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Hiatal Hernia is More Frequent than Expected in Bariatric Patients. Intraoperative Findings during Laparoscopic Sleeve Gastrectomy

Ionut Hutopila[1,2], Catalin Copaescu[1,3]

[1]Ponderas Academic Hospital, Bucharest, Romania
[2]University of Medicine and Pharmacy "Titu Maiorescu", Bucharest, Romania
[3]"Grigore T Popa" University of Medicine and Pharmacy, Iasi, Romania

Corresponding author:
Ionut Hutopila, MD
PhD Candidate University of Medicine and Pharmacy "Titu Maiorescu"
Ponderas Academic Hospital
Nicolae Caramfil Street, no. 85 A
district 1, Bucharest, Romania
E-mail: Ionut.Hutopila@ponderas-ah.ro

Abbreviations:
HH – Hiatal hernia;
HHR – Hiatal hernia repair;
GERD – Gastroesophageal reflux disease
LSG – Laparoscopic sleeve gastrectomy;
EGD – Esophagogastroduodenoscopy;
SPAIH - Surgical protocol for active identification of hiatal hernia.

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Rezumat

Hernia hiatală este mai frecventă decât știm preoperator. Descoperiri intraoperatorii la pacienții cu gastrectomie longitudinală laparoscopică

Introducere: obezitatea este un factor de risc pentru apariția bolii de reflux gastro-esofagian (BRGE) şi a herniei hiatale (HH). Un număr important de pacienți cu obezitate au HH. Pentru evaluarea gastrointestinală preoperatorie sunt folosite endoscopia digestivă superioară (EDS) şi studiul radiologic eso-gastro-duodenal cu bariu. Nu toate HH pot fi diagnosticate preoperator, o parte dintre acestea sunt descoperite în timpul gastrectomiei gastrectomiei longitudinale laparosopice.
Obiectiv: evaluarea posibilelor corelații între prezența herniei hiatale şi datele clinice, radiologice şi endoscopice preoperatorii caracteristice BRGE şi HH. Locație: Ponderas Academic Hospital, Centru de Excelență în Chirurgia Bariatrică şi Metabolică.
Material şi Metodă: studiu prospectiv desfăşurat în perioada ianuarie 2015 - mai 2016, care include pacienții cu gastrectomie longitudinală laparoscopică cu sau fără repararea concomitentă a herniei hiatale. Au fost analizate caracteristicile pacienților, co-morbiditățile, simptomele GERD, studiile radiologice cu substanța de contrast oral, endoscopiile şi protocoalele operatorii.
Rezultate: au fost identificați 695 pacienți (260 de bărbați şi 435 de femei) care îndeplinesc criteriile de includere (gastrectomie longitudinală laparoscopică ± recalibrarea hiatusului esofagian). Vârsta medie a pacienților a fost de 41 ± 11,71 ani şi indicele de masă corporală (IMC) a fost de 41,96 ± 7,28 kg/m². Întregul lot studiat a

fost investigat prin endoscopie digestivă superioară, diagnosticul de HH fiind stabilit pentru 339 pacienți (48,78%). În toate aceste cazuri, HH a fost reparată simultan cu efectuarea gastrectomiei longitudinale laparoscopice. Preoperator diagnosticul de HH a fost stabilit pentru 192 pacienți [(56,63%)- grup A]. Folosind protocolul pentru identificarea activă a herniei hiatale nediagnosticate preoperator - SPAIH, HH a fost descoperită intraoperator pentru 147 de pacienți (43,37%) - grup B. *Concluzii:* diagnosticarea HH prin endoscopia digestivă superioară şi studiu radiologic esogastro-duodenal cu bariu este suboptimală şi, prin urmare, pentru un număr semnificativ de pacienți, HH a fost descoperită intraoperator, folosind protocolul chirurgical - SPAIH. Recalibrarea hiatusului esofagian concomitent cu gastrectomia longitudinală laparoscopică reprezintă o tehnică reproductibilă, care ar putea preveni postoperator progresia HH şi limitarea posibilelor complicații evolutive ale bolii de reflux gastroesofagian.

