scaffold gradually absorbed over 6 months and replaced by vascularized soft tissue, leaving no permanent material behind.[18, 19]

The aim of this study was to report the long-term results of a single institution series of HHR during bariatric surgery, evaluating PC's safety and efficacy, simple or reinforced with a biosynthetic, absorbable mesh. The primary endpoint of this study was the rate of PC's failure. Secondary endpoints were postoperative complications related to PC, dysphagia rate, GERD symptoms control (in terms of PPI therapy needing), endoscopic findings, and re-operation rate.

Materials and methods

This is a retrospective study on a prospective database of 1876 morbid obese patients that underwent bariatric surgery in our Center of Excellence between 2011-2019; most commonly laparoscopic procedures performed were LSG (1485, 79%), standard R-en-Y gastric bypass LRYGB (176, 9.3%), one anastomosis gastric bypass LOAGB/MGB (131, 7%), both as primary and revisional surgery. Other procedures included: gastric banding and gastric plication, both abandoned from 2012; duodenal switch BPD-DS, single anastomosis duodeno-ileal bypass with sleeve SADI-S, revisions of the LSG, revisional bariatric procedures. Patients that underwent concomitant HHR simple (group A) or reinforced (group B) during any bariatric surgery were included in this study, designed and approved by the local board.

Preoperative workup and surgical technique have been illustrated in detail elsewhere.[20] All patients' candidate to bariatric surgery underwent preoperatively esophagogastroduodenoscopy (EGDS) with helicobacter pylori (HP) testing. Contrast X-ray studies with barium or CT scan with 3D reconstruction were indicated in case of endoscopic diagnosis of large HH. All symptomatic GERD patients received preoperatively PPI. Patients demographics, obesity-related comorbidities, PPI use, mortality, conversion rate, operative time, intra- and perioperative (30 days) complications Clavien-Dindo classification,[21] postoperative hospital stay, mesh-related complications, resolution or persistence of GERD symptoms, endoscopic esophageal lesions and clinical and/or radiological HH recurrences, were prospectively evaluated and recorded in a devoted database. Exclusion criteria were BMI (>60 kg/m^2) and type IV HH.

Briefly, the surgical technique of concomitant HHR during laparoscopic bariatric surgery was usually performed before the particular bariatric technique and consisted in full exposure of the hiatal area, HH reduction, abdominalization of the esophagus for at least 3 cm and HSA intraoperative measurement.[11, 22] Patients with sliding HH and HSA <4 cm^2 underwent simple PC with interrupted nonabsorbable sutures (Prolene® polypropylene 1/0, Ethicon Endosurgery, New Brunswick, NJ, USA), while patients with larger hiatal defect (>4 cm^2) and pillars' weakness underwent on-lay mesh-reinforced PC (Figure 1A-C). Mesh was tailored to 8/7 cm, cutting the left part of the mesh, creating a hole in the up-

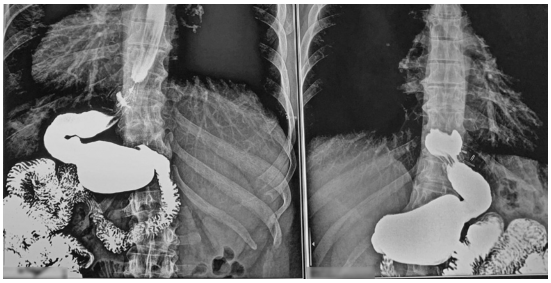

Figure 2.—Radiological, asymptomatic hiatal hernia recurrence (<2 cm) seen on contrast X-ray study 12 months postoperative after LSG and concomitant, simple posterior cruroplasty for initially symptomatic hiatal hernia. EGDS negative for esophageal lesions and patient does not need PPI therapy.

