Surgery in Practice and Science 14 (2023) 100197

Contents lists available at ScienceDirect

Surgery in Practice and Science

journal homepage: www.sciencedirect.com/journal/surgery-in-practice-and-science

Pre-operative bariatric patient characteristics driving hiatal hernia repair decision by operating surgeons

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ARTICLE INFO

Keywords:
Obesity
GERD
Hiatal hernia
Hiatal hernia repair
RYGB
Sleeve gastrectomy

ABSTRACT

Background: Hiatal hernia (HH) is routinely reported in 40% of bariatric surgery patients. Left unrepaired, HH can lead to post-surgical reflux, regurgitation, and vomiting.
Objectives: We hypothesize that patients with pre-operative reflux symptoms and a higher body mass index (BMI) will receive hiatal hernia repairs (HHR) more often. The study aim was to analyze the variables that drive HHR decision by operating surgeons.
Methods: The records of 551 patients who underwent endoscopy in preparation for bariatric surgery were analyzed. Prevalence of HH was derived based on esophagogastroduodenoscopy (EGD) findings performed by a bariatric surgeon during patients' bariatric surgery. The relationship between categorical participant attributes was calculated using a significance level of 0.05.
Results: The groups consisted of 295 Roux-en-Y gastric bypass (RYGB) and 264 sleeve gastrectomy (SG) patients with preoperative HH identified in 310 patients. SG and a decreased BMI were significant for receiving a HHR. Type II diabetes (T2D), duodenitis found on EGD and pathology report, esophagitis, and Roux-en-Y gastric bypass (RYGB) were significant for not receiving a HHR. Only duodenitis, RYGB, and SG were found to be significant factors after multivariate analysis.
Conclusions: While some pre-operative patient characteristics may not impact a surgeon's HHR decision in the bariatric population, our study suggests that duodenitis, SG, and RYGB may influence a surgeon's HHR decision.

Introduction

Hiatal hernias (HHs) commonly occur in the general population, oftentimes arising from incidental radiologic or endoscopic studies [1]. Although HH's exact prevalence is not well characterized as a majority of patients are asymptomatic, HHs are routinely reported in 40% of bariatric surgery patients [2,3]. HH pathogenesis is not well understood, currently described in the literature as being multifactorial in nature [4,5]. Presenting symptoms of HH are often similar to gastroesophageal reflux disease (GERD), including heartburn, chest pain, and dysphagia [3,6]. Regarding HH treatment, management of GERD symptoms has been well described, but there is still a lack of consensus regarding the surgical repair of HHs, as there is much debate concerning surgical intervention timing [7].

Current Society of American Gastrointestinal Endoscopic Surgeons (SAGES) guidelines only provide strong recommendations for surgery in symptomatic patients with paraesophageal hernia (PEH), with an emphasis placed on patients presenting with acute obstructive symptoms or gastric volvulus [7]. Conversely, SAGES provides a strong recommendation against surgery for asymptomatic patients with type 1 hernias [8]. Lastly, SAGES provides weak recommendations regarding asymptomatic PEH surgical treatment, stating that surgical consideration should include the patient's age and co-morbidities [8]. SAGES weakly recommends repairing all detected HHs during Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG) [8].

Recently published updates on HH treatment recommend that patients under 50 years old be considered for hiatal hernia repair (HHR), with surgery being elective in octogenarian populations [3,7]. However, these novel recommendations have yet to be added to the 2013 SAGES guidelines for HH management. Overall, these guidelines are not

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https://doi.org/10.1016/j.sipas.2023.100197
Received 1 June 2023; Received in revised form 24 June 2023; Accepted 28 June 2023
Available online 1 July 2023

comprehensive, as many patient populations are not commented upon, leaving an opportunity for surgeon preference regarding HHR. Additionally, these guidelines were made utilizing a moderate quality of evidence that is weakly supported.

Presently, literature has clearly described common trends in populations with a diagnosed HH. HH rates are higher in patients with morbid obesity and rise as age increases [9–11]. Surprisingly, one study observed lower rates of HH in those with type II diabetes (T2D) [12]. Existing literature is unclear on the HH incidence between genders, with recent publications yielding varying results [11,13]. Nevertheless, the prevalence of HH is well-known to increase in patients with concurrent GERD, occurring almost six times more frequently [11,14]. In terms of bariatric populations, Roux-en-Y gastric bypass (RYGB) surgery has been demonstrated to significantly improve GERD symptoms, and increasing evidence suggests that sleeve gastrectomy (SG) worsens GERD symptoms [15,16]. GERD prevalence is reportedly higher in patients undergoing RYGB than SG, yet SG patients are more likely to undergo concomitant HHR [18].