Cuvinte cheie: protocol chirurgical, identificare activă, diagnostic intraoperator, SPAIH, hernie hiatală, boala de reflux gastroesofagian, BRGE, obezitate, gastrectomie longitudinală laparoscopică

Abstract

Background: obesity is a risk factor for gastro-esophageal disease (GERD) and hiatal hernia (HH) occurrence. A substantial number of obese patients have HH. Esophago-gastro-duodenoscopy (EGD) and Barium X-ray oral study are used for preoperative gastrointestinal evaluation. Not all HH can be diagnosed before surgery, some are discovered during laparoscopic sleeve gastrectomy (LSG).
Aim: to assess the possible correlations between intraoperative presence of hiatal hernia (known or new discovered) and preoperative clinical, radiological and endoscopic data specific for GERD and HH.
Setting: single institution Ponderas Academic Hospital, Center of Excellence in Bariatric and Metabolic Surgery.
Material and Methods: The prospectively maintained database of the institution was retrospectively quired to identify all the patients who underwent primary Laparoscopic Sleeve Gastrectomy (LSG) without/with concomitant hiatal hernia (HH) repair between January 2015 to May 2016. Patient characteristics, co-morbidities, GERD symptoms, radiologic oral contrast study, endoscopy and operative details were analyzed.
Results: six hundred ninety-five patients (260 male and 435 female) were identified meeting inclusion criteria (LSG ± HH repair). Mean age of patients was 41 ± 11.71years and average body mass index (BMI) was 41.96 ± 7.28 kg/m². Preoperative upper gastrointestinal contrast series and endoscopy were performed for entire group study and demonstrated a hiatal hernia in 339 patients (48.78%). In all these cases, HH was repaired concomitantly with LSG. One hundred ninety-two patients (56.63%) were diagnosed with HH before operation and confirmed intraoperatively (Group A). The diagnosis of hiatal hernia was established intraoperatively for 147 patients (43.37%) – group B, using the surgical protocol for active identification of preoperative undiagnosed hiatal hernia - SPAIH.
Conclusion: preoperative investigations such as EGD and barium X-ray oral study are suboptimal in diagnosing HH, therefore, in a significant number of patients, the presence of HH has been established using our surgical protocol – SPAIH. Crura approximation (HHR) concomitantly with laparoscopic sleeve gastrectomy is reproducible, may prevent the HH progression and possible GERD complications in the postoperative period of time.

Key words: surgical protocol, active identification, intraoperative diagnosis, SPAIH, hiatal hernia, GERD, gastroesophageal reflux disease, obesity, laparoscopic sleeve gastrectomy

Introduction

Obesity associates local and general conditions that cause a higher prevalence of gastro-esophageal reflux (GERD) and hiatal hernia (HH)(1). In the population of bariatric patients up to 40% have HH (2). The possible evolution of GERD with erosive esophagitis to Barrett's esophagus or adenocarcinoma, justify an appropriate diagnosis, treatment and follow-up in obese patients (3). In this scenario the body weight control is core for the GERD management in obese patients.

The increasing of the obese population has consequently determined the positive evolution of the number of bariatric surgeries performed worldwide. In recent years, Laparoscopic Sleeve Gastrectomy (LSG), known to be an easy reproducible well-standardized technique with very good results on weight loss became the most used bariatric procedure (4). After this natural evolution, it is highly probable that, patients with obesity, candidates for bariatric intervention, could present a HH at the same time with LSG.

Considering this frequent association and the attempting to prevent the potential immediate and late consequences of leaving in place a hiatal hernia, many surgeons accept the recalibration of the esophageal hiatus concomitantly with LSG as a solution for GERD (5,6). Nevertheless, this surgical attitude did not reach a consensus and, the results on GERD improvement or prevention are still controversary (7-9). Some other solutions to prevent GERD and its complications or HH recurrence, were inspired from the classic antireflux surgery, such as: laparoscopic sleeve gastrectomy associated with Hill's cardiopexy (10), with anterior fundoplication (11) with 360 degrees Nissen valve (12), or cardiopexy with ligamentum teres (13,14). Long-terms results of these procedures are not yet known. Currently, probably the best control of GERD in morbidly obese patients is offered by laparoscopic RYGBP (15).

A particular situation for obesity is the difficulty to preoperatively identify the patients presenting GERD, HH or both, due to the lack of correlation between preoperative GERD symptoms and GERD-specific endoscopic and radiological signs. In a previous article we have demonstrated that GERD is more frequent than expected in asymptomatic obese patients, demonstrating that 62% of them had esophagitis at endoscopy(16).