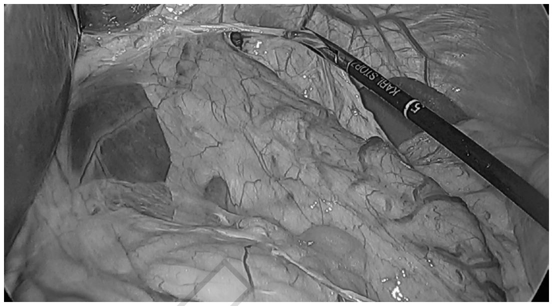

Figure 3.—Intraoperative findings in GERD recurrent, symptomatic patient, of failure of the initial posterior cruroplasty for hiatal hernia repair during LSG, with recurrence of the hiatal hernia, intrathoracic sleeve migration (>2 cm) and disruption of the surgical suture.

per part for the esophagus passage, obtaining an asymmetrical "u," with the right part longer for adequate right pillar reinforcement. Afterwards, the mesh, rolled like a cigarette, was inserted through the 10-mm trocar, superimposed on the PC and fixed with absorbable 2/0 stitches and glue application (Figure 1D, E).

Postoperative HHR check-up consisted in upper gastrointestinal contrast X-ray studies every 12 months, with any hiatal hernia seen on the radiological contrast image <2 cm in length defined as "radiological asymptomatic recurrence" (Figure 2).[22] EGDS surveillance was recommended routinely every 24 months or whenever symptomatology or radiological examination required. Barium swallow and CT-scan with 3D reconstruction was indicated when EGD showed recurrent HH, to demonstrate the ITM. Esophageal 24-hour pH/impedance reflux monitoring completed the work-up in selected cases, in order to measure the amount of gastro-esophageal reflux (both acidic and non-acidic) and to assess whether the symptoms were correlated with the reflux.

Other criteria used was the obstinacy of PPI therapy, which is routinely interrupted 6 months after initial bariatric procedure and the continuance of the therapy was considered a persistence or recurrence of the preoperative GERD. The failure of the cruroplasty was defined as recurrence of the HH, defined as disruption or enlargement of the suture repair (see Figure 3, demonstrated by ITM of the operated stomach ≥2cm (Figure 4), symptomatic for GERD (recurrence, persistence or de novo) and nonresponsive to medical treatment, requiring revisional surgery.

Figure 4.—Intrathoracic sleeve migration (>2 cm) seen on postoperative contrast X-ray studies with barium, in GERD recurrent, symptomatic patient with previously LSG and simple posterior cruroplasty, defined as failure of the cruroplasty.

Our intention-to-treat consisted in 2 situations: first was the symptomatic failure of the PC, non-responsive to medical treatment; second consisted in GERD recurrence or persistent despite medical treatment, without any evidence of HH recurrence (no failure of the PC).

Results

A total of 250 patients undergone bariatric surgery and concomitant HHR (13%); demographics and types of operation are reported in Table I, II and results in Table III. Simple PC (group A) was performed during 130 LSG, 5 re-sleeves and 15 LGB and one LMGB; mean BMI was

Table I.—*Demographics, pre- and intraoperative data in 250 patients undergoing bariatric surgery and concomitant hiatal hernia (HH) repair, with simple posterior cruroplasty (PC) in group A* vs. *reinforced PC with Bio-A biosynthetic, absorbable mesh in group B. Preoperative endoscopic findings (performed in all patients included in the study).*

Demographics	Group A (151 pts) simple PC	Group B (99 pts) reinforced PC	P value
Age (years Mean±SD)	46.6±10.1	47.5±12.1	0.67
Sex (M/F)	35/116	22/77	0.86
BMI (kg/m², Mean±SD)	43.4±5,8	44.6±7.7	0.13
Primary/revisional surgery	138/13	83/16	0.070
Symptomatic patients	52	44	0.0001
Preoperative HH's diagnosis	102 (67.5%)	72 (72.7%)	0.38
Intraoperative HH's diagnosis	49 (32.4%)	27 (27.7%)	0.38
Endoscopy and biopsy			
GERD symptoms	45 (29.8%)	53 (53.5%)	0.0001
Esophagitis	14 (9.2%)	25 (25.2%)	0.0006
Responder to preoperative PPI therapy	42/45 (93.3%)	48/53 (90.5%)	0.61
NERD	31 (20.5%)	28 (28.2%)	0.15
Barrett preoperative	1	0	0.68

