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ORIGINAL CONTRIBUTIONS

Factors Affecting the Development of Gallstones Following Laparoscopic Sleeve Gastrectomy

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Abstract

Sleeve gastrectomy (SG) is a widely accepted procedure that has gained popularity among both bariatric surgeons and patients. There is still limited data in the literature on the formation of gallstones following laparoscopic sleeve gastrectomy, and so the present study determines the incidence of and potential risk factors related to the development of gallstones following laparoscopic sleeve gastrectomy. The data of patients who underwent laparoscopic sleeve gastrectomy at a single center due to morbid obesity between January 2014 and December 2017 was retrospectively reviewed and analyzed. The patients were divided into two groups, as those with gallstones detected on ultrasound at 12 months and those without gallstones. Data of the two groups was compared. BMI did not differ significantly between patients with positive (+) and negative (−) ultrasound findings ($p > 0.05$). Aside from age, hypertension, and coronary artery disease, other preoperative parameters showed no significant association with the development of gallstones in USG (−) and USG (+) patients. The present study identified no significant relationship between a decrease in BMI following LSG and the postoperative development of gallstones. Preoperative hypertension and coronary artery disease were found to be significantly related to the development of gallstones after surgery. The authors suggest that patients with preexisting CAD and hypertension in the preoperative period must be followed-up with ultrasound more meticulously.

Keywords Obesity · Laparoscopic sleeve gastrectomy · Cholelithiasis

Introduction

Sleeve gastrectomy (SG) has been proposed as the first stage in a multi-stage duodenal switch procedure and afterwards has become a restrictive bariatric surgical procedure. It involves the resection of the large portion of the stomach along the greater curvature without interfering with innervation or passage of food [1]. Sleeve gastrectomy (SG) is a widely accepted bariatric procedure that has gained popularity among both bariatric surgeons and patients, and is preferred due to the relatively better outcomes in terms of weight loss in the short and medium term, and its relative operative simplicity and low operation risk [2, 3].

Similar to other bariatric surgical procedures, gallstones occur more commonly after laparoscopic sleeve gastrectomy (LSG) [4]. Due to the fact that obese patients have a higher rate of cholelithiasis than the normal population and that rapid weight loss for any reason poses a risk factor for cholelithiasis, there is an exponentially increased risk of developing gallstones after sleeve gastrectomy [4]. Increased cholesterol saturation in the bile and biliary mucin concentrations in the gall bladder are important pathophysiological characteristics of gallstones that are related with rapid weight loss [5].

Studies have reported a rate of 7–16% for symptomatic gallstones following a gastric bypass procedure [6–8]. Accordingly, prophylactic cholecystectomy, intraoperative ultrasound, simultaneous cholecystectomy, the use of ursodeoxycholic acid following surgery, and close follow-up have been reported to avert complications, although none of these approaches can be considered standard of care in routine practice [6, 8–10]. There is still limited data in the literature regarding the formation of gallstones following laparoscopic

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sleeve gastrectomy. The present study determines the incidence of and potential risk factors for the development of gallstones following laparoscopic sleeve gastrectomy.

Method

The data of patients who underwent laparoscopic sleeve gastrectomy in a single center due to morbid obesity between January 2014 and December 2017 was reviewed retrospectively and analyzed. BMI (body mass index) was measured preoperatively and abdominal ultrasound and routine laboratory tests were performed for all patients. Blood tests and BMI measurements were repeated at 1 and 6 months after surgery. Routine blood tests, BMI measurement, and abdominal ultrasound were performed at 12 months after surgery. The study included patients who did not have gallstones in the gall bladder in the preoperative abdominal ultrasound, and those who underwent control ultrasound at 12 months. Patients who had underwent cholecystectomy before surgery, those who were found to have gallstones in the gall bladder in a preoperative ultrasound and underwent simultaneous cholecystectomy, and those lost to follow-up were excluded.

All operations were performed by the same surgeon using the same surgical procedure. The BMI of all patients was above 40, and a Jackson-Prat drain was placed into the abdominal cavity as a matter of routine. Methylene blue was administered preorally 3 days after surgery for control purposes; after which, oral intake was initiated. The drains were removed on postoperative day 4 or 5 and the patients were discharged. Patients attended control visits at 1, 6, and 12 months after surgery.

The patients were divided into two groups as those with gallstones detected on ultrasound at 12 months and those without gallstones. The demographic data of the patients and the preoperative and postoperative findings were entered into the SPSS (Statistical Package for the Social Sciences) software, and the data of the two groups was compared.

