Journal of Experimental and Clinical Medicine
https://dergipark.org.tr/omujecm

Research Article

J Exp Clin Med
2022; 39(4): 1223-1229
doi: 10.52142/omujecm.39.4.50

Risk factors associated with the development of trocar site hernia after laparoscopic bariatric-metabolic surgery

Muzaffer AL

Department of Surgery, Faculty of Medicine, Near East University, Nicosia, Cyprus

Received: 11.08.2022 • **Accepted/Published Online:** 07.09.2022 • **Final Version:** 29.10.2022

Abstract

The aim of this study is to investigate the effects of three laparoscopic bariatric-metabolic surgery (BMS) techniques [sleeve gastrectomy (SG), SG with transit bipartition (SG-TB), one anastomosis gastric by-pass (OAGB)] and patients' sociodemographic and clinical features on trocar site hernia (TSH) development after laparoscopic BMS. This was a retrospective study conducted between January 2015 and February 2022. A total of 54 obese patients, 18 who developed TSH and 36 who did not develop TSH during follow-up after laparoscopic BMS, were included in the study. The mean age was 55.28 ± 7.98 years in the TSH group and 40.58 ± 11.47 years in the non-TSH group (p < 0.001). Seventeen (94.4%) of the TSH group and 23 (63.9%) of the non-TSH group were females (p = 0.021). TSH developed in 1 patient who underwent SG (5.6%), 1 patient who underwent OAGB (5.6%), and 16 patients who underwent SG-TB (88.9%). Multiple logistic regression analysis revealed that high age (p=0.018) and undergoing SG-TB (p=0.018) were independently associated with TSH development. In order to reduce TSH risk and to increase the chance of early diagnosis in patients with advanced age or SG-TB recipients, we believe that taking additional intraoperative precautions and performing closer follow-up will be necessary.

Keywords: trocar site hernia, sleeve gastrectomy, sleeve gastrectomy with transit bipartition, one anastomosis gastric by-pass, bariatric-metabolic surgery, rick factors

1. Introduction

Bariatric-metabolic surgery (BMS) is being performed with increasing frequency in the treatment of obesity and metabolic disorders (1-3). Although BMS seems to be the most effective and permanent treatment option for obesity, it is associated with a number of perioperative complications. These include anastomotic bleeding, leakage, myocardial infarction, pulmonary embolism, and even mortality, while delayed complications, such as dumping syndrome, malnutrition due to malabsorption, inadequate weight loss, and marginal ulceration, may also be encountered relatively frequently (2, 4, 5).

Besides the common complications of laparoscopic BMS, trocar site hernia (TSH) is a problem whose true incidence is difficult to detect and its likelihood is often ignored by many surgeons, especially because TSH usually occurs long after the primary surgery, is asymptomatic at onset, and remains difficult to diagnose when weight loss after surgery is limited (6, 7). Current estimates of TSH incidence after BMS report a range of 0–39.3%, although it is notable that these values are dependent upon the method of TSH diagnosis and follow-up time (6, 8). It has been shown that higher TSH risk is observed in patients with diabetes mellitus, postoperative malnutrition, higher intraabdominal pressure, difficulty in full-thickness closure of the trocar site, thicker peritoneum, and larger preperitoneal space (5, 9, 10). Moreover, it is difficult to diagnose TSH by inspection and palpation in obese patients because of excess subcutaneous fat tissue (3, 11). There are various studies which have used imaging methods for the detection of postoperative abdominal wall defects in obese patients, and it is evident that the presented incidence of TSH is much higher in these studies (6, 8, 12, 13). Considering the difficulty of diagnosis and the delayed nature of this complication, we believe that the risk of TSH after laparoscopic BMS should be taken into account and risk factors that facilitate the development of TSH must be identified. In a study investigating the effects of many factors, including BMS procedures, only excessive weight loss was identified as a risk factor for TSH (14). Furthermore, although there are many studies assessing TSH frequency and risk factors in non-BMS laparoscopic procedures (7, 15-17), there are very few which have investigated risk factors specific to BMS (9, 14, 18). In fact, a recent systematic review described TSH development following BMS as "an underestimated issue" (6).

In this study, we aimed to investigate the effects of three laparoscopic BMS techniques and some other sociodemographic and clinical features of patients with regard to their influence on TSH development after laparoscopic BMS.

*Correspondence: drmuzaffer61@hotmail.com

2. Material and Methods

This retrospective case-control study was carried out by including patients who underwent BMS from January 2015 to February 2022 in our bariatric surgery Center of Exellence, Department of General Surgery, Büyük Anadolu Hospital, Samsun, Turkey. The study was approved by the Ethics Committee of Büyük Anadolu Hospital (date: 28.07.2021, no: 04). The study was conducted according to the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments. Due to the study's retrospective nature, written informed consent was deemed unnecessary by the ethics committee. All data were recorded anonymously.