Table II.—*Laparoscopic bariatric procedures performed in concomitancy with posterior cruroplasty (PC) during 2011-2019 in a Bariatric Center of Excellence.*

Bariatric procedures with concomitant PC	Group A (151 pts) simple PC	Group B (99 pts) reinforced PC
LSG	130	62
Re-sleeves	5	5
PC after LSG	0	10
Primary LRYGBP	15	22
Primary LOAGB/MGB	1	0
Total patients	151	99

LSG: sleeve gastrectomy; LRYGBP: R-en-Y gastric bypass; LOAGB/MGB: single anastomosis gastric bypass.

Table III.—*Results after concomitant posterior cruroplaty PC during bariatric surgery, simple (group A)* vs. *reinforced (group B). Barrett cardiac metaplasia without goblet cells. Postoperative esophagitis registered in group A (8 class A, 5 class B and 2 class C) and in group B (5 class A, 1 class B and 2 class C).*

Results	Group A simple PC	Group B reinforced PC	P value
Mortality rate	1	0	0.68
Conversion to open	0	1	0.35
Mean operative time (minutes)	105±38.2	141±52.2	0.0001
Postoperative stay (days)	3±1.29	4±1.43	0.0003
Mean follow-up (range)	49.1 months	50.9 months	0.023
Drop-out (patients)	11 (7.3%)	5 (5%)	0.48
GERD symptoms persistent postoperatively	15 (33.3%)	14 (26.4%)	0.45
De novo GERD	15 (10.7%)	12 (12.7%)	0.63
PPI therapy after surgery	30 (21.4%)	26 (27.6%)	0.27
Postoperative Esophagitis	15 (21.1%);	8 (14.5%);	0.34
Barrett postoperative	0	1	0.35
Transient dysphagia <6 weeks	15 (10%)	8 (%)	0.62
Mesh-related complications	0	0	-

43.3±5.8 kg/m² and HSA mean size was 3.4±2 cm². Reinforced PC (group B) was performed in 99 cases: 62 primary LSG, 22 GB and 15 different revisions of LSG; mean BMI 44.6±7.7 kg/m² and HSA mean size 6.7±2 cm².

In a total of 174 patients (69.6%), the HH diagnosis was made preoperative: in 102 (67.5%) patients of group A and 72 (72.7%) of group B, without any significant difference (P>0.3). Eighty patients were asymptomatic despite the preoperative HH diagnosis (50 in group A, 28 in group B). A statistically significant higher number of GERD symptomatic patients were encountered preoperatively in group B 53.5% vs 29.8% in group A, P=0.0001. The endoscopic findings are reported in Table I, showing a higher percentage of esophagitis in group B 25.2%, P<0.0006: Los Angeles classification (LAC) A in 11 patients, 9 with class B and 5 with class C (P=0.0006), while in group A consisted in LAC A in 11 patients, 3 with class B. Class B or C was a certain contraindication to LSG. One case of cardiac metaplasia was detected preoperatively in a patient with symptomatic HH; a LRYGB and simple PC was performed, and endoscopic control after 24 and 48 months showed complete resolution. NERD was detected in 31 (20.5%) patients of group A and in 28 (28.2%) of group B, without significant difference between them. All symptomatic patients were in preoperative PPI therapy, continuously in 77% and on demand in 23%. The PPI response rate in symptomatic GERD patients was high in both groups (group A 93.3% vs group B 90.5%; P>0.6). The median preoperative GERD–HRQL score of all the patients was 16.