A complete preoperative evaluation is of great importance to identifying a possible hiatal hernia, therefor, modifying the surgical strategy to prevent the postoperative GERD and its consequences. This approach will include the hiatal hernia repair (HHR) and the maintaining the gastroesophageal junction in a physiological below the diaphragm position and it will be part of the preoperative informed consent (16).

However, there are circumstances in which hiatal hernia cannot be demonstrated preoperatively or even intraoperatively. The consequence is performing only the LSG, without addressing to HH, thus explaining the high incidence of the postoperative "de novo" GERD, caused in fact, by a left in place diaphragmatic defect.

The objective of the present study is to assess the correlations between intraoperative presence of hiatal hernia and preoperative clinical, radiological and endoscopic data specific for GERD and HH.

Material and Methods

The study was performed in a single center, Ponderas Academic Hospital designated as Center of Excellence in Bariatric and Metabolic Surgery. The prospectively maintained database of the institution was retrospectively quired to identify all the patients who underwent primary Laparoscopic Sleeve Gastrectomy (LSG), without/with concomitant hiatal hernia (HH) repair, between January 2015 to May 2016.

The study was approved by the Institutional Ethical Committee and, a consent was obtained for every participant.

Data collected included demographic characteristics, co-morbidities, GERD symp-

toms, radiologic oral contrast study, endoscopy and intraoperative information regarding the intraoperatively confirmed or newly discovered HH.

Patients candidates for other metabolic procedures in the same interval, and those who had a medical history of bariatric or antireflux endoscopic or surgical procedure were excluded from the study.

Clinical Assessment

Typical GERD symptoms were considered relevant for this study: heartburn, regurgitation, epigastric pain, dysphagia as well as the use and the therapeutic effects of acid reflux medication. The information was prospectively collected during the preoperative medical evaluation and it was based on the patients' reports. Beside this, all the bariatric surgery candidates have to complete a specific clinical symptoms questionnaire which includes the investigation of GERD, as a general protocol in our center (16).

Upper GI study (X-Ray)

Radiological upper gastrointestinal examination was performed in each patient included in the study. The radiologist noted the presence of the radiological signs of GERD and/or of hiatal hernia. Multiple incidence examinations were performed after taking several swallows of barium sulfate, including a front view standing, right anterior oblique and supine Trendelenburg position. The morphology and the function of esophagus, the esogastric junction's position and competence, the presence of the hiatal hernia is evaluated. The stomach's characteristics, its' emptying time and acid reflux medication he duodenal clearance are studied, too. The Upper GI study is also routinely performed postoperatively in all the patients (17,18).

The system used was Siemens Luminos Fusion – Fluorospot Compact (Siemens Healthcare GmbH, Erlangen, Germany) (*Fig. 1*).

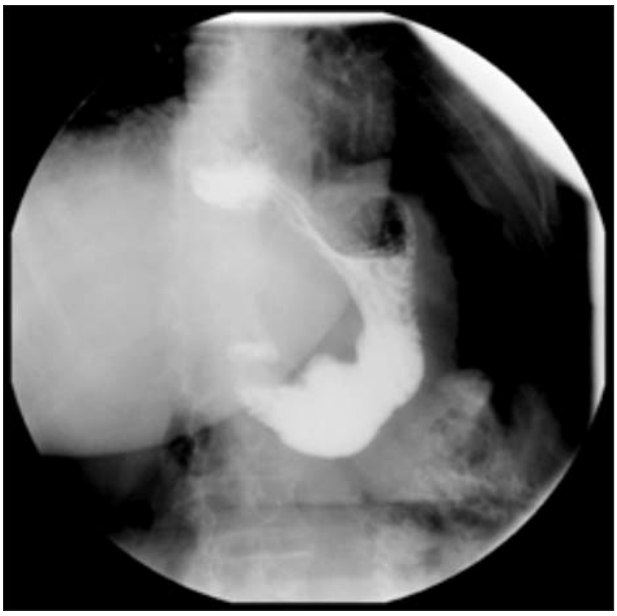

Figure 1. Upper gastrointestinal barium swallow study demonstrates the presence of the hiatal hernia