Currently, the decision-making criteria of operating surgeons to repair a HH is poorly reported. Furthermore, the characteristics of patients undergoing HHR are sparsely researched, with SAGES guidelines providing unclear comorbidities for HHR considerations; left unrepaired, HH can lead to significant reflux, regurgitation, and vomiting post-bariatric surgery [8]. Therefore, the aim of this study was to analyze the characteristics of patients that receive HHR and the variables that drive HHR decision by operating surgeons, mainly the specific patient demographics that surgeons tend to perform a HHR on. We hypothesized that patients with a HH identified on upper endoscopy, GERD, and an increased body mass index (BMI) would receive HHRs more often.

Materials and methods

We conducted a retrospective cohort study including 559 patients who underwent upper endoscopy in preparation for primary bariatric surgery. Prevalence of HH was based on esophagogastroduodenoscopy (EGD) findings performed by a bariatric surgeon or intraoperative finding during bariatric surgery. HH presence was classified as a hiatal defect twice the endoscope size (greater than 2 cm) on retroflexion. This study included three bariatric surgeons that also served as the endoscopists for preoperative EGD evaluation. Inclusion criteria consisted of patients 18 years or older who underwent an EGD in preparation for primary bariatric surgery (RYGB or SG), received their respective surgery from 02/04/2013 to 09/07/2016, and had a virgin hiatus. Patients were excluded if they had a history of previous bariatric surgery, were undergoing a revision, or had a hiatal dissection (such as a prior Nissen fundoplication, lap-band, SG converted to a RYGB, or a RYGB redo). Patients that underwent SG or RYGB for reasons unrelated to metabolic/weight loss surgery were also excluded. Ethical approval was given through the Institutional Review Board process at the applicable affiliated medical school.

Statistical analysis

We conducted descriptive analyses of categorical data to report frequencies, median, and range for continuous data. Chi-square or Fischer's exact test was utilized to investigate the association between patients, disease, operative-related attributes, and HHR status. The differences in distribution of continuous data across patients with versus without HHR were investigated utilizing the Mann-Whitney U test. Logistic regression was utilized to ascertain the effects of esophagitis, BMI, insulin-dependent Type 2 Diabetes Mellitus (T2D), duodenitis found on EGD and on pathology report, and bariatric surgery type on the likelihood that participants underwent HHR. The logistic regression model was built using a backward regression and removed predictor variables that were not considered to be statistically significant. A p-value less than 0.05 indicted statistical significance. The analyses were conducted using the SPSS software version 26.

Results

Out of the 559 patients included in this study, 310 patients had a preoperative HH identified and 45 had a HH identified during their bariatric surgery. Out of these 355 patients (Males = 69, Females = 286), 164 patients underwent HHR (Males = 25, Females = 139) and 191 patients did not undergo HHR (Males = 44, Females = 147). Gender did not impact HHR status ($p = 0.064$) (Table 1).

Out of the 116 patients with T2D, 62.1% did not receive a HHR and 37.9% did ($p = 0.03$). Additionally, 31 patients had notable duodenitis on EGD, of which 71% did not receive a HHR and 5.5% did ($p = 0.042$). Similarly, 37 patients were found to have duodenitis on the pathology report, of which 73% did not receive a HHR and 27% did ($p = 0.013$). 23 patients were found to have esophagitis, of which 78.3% did not receive a HHR and 21.7% did ($p = 0.015$). Pre-operative factors of having insulin-dependent T2D or duodenitis were noted to be statistically significant for not receiving a HHR ($p < 0.05$) (Table 1).

Of the patients that did receive a HHR, the mean BMI was 47.3, while the mean BMI of not receiving a HHR was 49.7 ($p = 0.015$). Moreover, 192 patients underwent SG, of which 27.1% did not receive a HHR, while 72.9% of patients did ($p < 0.001$) (Fig. 1). These pre-operative factors of having a lower BMI and undergoing SG were statistically significant for receiving a HHR (Table 1). Conversely, while 163 patients underwent RYGB surgery, 139 of these patients did not receive a HHR and 24 did ($p < 0.001$) (Fig. 1). Therefore, undergoing RYGB was statistically significant for not receiving a HHR (Table 1).