Mean operative time was 121±57.05 min for all patients, and it was significantly longer in B group (141±52.3 min, P=0.0001). The conversion rate to open surgery was 0.4% (1 case of intraoperative onset of ventricular fibrillation requiring defibrillation in group B). Mortality rate was 0.4 (1 case of leak in group A, complicated with ITM and mediastinitis in the early postoperative course). Mean postoperative stay was 3.8±1.38 days; it was statistically significant longer for group B (4±1.43 days, P=0.05). Perioperative complications occurred in 13 patients out of 250 (5.2%); 6 patients (4%) in group A and 7 (7%) in group B. In group A, complications were as follow: grade II (2 cases), grade IIIa (2 cases) and grade IIIb (one case): two bleedings, one pleural effusion, one midgastric stenosis and one incisional hernia; grade V 1 death due to leak complicated by mediastinitis. In group B, the perioperative complications were grade I (1 case of fever and vomiting); grade II (3 bleedings and one pleural effusion), grade IIIa: one bleeding treated with percutaneous drainage and one gastric leak successfully treated with self-expandable metal stent.

Mean follow-up was 50 months, 49.1 in group A and 50.9 in group B, respectively. Drop-out rate was excellent: 11 patients in group A (7.3%), from which 2 deaths for independent causes and 5 patients (5%) in group B.

A total of 45 (29.8%) patients of group A and 53 (53.5%) patients of group B reported GERD symptoms preoperatively. During the postprocedural follow-up, 15/45 (33.3%) cases in group A and 14/53 (26.4%) cases in group B declared persistent or recurrent GERD (P>0.45). Interestingly, significantly less patients of group B suffered by GERD symptoms postoperatively than those of group A (P<0.0003). Analogically, the use of PPI was not different between the groups postoperatively (group A 21.4% vs group B 27.6%; P>0.27) but the group B patients showed a significant decrease in PPI therapy after the surgery (P<0.0003). Control EGDS was performed in 71 (50.7%) patients of group A and 55 (58.5%) patients of group B (P>0.2). Symptomatic patients were 30 (21.4%) in group A and 26 (27.6%) in group B, all accepted EGDS control. Endoscopic report of esophagitis was recorded in 15 (21.1%) cases in group A (8 class A; 5 class B; 2 class C LAC) and in 8 (14.5%) cases in group B (5 class A; 1 class B; 2 class C LAC) (P>0.3). The median postoperative GERD–HRQL score of all the patients was 4.

Failure of the PC as reason of reintervention, with symptomatic intrathoracic migration (ITM) and nonresponsive to medical treatment, was encountered in 12 cases (8%) of group A vs. only 4 cases (4%) of group B (P=0.23) (Table IV); it was assessed by EGDS, contrast X-ray studies and 3D-CT scan). Patients with clinical and radiological recurrence were offered reinforced PC and LRYGB. All cases showed symptom remission and suspended PPI regimen within 3 months after surgery. Only one case of HHR's failure was encountered in the LRYGB group, surgically reviewed as well (anterior cruroplasty).

One case of cardiac metaplasia without goblet cells (Figure 5)[23] was detected in a patient with LSG and failed reinforced PC (7 cm ITM of the LSG after 4 years), successfully converted to LRYGB, with HH reduction and reinforced redo of the PC; at 18 months of follow-up, no Barrett's recurrence was recorded. The Cox hazard

Table IV.—*Reasons to conversion LRYGB: failure of the posterior cruroplasty PC was defined as symptomatic hiatal hernia's recurrence, with intrathoracic migration >2 cm, nonresponding to medical treatment and requiring revisional surgery.*

Reasons to conversion for failure of the PC	Group A (pts no 151) simple PC	Group B (pts no 99) reinforced PC	P value
Recurrent GERD + failure	12 (8%)	4 (4%)	0.23
Recurrent GERD (no failure)	2 (1.3%)	1 (1%)	0.82
Endoscopic mucosal lesions post-sleeve (metaplasia)	0	1	0.93
Overall conversions	14	5	0.22