Upper Gastrointestinal Endoscopy

Esophagogastroduodenoscopy (EGD) was performed under i.v. sedation with Midazolam using Olympus Exera III platform. EGD assess the presence of hiatal hernia and/or esophagitis and its' A to D grade staging was following the criteria of the Los Angeles classification (19). EGD was also ruling-out any esophago-gastroduodenal lesion which might be treated before or during the LSG or may be a contraindication for LSG or bariatric surgery. EGD is a mandatory investigational step of the preoperative work-up before bariatric surgery (16,20). However, EGD cannot be always performed days or weeks before surgery, due to the significant risks of ambulatory anesthesia in morbid obese patients. In these specific situations, the EGD evaluation is performed inside the OR, under general anesthesia with oro-tracheal intubation, just before the bariatric procedure. The laparoscopic exploration precludes EGD, and the first jejunal loop is transitory clamped with atraumatic forceps in order to prevent the gas distension of the small bowel. The bariatric team is assuming this only option to complete the preoperative work-up and the

patients consents the change of the surgical indication, including postponing or giving-up to bariatric surgery.

Evaluation of the Operative Protocol – Reading the Information

The existence of hiatal hernia was established according to the specific anatomical criteria. Two categories were identified:

1. HH preoperatively diagnosed and intraoperatively confirmed (Group A);
   - The preoperative HH diagnosis was considered for all the patients who had evidence of HH at both endoscopy and radiology.
2. HH preoperatively unknown and intraoperatively discovered (Group B);
   - a surgical protocol (described below, at the operative technique) was used to active search for HH.

In all the patients with HH (both above mentioned categories) we looked for correlations with the preoperative GERD symptomatology, with the results from the X-ray oral contrast study and from the endoscopy. Several correlations with demographic characteristics were done.

Operative Technique

Our technique for LSG, aiming to fashion a narrow, long, uniform and un-twisted gastric tube from angle of His to pylorus, was previously described (21). However, some technical details are particularly relevant for the present study. Since 2013, we have introduced in our bariatric surgery program a surgical protocol consisting of the active identification for a potential undiagnosed hiatal hernia (SPAIH). Mainly, it includes dissection's rules and a meticulous exploration of the diaphragmatic area of the hiatus, in order to identify any direct or indirect sign of a diaphragmatic defect.

The specific surgical steps for dissection are:

1. the mobilization of the gastric fundus, posteriorly extended to the area nuda (*Fig. 2*),

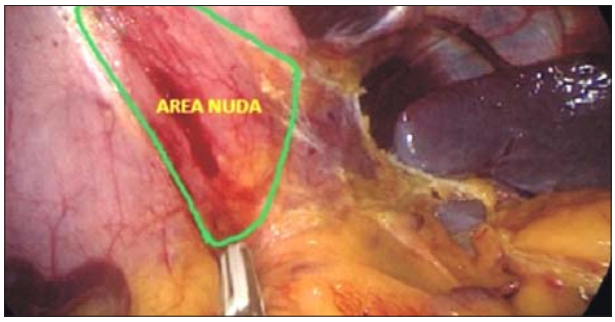

Figure 2. Mobilization of the gastric fundus with exposure of the area nuda

2. complete exposure of the anterior aspect of the left diaphragmatic crus (*Fig. 3*),
3. precardial fat pad (Belsey's fat) dissection to allow a better visualization of the angle of His and the gastro-esophageal junction (*Fig. 4*).

Following these steps, the operative field reveals several situations which may suggest the existence of a hiatal hernia:

- The inferior esophagus cannot be demonstrated into the abdomen - (*Fig. 5*);

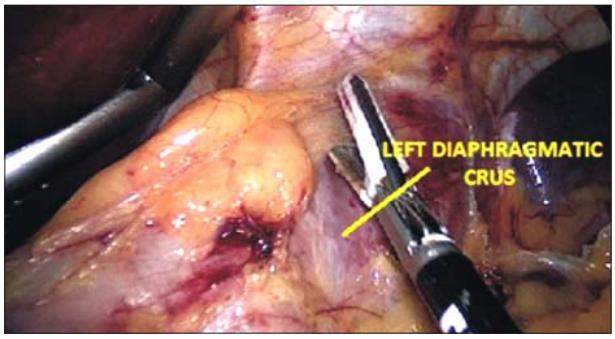

Figure 3. Complete exposure of the anterior aspect of the left diaphragmatic crus