Statistical Analysis

Descriptive statistics included mean, standard deviation, median, minimum, maximum, frequency, and ratio. A Kolmogorov-Smirnov test was used to test whether the variables were normally distributed. An independent sample *t* test and a Mann-Whitney *U* test were used for the analysis of quantitative data. A Wilcoxon test was used in the analysis of quantitative data. A chi-square test was used in the analysis of qualitative data, and Fischer's exact test was used when the requirements for chi-square were not met. SPSS version 22.0 software was used in the analysis.

Results

A total of 171 patients underwent surgery in the specified study period: 14 patients were excluded due to a history of cholecystectomy, and 21 were withdrawn from the study as they did not complete the 12-month follow-up period (did not regularly attend control visits). Cholelithiasis was detected in six patients preoperatively, and these patients underwent simultaneous cholecystectomy. The study was completed with a total of 130 patients, of which eight patients (6.1%) underwent cholecystectomy after becoming symptomatic at the end of 1 year. The general characteristics and demographic data of the groups are presented in Table 1. Age was significantly higher in patients with gallstones detected in the gall bladder on ultrasound at 12 months than that in patients without gallstones ($p < 0.05$). There was no significant difference in gender distribution between the USG (−) and USG (+) patients ($p > 0.05$). BMI did not differ significantly between the USG (−) and USG (+) patients ($p > 0.05$). The rates of smokers, alcohol abusers, and patients with DM (diabetes mellitus) and gastroesophageal reflux were not significantly different between the USG (−) and USG (+) patients ($p > 0.05$). The rates of patients with HT (hypertension) ($p = 0.048$) and coronary artery disease (CAD) ($p = 0.048$) were found to be significantly different (Table 2).

Table 1 The general characteristics and demographic data

		Min–max	Median	Med. ± s.s./*n*, %
Age		17.0–65.0	37.0	37.1 ± 10.8
Sex	Male			37 27.2%
	Female			99 72.8%
BMI		40.0–62.0	46.0	46.2 ± 3.8
Smoker				47 34.6%
Alcohol user				13 9.6%
DM				107 78.7%
HT				77 56.6%
CAD				47 34.6%
Gastroesophageal reflux				35 25.7%
Preoperative gallstone	(−)			6 4.4%
	(+)			130 95.6%
BMI				
Preoperative		40.0–62.0	46.0	46.2 ± 3.8
Postoperative 6 months		23.0–39.0	30.0	30.1 ± 3.9
Postoperative 12 months		22.0–32.0	27.0	26.7 ± 2.1
HbA1c				
Preoperative		3.2–11.8	6.1	6.3 ± 1.7
Postoperative 6.Ay		3.1–8.5	4.9	5.0 ± 1.2

BMI, body mass index; *DM*, diabetes mellitus; *HT*, hypertension; *CAD*, cardiovascular disease; *HbA1c*, hemoglobinA1c

Table 2 With and without gallstones in postoperative USG

		Abdomen USG gallstone (−)				Abdomen USG gallstone (+)				*p*	
		Med. ± s.s./*n*, %			Median	Med. ± s.s./*n*, %			Median		
Age		35.6	±	10.7	35.0	42.7	±	10.3	42.0	*0.002*	*t*
Sex	Male	29		28.2%		6		22.2%		0.536	X^2
	Female	74		71.8%		21		77.8%			
BMI		46.1	±	3.5	46.0	45.6	±	3.7	45.0	0.563	*m*
Smoker		33		32.0%		9		33.3%		0.898	X^2
Alcohol user		9		8.7%		3		11.1%		0.705	X^2
DM		80		77.7%		22		81.5%		0.568	X^2
HT		52		50.5%		20		74.1%		0.028	X^2
CAD		29		28.2%		13		48.1%		0.048	X^2
Gastroesophageal reflux		22		21.4%		9		33.3%		0.194	X^2
BMI											
Preoperative		46.1	±	3.5	46.0	45.6	±	3.7	45.0	0.563	*m*
Postoperative 6 months		29.7	±	3.6	29.0	31.0	±	4.3	32.0	0.182	*m*
Change according to preop period		*0.000*			*w*			*0.000*	*w*		
Postoperative 12 months		26.5	±	2.0	27.0	27.3	±	2.2	27.0	0.112	*m*
Change according to preop period		*0.000*			*w*			*0.000*	*w*		
HbA1c											
Preoperative		6.3	±	1.7	6.1	6.1	±	1.7	6.1	0.735	*m*
Postoperative 6 months		5.0	±	1.1	4.9	5.1	±	1.3	4.8	0.938	*m*
Change according to preop period		*0.000*			*w*			*0.000*	*w*		

In both groups, BMI and Hba1c values were significantly decreased compared to preoperative period

t, *t* test; *m*, Mann-Whitney *U* test; X^2, chi-square test (Fischer test); *w*, Wilcoxon test

BMI, body mass index; *DM*, diabetes mellitus; *HT*, hypertension; *CAD*, cardiovascular disease

BMI and HbA1c (hemoglobin A1c) prior to surgery and at the postoperative 6 and 12 months did not show a significant difference between the USG (−) and USG (+) patients ($p > 0.05$) (Fig. 1).