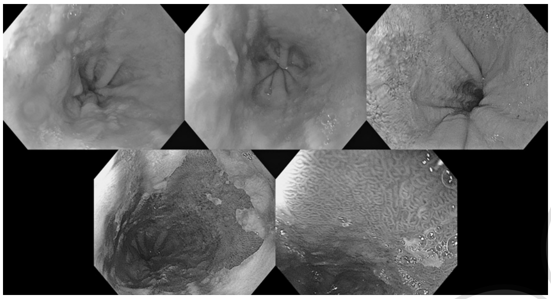

Figure 5.—Endoscopic findings in one case of postoperative Barrett esophagus C1M5 Praga classification[23] with NBI evaluation (Narrow Band Imaging) after failure of posterior cruroplasty during initial LSG. The patient was submitted to conversion to LRYGB and reinforced posterior cruroplasty.

analysis showed that the use of more than four stitches for cruroplasty represents a negative factor on recurrence (HR=8; $P<0.05$).

GERD as reason for reoperation without a failure of the PC was encountered in 3 cases: 2 recurrent cases in group A and one de novo GERD in group B. Local situation was checked before (contrast X-ray studies, EGDS that showed non erosive reflux disease) and during the reoperation, but no revision of the PC was needed; conversion to LRYGBP was performed and all showed symptom remission and suspended PPI within 3 months after surgery.

No case of mesh infections was registered at any time, despite the presence of one case of leak after LSG. No cases of esophageal stenosis or erosion were registered during the EGDS performed postoperatively. Additionally, no cases of postoperative hiatal area's fibrosis/distortion were recorded by CT scan performed for recurrent cases or in cases needing surgical revision (N.=4). Only transient dysphagia was reported in 12 patients: 15 in group A (10.4%) and 8 in group B (8%) and resolved within 6 weeks by diet counseling and prokinetic drugs (Table III).

Discussion

Concomitant HHR is already an established reality during bariatric surgery.[6, 24, 25] Recent studies accomplished that HHR in patients undergoing LSG reduces GERD rates after surgery. The first systematic review to examine the efficacy and technical aspects of simultaneous LSG and HHR concluded that the combined approach is safe and effective and results in acceptable postoperative GERD rates, with 16 of 17 studies showing good outcomes; the authors therefore recommended this combined approach.[24] Eighteen % of the patients operated by North American centers, participating to the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP), underwent concurrent HHR during LSG.[25] From 130.000 patients participating to the same program, concomitant HHR was significantly more common during LSG compared to LRYGB (21.0% vs 10.8%, $P<0.0001$), despite the lower preoperative GERD rate. These results not only suggest a marked difference in the intraoperative management of HH during bariatric surgery procedures, but also underline the fact that PC was used in up to 31% of the surgeries, in order to prevent recurrences and GERD. Therefore, in order to provide good technical results, it is imperative to assume that HH should be searched and repaired during LSG.[8] LRYGB patients are more likely to have preoperative GERD compared to LSG and the efficacy and success of LRYGB in reducing GERD symptoms up to 3 years postoperatively has already been demonstrated.[25] Hence, the lower rate of concurrent HHR in LRYGB patients could be attributed to the overall success rate of LRYGB in treating GERD symptoms, possibly attributed to the minimization of acid production in addition to bile diversion, inherent components of this procedure. However, a less aggressive approach to HHR during LRYGB, especially in large hiatal defects, may lead to less than favorable outcomes. In our experience, concomitant HHR during bypass procedures was used in 38 patients, with a higher distribution in the larger hiatal defects group B (>4 cm^2); in only one case surgical revision was needed for GERD persistence, when anterior cruroplasty was performed in addition to the initial reinforced PC.