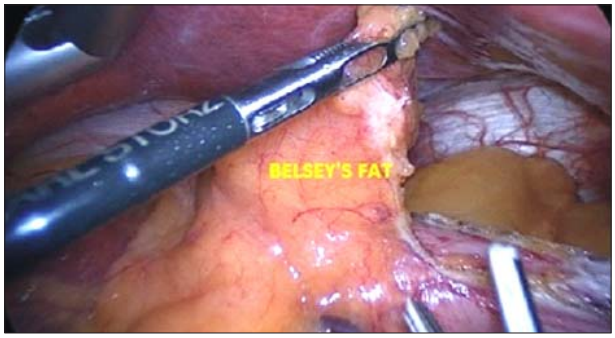

Figure 4. Precardial fat pad (Belsey' fat) dissection

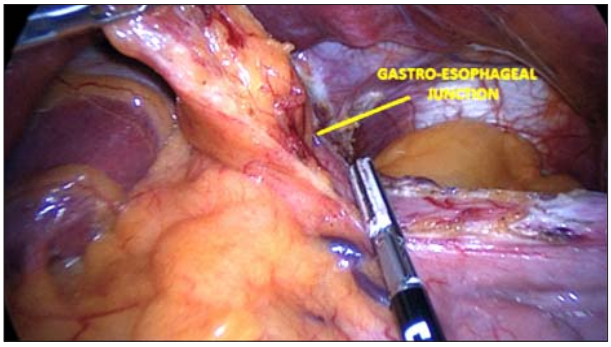

Figure 5. No identification of the abdominal esophagus after the fat pad's mobilization

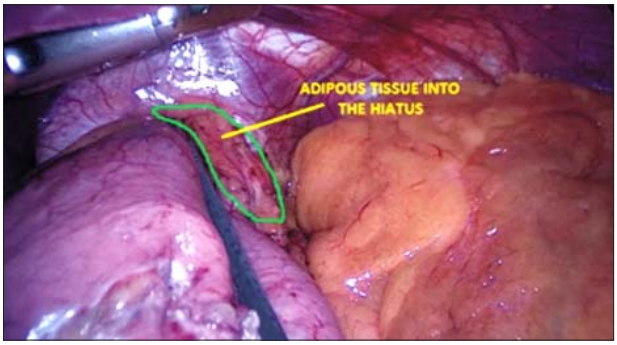

Figure 6. Pericardial adipose tissue retracted into the hiatus

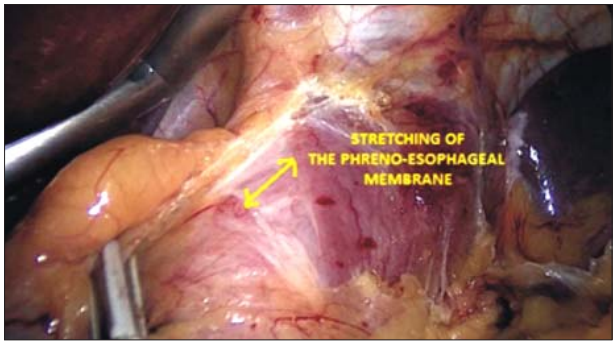

Figure 7. Stretching of the phreno-esophageal membrane

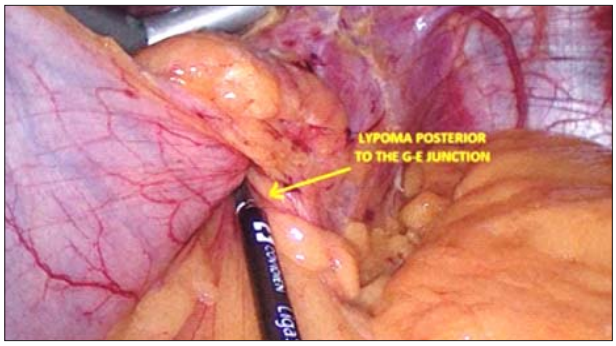

Figure 8. Para-esophageal lipoma localized posteriorly to the gastro-esophageal junction

- The pericardial adipose tissue is retracted into the hiatus (*Fig. 6*);
- An abnormal high laxity and stretching of the phreno-esophageal membrane, most frequently observed at the level of the gastrophrenic ligament (*Fig. 7*);
- The presence of a paraesophageal lipoma, usually posteriorly siding the GE junction (*Fig. 8*).