As described above, univariate analysis revealed that esophagitis ($p = 0.015$), T2D ($p = 0.03$), duodenitis on EGD ($p = 0.042$), duodenitis on pathology report ($p = 0.013$), BMI ($p = 0.15$), and bariatric surgery type ($p < 0.001$) all significantly impacted HHR rates (Table 1). Furthermore, when forward stepwise logistic regression was performed on these variables, this multivariate analysis demonstrated continued statistical significance ($p < 0.05$) regarding duodenitis found on pathology report and SG surgery type. This model explained only 49.1% of the variance in HHR rates and correctly classified 78.5% of cases. Thus, patients who underwent SG compared to RYGB were fifteen times more likely to undergo a HHR. Furthermore, duodenitis found on pathology demonstrated a two times reduction in the probability of undergoing a HHR. Factors noted in the univariate model, including esophagitis, T2D, and BMI did not significantly impact HHR rates in the multivariate analysis (Table 2). Duodenitis on EGD was not included due to the redundancy of its correlation with duodenitis found on pathology.

Notably, pre-operative characteristics that did not significantly impact HHR rates included the patient's age, OSA, HTN, HPL, GERD, OA, gastritis found on EGD and pathology, gastric and duodenal ulcers, gastric erosions, polyps, *H. pylori*, and Barrett's esophagus (all noted on upper endoscopy) ($p > 0.05$ for all variables).

Table 1
Characteristis of patients with hitatal hernias and their repair status.

Variable		-HHR N=191	+HHR N=164	P value
Sex	Female	147	139	0.064
	Male	44	25	
BMI	49.7 ± 9.4	47.3 ± 6.8	<0.001	
DM	Yes	119	120	0.03
	No	72	44	
Bariatic Surgery	Sleeve	52	140	<0.001
	RYGB	129	24	
Esophogities	Yes	173	159	0.015
	No	18	5	
Duodenitis	Yes	166	154	0.042
	No	22	10	
Duodenitis Path	Yes	164	154	0.015
	No	27	10	

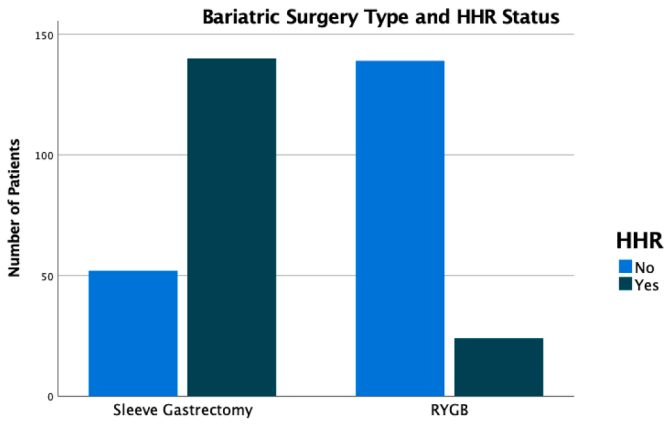

Fig. 1. The number of bariatric surgery patients who underwent hiatal hernia repair, separated by bariatric surgery type.

Discussion

If a HH is incidentally found at the time of a SG, the authors will repair this HH regardless of type or size, as SG is prone to producing GERD symptoms. If an incidental HH is found at the time of RYGB, then a HH is only repaired if it is type II, III, or IV, as this would limit the ability to create the gastric pouch for the RYGB. Incidentally found type I sliding HHs are not repaired by the authors at the time of RYGB.

Our results characterize multiple pre-operative features and comorbidities of patients that receive HHR, a novel fund of knowledge currently lacking in the literature. Here, we retrospectively examined patients' charts after undergoing HHR to assess if there were statistically significant patient characteristic patterns that drove surgeons to repair a HH. This study solely examined patients that underwent bariatric surgery in a single tertiary healthcare institution.

Results demonstrated that patients with a history of SG were more likely to undergo a HHR. This finding agrees with a recent study that examined over 100,000 cases, finding that SG populations more commonly had a HHR, despite the lower prevalence of GERD in the SG population as compared to the RYGB population. [17] Patients who undergo SG may develop post-surgical GERD due to disruption of the Angle of His, which prevents acid reflux, when performing the SG. [15] Furthermore, SG involves creating a gastric tube, with low compliance and high intragastric pressure, worsening GERD as gastric secretions are refluxed into the esophagus [15]. Due to SG worsening GERD symptoms, aggressive approaches to repair a HH in SG patients may be necessary [15].