Strategies focused on the development of new type of mesh, like the slowly absorbable biosynthetic meshes, have been introduced recently to combine the advantages of both a synthetic mesh (no degradation shortly after implantation) and a biological mesh (the remodeling aspects and the better tolerance in case of contamination). These advantages, combined with the proven complete absorption 7 months after positioning,[18] made us choose the Bio-A® mesh for the PC's reinforcement. Our experience with concomitant HHR during bariatric surgery was gradually analyzed and published lately, focusing on the outcomes of long-term follow-up, especially in the reinforced group with Bio-A® mesh.[6, 17, 20, 22] Surgical technique's choice[22] was made on a multifactorial base: patient's demographics, the dimensions of the hiatal defect (routine intraoperative HSA measurement), score of esophagitis, and severity of symptoms; no long-term complications were recorded due to the concomitant PC, not even in the case when bioabsorbable, synthetic mesh was used (no mesh-related complications, no long-term dysphagia). Second report of our series was on the results of a prospective randomized study comparing concomitant PC during LSG, 48 cases with simple vs 48 cases of reinforced PC and it was updated recently with results after 5 years follow-up.[20] The general trend confirmed that reinforced cruroplasty was highly effective in a certain subgroup of patients with weakness of the pillars and medium hiatal defect (range 4–8 cm^2), with no side effects or complications related to the use of the totally absorbable synthetic mesh. Even so, patients should be informed about a possible recurrence. At the same time, an acceptable rate (80%) of GERD symptoms control was achieved on long-term follow-up. Successively, results on 92 consecutive patients with reinforced PC during bariatric surgery with mid-term follow-up (mean 41 months) supported the use of absorbable mesh for HHR (safe profile with nil complications rate), showing excellent recurrence rate results (5.4%) and good GERD symptoms control.[17] The present analysis has completed the results of the overall experience in 250 consecutive patients, confirming the role of PC in the prevention of HH recurrence. This was seen especially in the reinforced group (4% failure vs. 8% in the group with simple PC), even if patients with a larger HSA (anatomical difference) and higher incidence of GERD were included in this group.

When speaking strictly about LSG and concomitant PC, we report a combined HH recurrence in 15 cases with ITM out of 192 cases (7.8%), which is an underestimated complication of LSG, commonly seen in patients with central obesity, chronic constipation, and post-LSG GERD.[26] Due to the higher incidence at long term of cruroplasty's failure in group A (simple PC) in respect to group B (reinforced PC), it seems reasonable to recommend in the obese population the cruroplasty's reinforcement, but this would be amended by costs, availability and technical skills. The combined cruroplasty's failure rate (6.4%) at 5 years after bariatric surgery and concomitant PC is similar or less than studies on traditional antireflux surgery.[27]

Limitations of the study are determined by the incomplete follow-up (approximatively 10% of patients are lost to follow-up) and the incomplete endoscopic postoperative surveillance. EGDS was considered an invasive investigation; only 51.6% of the asymptomatic patients accepted it. All symptomatic GERD patients underwent postoperative EGDS, and severe esophagitis B or C was found in 11 patients, with only one case of Barrett's esophagus identified that were consecutively converted to LRYGBP. This is in contradiction with some recent studies that showed an increase of Barrett's esophagus after LSG on long-term follow- up, even in asymptomatic patients.[8] So, our findings related to the cruroplasty's failure (a combined rate of HH recurrence at 4 years of 6.4%) are driven by the symptomatology accused by the patients that returned to us, seeking for treatment. We don't know the exact percentage of failure in the whole study group, because asymptomatic patients might not be investigated completely for recurrence and refused EGDS. We consider another limitation determined by the endoscopic Hill classification of HH only recently introduced in our practice,[28] that was shown to be slightly stronger compared to the axial length of a HH and might replace in the general practice the axial length in the endoscopic assessment of the mechanical antireflux barrier of the gastroesophageal junction. Nevertheless, we introduced in the last 2 years the expressed, compulsory endoscopic surveillance of LSG patients every 2 years. Other limitation might derive by the partially controlled use of PPI postoperative, which was overused in some patients, due to the availability of easy prescriptions from the general practitioner.

Conclusions

An aggressive search for and repair of HH during any bariatric procedure seems advisable, allowing a low HH recurrence rates. Additional measures, like mesh reinforcement of crural closure with biosynthetic, absorbable mesh, seem to improve results on long term follow-up, especially in case of larger hiatal defects. In our experience, reinforcement of even smaller defects seems advisable in obese population.

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