Once the HH is confirmed, a circumferential and mediastinally extended dissection the inferior esophagus is performed, aiming the abdominal repositioning of the gastroesophageal junction at least 4 cm bellow the diaphragm. A posterior crura approximation, using non-absorbable interrupted sutures is subsequently performed. The HH repair, precludes the sleeve gastric resection along a 35-Fr bougie, in most of the cases. Sometimes, the signs of a sliding hiatal hernia are evident after completing the longitudinal division of the stomach. The inspection of the stapled line demonstrates its' upper part spontaneous migration into the mediastinum (*Fig. 9*). In this scenario, the dissection and the repair of the HH are performed after the gastric resection. In each of the surgical options, our protocol includes over-sewing the entire staple line by means of 2.0 non-absorbable monofilament suture.

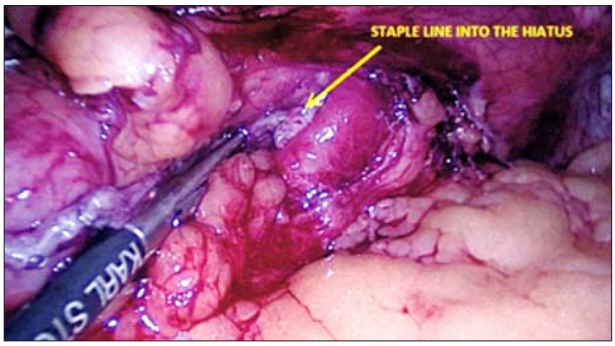

Figure 9. Migration of the gastric tube into the mediastinum after the longitudinal resection

Statistical Analysis

The software used for analysis was R program, version 3.5.2 Copyright (C) 2018 The R Foundation for Statistical Computing, R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org.

The data are presented as mean±SD for continuous variables and absolute frequency and relative frequency for the categorical variables. A p-value lower than 0.05 was considered representative for statistical significance. To investigate the possible correlations the rho Spearman was calculated.

Results

From January 2015 to May 2016, a total of 695 patients (260 male and 435 female) underwent LSG. Mean age of patients was 41 ± 11.71years and average body mass index (BMI) was 41.96 ± 7.28 kg/m².

All the patients completed the preoperative investigational work-up as described. EGD was intraoperatively performed in five patients (0.7%). HH was discovered in two and esophagitis Los Angeles A in three of them. None of these five patients needed the postponing or changing of the LSG procedure.

The bariatric team is assuming this only option to complete the preoperative work-up and the patients consents the change of the surgical indication, including postponing or giving-up to bariatric surgery.

A substantial number of patients had related obesity disorders such as dyslipidemia (63.74%), arterial hypertension (39.42%) and Type 2 Diabetes Mellitus (19.57%). Demographics, anthropometric data and comorbidities are presented in *Table 1.*

Of the entire studied group, HH (preoperatively and intraoperatively diagnosed) was found in 339 patients (48.78%) and it was simultaneously repaired with LSG in all the cases.

One hundred ninety-two patients (56.63%) were identified in the Group A, as the diagnosis of HH has been preoperatively set-up and confirmed intraoperatively. Hiatal hernia was intraoperatively discovered in a significant number of patients, as many as 147 (43.37%), included in Group B. Of the Group A, only 68 patients (35.41%) had typical GERD symptoms.