Alternatively, RYGB patients were found to receive a HHR repair less often than SG patients. Existing literature supports this finding that RYGB populations are less likely to undergo HHR by operating surgeons, hypothesized to result from the small gastric pouch created in RYGB, causing decreased gastric acid production and less accumulating gastric acid in the stomach, theoretically decreasing GERD symptoms [17,18].

Patients with duodenitis were two times less likely to receive a HHR, which we hypothesize is a result of the surgeon considering other etiologies for the patients' reflux symptoms than a HH defect. Additionally, this could be considered a more ill patient, increasing a surgeon's hesitancy to prolong their operation in order to perform a HHR. Further clarification on the rationale of duodenitis regarding its influence of HHR status will need to be ascertained and addressed in future studies, as it is presently unclear as to why having duodenitis decreased HHR rates.

Lastly, other co-morbidities examined, including age, OSA, HTN, HPL, and OA did not influence HHR rates ($p > 0.05$), as well as BMI and T2D after multivariate analysis. These factors were included as we hypothesized that patients with HH and such comorbidities would either be treated more or less aggressively, due to the more ill nature of the patient versus the increased perioperative complication of such a patient. GERD, gastritis found on EGD and pathology, gastric and duodenal ulcers, gastric erosions, polyps, the presence of *H. pylori* infection, and Barrett's esophagus were found to also be statistically insignificant on influencing HHR rates. These factors were examined under the assumption that such patients may have increased gastric secretion and GERD symptoms. Our findings support that such comorbidities have little influence on a surgeon's cognitive process when deciding to perform a HHR. We originally hypothesized that patients with a HH identified on upper endoscopy, GERD, and an increased body mass index (BMI) would receive HHRs more often. However, it was found that none of these factors significantly affect HHR rates after multivariate analysis.

In terms of gender, this study did not find that this factor significantly influenced HHR decision. Present literature has opposing findings on the effect of gender on HH rates and GERD symptoms [10,12,13]. Our findings demonstrate that operating surgeons most likely mimic this understanding; therefore, operating surgeons may not include this patient characteristic in their decision-making criteria for HHR determination.

As this study sample size was limited to a tertiary healthcare system, these results may not be representative of the general population; therefore, a larger sample size would increase the study power. Other study weaknesses include confounding factors, such as increased BMI affecting HHR decision and preoperative surgeon selection bias in deciding to not perform a HHR in RYGB patients with a type 1 sliding HH. Additionally, the presence of GERD and operation type may have been confounding factors, as our results support that the presence of GERD increased the likelihood of undergoing RYGB, which decreased the chance of HHR. Given that esophagitis, T2D, and BMI were not statistically significant factors after performing a multivariate analysis, it is not clear that these factors influence HHR, indicating that further research on this topic is highly necessary. As our findings were a pilot study to examine what factors and comorbidities may influence HHR, we hope future studies can build upon these findings to analyze potential influential factors in greater detail.

Conclusions

The goal of this study was to pilot the expansion of SAGES guidelines for surgically treating HH. We hypothesized that significant comorbidities would impact bariatric surgeons' perioperative HHR decision. Our study shows that HHR decision-making criteria may be multifactorial in nature, taking surgeon preference into account. HHR has been a weakly explored topic in current medical literature. Through further studies,

Table 2
Logistic regression on undergoing a HHR using a stepwise forward likelihood ratio method.

		B	S.E.	Sig.	Odds Ratio	95% C.I. for Odds Ratio		Hosmer and Lemeshow test
						Lower	Upper	
Step 1	SG	2.740	0.274	<0.001	15.482	9.042	26.508	<0.001
	Constant	-1.756	0.221	<0.001	0.173			
Step 2	Duodenitis Present	0.936	0.456	0.040	2.550	1.044	6.230	0.324
	SG	2.741	0.276	<0.001	15.508	9.020	26.663	
	Constant	-2.603	0.480	<0.001	0.074			

SAGES HHR guidelines can be further clarified, standardizing the decision-making criteria for surgical HHR intervention and decreasing the need for an unindicated HHR.

CRediT authorship contribution statement

H. Zuercher: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Visualization. **B. Koussayer:** Methodology, Formal analysis, Writing – original draft, Visualization. **C. Wang:** Investigation. **B. Rachman:** Investigation. **V. Sands:** Investigation. **M. Sandhu:** Investigation. **C. McEwen:** Investigation. **R. Mhaskar:** Formal analysis. **C. DuCoin:** Conceptualization, Methodology, Validation, Supervision. **A. Mooney:** Conceptualization, Methodology, Validation, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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