2.1. Study population

A total of 54 obese patients, 18 who developed TSH and 36 who did not develop TSH in their follow-up after laparoscopic BMS, were included in the study. Participants in the control group were randomly assigned in a 2:1 ratio for patients undergoing BMS who met inclusion criteria, using an internet-based random number generator (https://www.random.org). The exclusion criteria were determined as follows for both groups: being younger than 18 or older than 65 years old, having undergone revision BMS, being diagnosed with a postoperative complication related to the trocar incision site (e.g., wound infection), presence of complications necessitating revision surgery after primary surgery, history of inguinal, femoral, umbilical or epigastric hernia, history of a previous abdominal surgery (e.g., cesarean section etc.), severe mineral or vitamin malnutrition after surgery, known wound healing disorder, steroid therapy, renal insufficiency or cancer. Patients who did not attend follow-up or had missing relevant data were also excluded from the study.

2.2. Data collection

Demographic information (age, sex, etc.), anthropometric data [height, weight, and body-mass index (BMI)], occupation, smoking status, number of transvaginal births among female participants, comorbidities and drug use, type of BMS procedure applied, use of protein supplementation, and necessary follow-up information were obtained from hospital records.

2.3. Operative technique and post-operative follow up

Patients with a BMI of ≥40 or a comorbidity with a BMI of ≥35–40 was considered eligible for BMS (19). The most appropriate BMS procedure was determined according to the preferences of the patients after necessary information was provided. All three surgical techniques [sleeve gastrectomy (SG), SG with transit bipartition (SG-TB), one anastomosis gastric by-pass (OAGB)] were performed under general anesthesia and with standard laparoscopical surgical procedures.

Five trocars for SG (20) and OAGB (21) were placed as recommended in the literature. In patients who underwent SG+TB, an 11-mm optic trocar was inserted one and a half hands from the xiphoid process, in addition to a 5-mm trocar from the right lateral, a 15-mm trocar from the left lateral, a 5-mm trocar from the left lower quadrant, and a 5-mm trocar from the xiphoid for the liver retractor. For the first stapler application in both SG and SG-TB, an 11 mm optical trocar was routinely removed and replaced with a 15 mm trocar. Sleeve material was taken out of the abdomen through a 15-mm umbilical trocar site in SG, and from the left lateral 15-mm trocar site in SG-TB.

Stapling devices and stapler materials (Endo GIA™; Covidien™; USA) in different sizes were used in all operations for basic anastomosis and stomach resection. In all operational procedures, trocar sites (except for the 5-mm fascial defect) were closed using 1/0 absorbable polyglactin (Vicryl™; Ethicon) sutures with the help of a trocar site closure device (Endo Close™ Auto Suture™; Covidien™ ; USA).

While no protein supplement was given to any patient in the SG-TB group postoperatively, it was given to the majority of patients in the SG and OAGB groups. The patients requiring protein supplementation were identified by an expert dietitian. Standard postoperative follow-up included clinical visits at 1 week, 1 month, 3 months, 6 months, 1 year, and once a year thereafter. TSH in symptomatic patients was confirmed by ultrasonography. Hernias developing in the 5-mm trocar sites were repaired by open surgery using polypropylene mesh. The remaining hernias were repaired with laparoscopic dual mesh and all the patients were discharged without any complications.

2.4. Statistical Analysis

All analyses were performed on IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA), with a significance threshold of $p<0.05$. For the normality check of the continuous variables, the Shapiro-Wilk test was used. Normally distributed continuous variables were analyzed with the independent samples t-test. Non-normally distributed continuous variables were analyzed with the Mann-Whitney U test. Categorical variables were analyzed with the chi-square tests or the Fisher's exact or Fisher-Freeman-Halton tests. Multiple logistic regression analysis (forward conditional method) was performed to determine significant risk factors of the trocar site hernia. The model included all parameters with univariate significance.

3. Results

The mean age of all participants was 45.48 ± 12.50 years. The TSH group had a mean age of 55.28 ± 7.98, while the non-TSH group had a mean age of 40.58 ± 11.47 years. Seventeen (94.4%) of the TSH patients and 23 (63.9%) of the non-TSH patients were female. There was a significant difference between the groups in terms of age ($p<0.001$) and sex ($p = 0.021$). While there was a significant difference between the groups in terms of height ($p = 0.037$) and weight ($p = 0.010$) in favor of the non-TSH group, there was no significant difference in terms of BMI ($p = 0.152$). In the TSH group, the percentage of housewives ($p = 0.021$), median number of births (among women) ($p<0.001$), frequencies of hypertension ($p =$

0.002) and type 2 diabetes mellitus (T2DM) ($p<0.001$), duration of T2DM ($p<0.001$), oral antidiabetic use ($p<0.001$) and the percentage of patients who underwent SG+TB ($p<0.001$) were significantly higher. All sociodemographic, anthropometric, and clinical characteristics and differences between the groups are summarized in Table 1.