In many patients of the Group B, the preoperative evaluation did not offer data to indirectly suggest the possibility of a hiatal defect, so, 112 (76.19%) patients did not have GERD symptoms, 101 (68.71%) patients had normal endoscopy and 112 (76.19%) did not have signs of gastroesophageal reflux at oral contrast study. For these cases, the preoperative EGD revealed esophagitis without HH in 46 (31.29%) patients (29- grade A, 13-grade B, 4-grade C) *Table 2.*

In the Group B (147 patients) we found a positive correlation of hiatal hernia incidence with the value of abdominal circumference, body weight and body mass

Table 1. Patients characteristics

	No. patients = 695 (%)
Sex	
M number of patients, (%)	260 (37.41)
F number of patients, (%)	435 (62.59)
Age	
mean±SD	41.68 ± 11.71
(range)	(16.00 - 74.00)
BMI	
mean±SD	41.96 ± 7.28
(range)	(30.00 - 80.40)
Weight	
mean±SD	122.35 ± 27.37
(range)	(71.00 - 234.00)
Abdominal circumference	
mean±SD	126.75 ± 18.47
(range)	(62.00 - 188.00)
T2DM	
Yes - number of patients, (%)	136 (19.57%)
No - number of patients, (%)	559 (80.43%)
AH	
Yes – - number of patients, (%)	274 (39.42%)
No– - number of patients, (%)	421 (60.58%)
Dyslipidemia	
Yes– - number of patients, (%)	443 (63.74%)
No – - number of patients, (%)	252 (36.26%)
Smokers	
Yes – - number of patients, (%)	263 (37.84%)
No – - number of patients, (%)	432 (62.16%)

Table 2. The result of the preoperative evaluation for patients with HH discovered intraoperatively

Preoperative Evaluation [147p (43.37%) - HH Discovered Intraoperatively]								
GERD symptoms		**EGD - Esophagitis**			**X-ray GERD**		**Esophagitis+X-ray GERD**	
No	Yes	No	Yes		No	Yes	No	Yes
112 (76.19%)	35 (23.81%)	101 (68.71%)	46 (31.29%)		112 (76.19%)	35 (23.81%)	127 (86.40%)	20 (13.60%)
		Grade A	Grade B	Grade C				
		29 (19.72%)	13 (8.84%)	4 (2.72%)				

index (p <0.001). In the Group A, the only positive correlation of HH was found with GERD symptoms *Table 3*.

In this situations, where there is no correspondence with the results from the preoperative evaluation, the surgical protocol for active identification of hernia (SPAIH) highlighted during the operation almost half (43.37%) of the total hiatal hernias from the study.

Discussions

Obese patients are at higher risk for development of gastrointestinal disease such as GERD and HH. Different mechanisms explain this association: increased intra-abdominal pressure, abnormal anatomy of the gastro-esophageal junction trough lengthening the phreno-esophageal membrane and hiatal hernia appearance, esophageal motility disorders (22, 23). Even if all these conditions are frequently associated , typical GERD symptoms are less common as a result of impaired visceral sensitivity due to obesity. Because of this discrepancy, the preoperative evaluation before metabolic surgery must contain mandatory upper gastrointestinal endoscopy and X-ray oral study (16). We had the same attitude with complete preoperative evaluation for all patients (N=695) included in the current study. Three hundred thirty-nine patients (48,78%) were preoperatively and intraoperatively diagnosed with HH. For 192 patients (27.62%) the diagnosis of HH was established preoperatively by endoscopy and upper GI study.

Regarding preoperative EGD with anesthesia for morbidly obese patients is considered challenging due to the negative impact on the respiratory system.(24) In such situations, patients are explored by endoscopy under general anesthesia at the beginning of the intervention. In our study we performed this procedure in five patients, discovering two cases of HH and three of Los Angeles A esophagitis. All patients who had this type of evaluation should be preoperatively informed and sign the consent on the possibility of

Table 3. Correlations of different parameters in patients with hiatal hernia (HH)intraoperatively discovered andHH preoperatively diagnosed

	HH Discovered Intraoperatively ρ Spearman (p value)	**HH Diagnosed Preoperatively ρ Spearman (p value)**
Age	0.11 (0.002)	0.07 (0.062)
Sex	0.12 (0.001)	-0.11 (0.003)
Weight	0.18 (< 0.001)	-0.12 (0.001)
BMI	0.19 (< 0.001)	-0.10 (0.004)
Waist circumference	0.24 (< 0.001)	-0.11 (0.003)
GERD symptoms	0.03 (0.348)	0.21 (< 0.001)

changing the surgical procedure if eso-gastric conditions such as, erosive esophagus, Barrett's esophagus, esophageal or gastric malignancy are demonstrated.