Discussion

In the present study, the formation of gallstones identified at 1-year follow-up after laparoscopic sleeve gastrectomy was observed in 27 out of 130 patients (20.7%). The decrease in BMI was not found to be related to the development of gallstones in the gallbladder. None of the parameters apart from the mean preoperative age, HT, and CAD was found to be of value in predicting the development of gallstones.

Recent studies have demonstrated a higher rate of gallstones and biliary sludge in patients undergoing bariatric surgery than the normal population, with studies reporting incidence rates ranging between 10% and 20% for gallstones or biliary sludge in the normal population [11]. On the other hand, the prevalence of gallstones in patients undergoing bariatric surgery ranges between 28% and 71%, which can be attributed to rapid weight loss and the increased tendency towards the development of biliary stones [12, 13]. It is assumed that cholesterol is mobilized from the tissue stores with rapid weight loss and excreted into the bile, resulting in lithogenic bile in relation to an increased biliary cholesterol saturation index [4].

It has been suggested that the probability of developing gallstones is related directly to the surgical method used for the treatment of morbid obesity. Hasan et al. [14] found that the rate of development of gallstones at the end of 1 year following LSG was 25.9%. Restrictive procedures such as gastric banding surgery and LSG should be associated with a lower risk of gallstone development due to the lack of interference with the biliary contraction mechanisms and enterohepatic circulation. Kiewiet et al. [15] reported a rate of 26.5% for asymptomatic gall bladder stones following gastric banding surgery in the Dutch population, and 6.7% of these patients become symptomatic. Sioka et al. reported a rate of 23.2% for the development of gallstones and a rate of 5.8% for symptomatic gallstones [16]. A North American study reported symptomatic and asymptomatic gallstones in 29% of the patients following LSG [17]. Symptomatic gallstones have been reported at a higher rate (up to 28.9%) in patients undergoing gastric bypass surgery when compared with patients undergoing LSG and gastric banding surgery [18, 19]. The rate of symptomatic and asymptomatic gallstones in the present study was 20.7% at the end of 1 year. The results of the present study regarding the development of gallstones following LSG were consistent with those reported in the literature.

The determination of predictive factors for the development of gallstones following bariatric surgery may be important for the selection of patients for specific prophylactic interventions [16]. These interventions include prophylactic cholecystectomy, intraoperative ultrasound and simultaneous cholecystectomy, postoperative prescription of ursodeoxycholic acid, and surveillance with regular ultrasound for gallstones. The routine use of these interventions has been examined for years; however, there is to date a lack of consensus on the optimum practice and the controversial points related to their use. In the present study, the patients underwent routine follow-up with ultrasound, and eight patients (6.1%) that became symptomatic