Table 1. Summary of patients' characteristics with regard to trocar site hernia

		Trocar site hernia		
	Total (n=54)	Yes (n=18)	No (n=36)	p
Age	45.48 ± 12.50	55.28 ± 7.98	40.58 ± 11.47	**<0.001**
Sex				
Female	40 (74.1%)	17 (94.4%)	23 (63.9%)	**0.021**
Male	14 (25.9%)	1 (5.6%)	13 (36.1%)	
Height, cm	163.54 ± 9.80	160.11 ± 6.86	165.25 ± 10.65	**0.037**
Weight, kg	108.4 (96.6 - 124.3)	97.45 (92.1 - 113.0)	113.05 (99.8 - 131.6)	**0.010**
Body mass index, kg/m2	40.41 (36.43 - 46.14)	38.60 (35.30 - 42.74)	40.86 (37.62 - 46.69)	0.152
Occupation				
Student	4 (7.4%)	0 (0.0%)	4 (11.1%)	**0.021**
Housewife	23 (42.6%)	13 (72.2%)	10 (27.8%)	
Desk job	12 (22.2%)	2 (11.1%)	10 (27.8%)	
Heavy job	15 (27.8%)	3 (16.7%)	12 (33.3%)	
Smoking	24 (44.4%)	7 (38.9%)	17 (47.2%)	0.771
Number of birth	2 (0 - 3)	3 (2 - 4)	0 (0 - 2)	**<0.001**
Hypertension	22 (40.7%)	13 (72.2%)	9 (25.0%)	**0.002**
Coronary artery disease	6 (11.1%)	1 (5.6%)	5 (13.9%)	0.651
Type II Diabetes mellitus	27 (50.0%)	16 (88.9%)	11 (30.6%)	**<0.001**
Duration of diabetes mellitus, years	1 (0 - 10)	9 (5 - 13)	0 (0 - 5)	**<0.001**
Drug use				
None	27 (50.0%)	2 (11.1%)	25 (69.4%)	**<0.001**
Oral antidiabetics	3 (5.6%)	3 (16.7%)	0 (0.0%)	
Insulin	9 (16.7%)	5 (27.8%)	4 (11.1%)	
Oral antidiabetics + Insulin	15 (27.8%)	8 (44.4%)	7 (19.4%)	
Operation				
Sleeve gastrectomy	14 (25.9%)	1 (5.6%)	13 (36.1%)	**<0.001**
Sleeve gastrectomy + Transit bipartition	26 (48.1%)	16 (88.9%)	10 (27.8%)	
One anastomosis gastric by-pass	14 (25.9%)	1 (5.6%)	13 (36.1%)	
Protein supplement	14 (26.4%)	2 (11.1%)	12 (34.3%)	0.102
Time between operation and hernia, months	8.5 (7 - 10)	8.5 (7 - 10)	-	N/A
Follow-up time, months	29 (20 - 65)	20 (12 - 65)	32.5 (23.5 - 65.5)	0.060

Data are given as mean ± standard deviation or median (1st quartile - 3rd quartile) for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables. Abbreviations: N/A: Not applicable

Multiple logistic regression analysis revealed that high age ($p=0.018$) and SG-TB ($p=0.018$) were the significant factors independently associated with TSH development. Patients who underwent SG-TB operation had 8.600-fold higher risk for TSH than other types of surgery (OR: 8.600, 95% CI: 1.446 - 51.152) (Table 2). Other variables included in the analysis, sex ($p=0.168$), height ($p=0.923$), weight ($p=0.129$), occupation ($p=0.799$), number of births ($p=0.191$), hypertension ($p=0.854$), T2DM ($p=0.600$), duration of T2DM ($p=0.097$) and drug use ($p=0.624$) were found to be non-significant (Table 2, Fig. 1., Fig. 2.).

Table 2. Significant risk factors of the trocar site hernia, multiple logistic regression analysis

	β coefficient	Standard error	p	Exp(β)	95.0% CI for Exp(β)	
Age	0.101	0.043	**0.018**	1.106	1.017	1.203
Sleeve gastrectomy + Transit bipartition	2.152	0.910	**0.018**	8.600	1.446	51.152
Constant	-6.954	2.201	0.002	0.001		
CI: Confidence Interval, Nagelkerke R^2=0.535						

No postoperative early complications occurred in any of the patients included in the study. The patients were followed up for a median of 29 (IQR: 20 - 65) months. TSH developed in 4 patients at the umblical 15-mm trocar site, in 11 patients at the 15-mm left lateral trocar site and in 1 patient at the right lateral 5-mm trocar site after SG-TB. After SG, TSH developed in 1 patient at the umblical 15-mm trocar site. After OAGB, TSH developed in 1 patient at the right 15-mm trocar site. The most common symptoms in 18 patients with TSH were pain while moving and swelling when lifting something heavy. Of note, the patient who developed TSH from the 5-mm incision on the right lateral side after SG-TB had been treated with hook cautery for bleeding from the trocar site. The median hospital stay after TSH repair was 2 days (IQR: 1-3).