Considering intraoperative diagnosis of a HH a true standard, preoperative barium X-ray barium swallow has a low sensitivity for detection of HH, with comparable results obtained in different studies: Goiten et al reported 36% (65/177), Mizrahi et al 33% (66/201), Fornari et al. 33% (30/93)(25-27). However, in our study we found that barium X-ray swallow has more sensitivity 56 % (192/339). Comparing with endoscopy seems that X-ray oral contrast examination has higher sensitivity in morbidly obese patients (27). Our results show similarity in sensitivity between EGD and barium X-ray swallow.

Even performing a complete upper GI evaluation consisting in X-ray oral contrast study and upper gastrointestinal endoscopy, due to the unsatisfactory value of sensitivity, a significant number of patients are diagnosed intraoperatively. Of the entire group of patients with HH in our study (339), in 43.37% (N=147) the diagnosis was set-up during the surgical intervention. More than that, we found lack of symptomatology for these patients. From 147 patients with HH diagnosed during LSG, 112 (76.19%) patients did not have any GERD symptoms. Therefore, we can discover HH in a consistent number of preoperative asymptomatic patients.

A few and unspecific preoperative correlations for a presence of HH are with the value of abdominal circumference, body weight and body mass index ($p < 0.001$).

So, in this particular situation where are less connections between the preoperative data (clinical and investigations) specific for HH/GERD and the existence of hiatal hernia, it is important to perform, by the time of LSG, a meticulous inspection of the diaphragmatic area and eso-gastric junction, to identify any sign of a possible HH. Hiatal hernia that are not discovered and repaired at the time of bariatric surgery may get larger with weight loss and loss of fat around the gastro-esophageal junction (28).

Is of great value to accurately determine the presence of a HH which untreated could generate or worsen GERD, with the sequential appearance of its' complications, during the postoperative period. In this respect, in Ponderas Academic Hospital, starting with 2013 we have introduced the Surgical Protocol for Active Identification of preoperative undiagnosed Hiatal Hernia (SPAIH) as a part of LSG interventions. Between 2013 and 2015 there were several stages of evolution in which the SPAIH protocol underwent modifications until the final form described in this study.

In patients with obesity, the excess of intraabdominal adipose tissue completely covers the esophageal hiatus and the gastro-esophageal junction, which increase the difficulty in finding a possible hiatal hernia. The active search consists of complete mobilization of the gastric fundus, with dissection of the left diaphragmatic pillar and, fat pad mobilization around the cardia. As consequence of this dissection different situations may occur: a frank hiatal defect, high laxity and important lengthening of the phreno-esophageal membrane, no abdominal esophagus and lipoma into the hiatus.

For all the hernias intraoperatively discovered (N=147) it was performed a recalibration of the esophageal hiatus. Hiatal hernia repair during LSG has been found to decrease gastroesophageal reflux disease (GERD) symptoms (5,29). Still, the effect of LSG on postoperative GERD is not fully understood, some studies present an improvement in GERD symptoms after LSG (30), other show "de novo" GERD after LSG (31-33).

A good preoperative detection of HH prior to surgery supports a better preoperative planning for hiatal hernia repair and, this is very important for both surgeons and patients. In the situations in which, the existent hiatal hernia is not detected during the preoperative evaluation, the intraoperative surgical protocol with active identification of hernia is very useful. Subsequently, the opportunity of HHR and the control of post sleeve GERD is offered.

The present study has some limitations due

to its' retrospective design. However, to our best knowledge, this is the largest study exploring the intraoperatively discovered hiatal hernias and searching for correlations with different parameters. Further comparative, prospective or randomized studies, designed to investigate the possibility to identify and treat the hiatal hernia and GERD in obese patients are expected to confirm our results and extend the research.

Conclusions

Due to the specific conditions, the preoperative investigations may miss the hiatal hernia, in obese patients.

Preoperative investigations such as upper gastrointestinal endoscopy and barium swallow X-ray study have unsatisfactory sensitivity which explain that almost half (43.37%) of the patients with hiatal hernias were discovered intraoperatively using the surgical protocol for active identification of undiagnosed hiatal hernia - SPAIH.

Crura approximation (HHR) concomitantly with laparoscopic sleeve gastrectomy is reproducible and may limit the HH progression and the possible GERD complications in the postoperative period of time.

Conflict of interest

No conflict of interest for any of the authors.

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