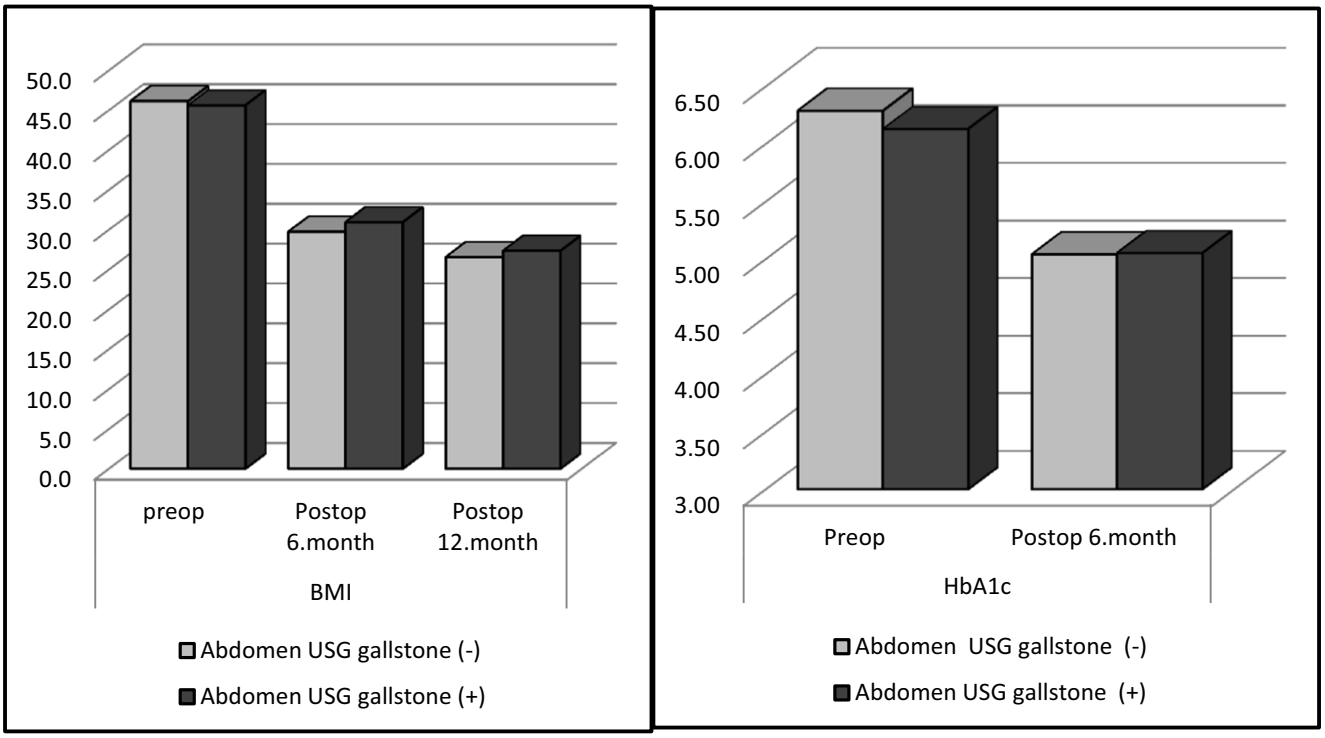

Fig. 1 Change in BMI and HbA1c*USG*, ultrasound; *preop*, preoperative; *postop*, postoperative; *BMI*, body mass index; *HbA1c*, hemoglobin A1c

underwent cholecystectomy. In a study involving 319 patients by Aridi et al. [20], 7.5% of the patients became symptomatic following LSG. In the studies by Li et al. and Sioko et al. [4, 16], the cumulative rate of symptomatic cholelithiasis was reported to be 3.8% and 5.3%, respectively. The rate of symptomatic cholelithiasis following Roux and Y Gastric Bypass (RYGB) surgery was reported to be in the range of 6.7–11.8% [21, 22]. When compared with LSG, the findings were consistent with the literature, and as was expected, the rate was lower when compared with that of RYGB.

Known risk factors for the development of gallstones in the general population, such as age, female gender, and obesity, can be useful in patient selection. In the present study, a significant relationship was identified between advanced age and the development of gallstones, consistent with the findings for the general population ($p = 0.002$). Previous studies have identified no relationship between comorbidities such as preoperative diabetes, hypertension, coronary artery disease, and the development of gallstones after surgery [13, 14, 21]. The present study identified a significant relationship between the development of gallstones after surgery and the presence of hypertension and coronary artery disease ($p = 0.028$–0.048). Aridi et al. [20] reported a similar relationship in their study, although in this, there are only a limited number of studies in the literature supporting this data [22].

Rapid weight loss has been accepted as a risk factor for the development of gallstones and subsequent symptomatic cholelithiasis in many studies [13, 16, 23]. Li et al. [4] reported that postoperative weight loss in excess of 25% is a predictive factor for the development of gallstones, and this finding could be useful in patient selection for ultrasound assessment after bariatric surgery [23, 24]. However, Aridi et al. [20] found no significant relationship between the percentage of excess weight loss (EWL%) and the postoperative development of gallstones. Similarly, Moon et al. [19] found no significant relationship between weight loss after LSG and the development of gallstones, and the present study identified no relationship between the decrease in BMI following surgery and the development of gallstones. This finding may be attributed to the fact that all patients in the present study underwent LSG.

The limitations of the study include its single-center focus, the relatively small number of patients, and the retrospective study design.

Conclusion

The general risk factors for the development of gallstones were not found to be consistent with the factors in the patient population undergoing LSG. The present study identified no significant relationship between decreased BMI following LSG and the postoperative development of gallstones. Preoperative hypertension and coronary artery disease were found to be significantly related to the development of gallstones after surgery. The authors suggest that patients with

preexisting CAD and hypertension in the preoperative period must be followed with ultrasound more meticulously.

Authors' Contribution All of the authors participated in the design, execution, and analysis of the paper and approved the final version.

Compliance with Ethical Standards

Board of ethics approval for this study was obtained from the ethics commission of Adiyaman University. Approval no. 2019/2-10. Approval date 20.03.2019. This study is retrospective and therefore no consent form is needed.

Conflict of Interest The authors declare that they have no conflict of interest.

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