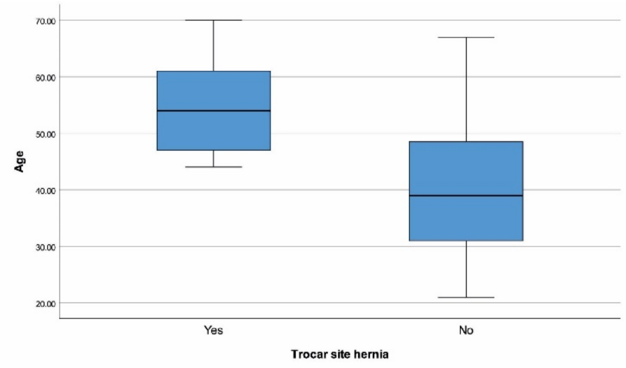

Fig. 1. Age with regard to trocar site hernia

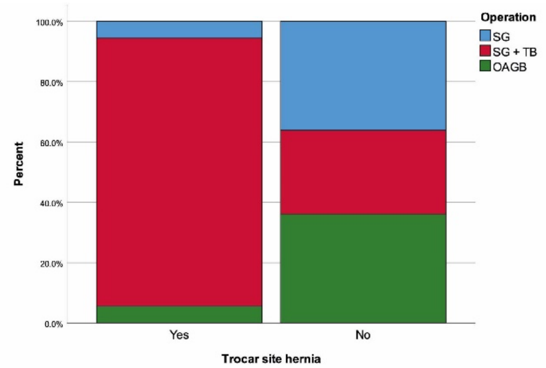

Fig. 2. Type of operation with regard to trocar site hernia

4. Discussion

Trocar site hernia is a neglected problem which is rarely diagnosed when only symptoms and physical examination are considered after BMS; however, various studies have shown that TSH frequency can reach 40% when imaging methods are utilized (6, 8, 14). As a result of the multiple logistic regression analysis of the present study, the most important risk factors for the development of TSH after BMS were found to be SG-TB and higher age.

Obesity stands out as a prominent risk factor for TSH development in a number of studies involving various patient groups and laparoscopic operations/ Obesity has been identified as a significant risk factor for TSH development in a number of studies involving different patient groups and laparoscopic procedures (9, 10). In this study, we sought to determine factors that increased TSH likelihood among patients who had undergone BMS for obesity treatment, and found that advanced age and SG-TB procedure were the risk factors independently associated with TSH development in this group of patients. Various risk factors (in addition to obesity) for TSH after laparoscopic surgeries have been described in the literature. The most common ones among these are size of the trocars, trocar site, long operating time, sex, advanced age, and smoking status (22-25). There are also some limited studies which have addressed the specific risk factors for TSH development after BMS (9, 14, 18, 26). In the multivariable analysis of a recent study, age, sex, BMI at baseline, BMI at follow-up, excessive weight loss, type of surgery, T2DM, smoking history, ASA score, abdominoplasty reconstruction, length of surgery, and length of hospital stay were evaluated to detect potential risk factors related to the development of TSH after BMS. The only factor that was related to a higher risk for TSH was found to be excessive weight loss (14). In another study investigating the risk factors for TSH in patients who underwent SG, TSH development was not found to be associated with sex, age, preoperative BMI, T2DM, comorbidities (hypertension, dyslipidemia, obstructive sleep apnea, metabolic syndrome), operation time, or weight regain (9). In another study examining similar risk factors, TSH was only found to be associated with the 12-mm trocar site closure after SG (18). Despite a lack of conclusive evidence on this matter, it appears that advanced age is a reasonable risk factor for TSH development, especially due to its relationship with fascia weakening, decreased abdominal muscle volume, and delayed wound healing (13, 22).

Various procedures have been described for BMS, and they have multiple advantages and disadvantages compared to each other. Almost all of them can be performed as open procedures as well as laparoscopic procedures. The laparoscopic approach may reduce the risk of incisional hernia, but it does not completely eliminate the risk (11, 21, 25). In an OAGB series of 407 patients, it was reported that none of the patients developed TSH during follow-up. However, in this study, the follow-up period was limited to an average of 160 days (21). Raziel et al. detected TSH in only 1 (0.3%) of 337 OAGB cases (27). In a study from Turkey, the incidence of TSH after SG was reported as 0.36% (28). In another study, 3.1% TSH was reported after laparoscopic SG-TB (29). We rarely come across studies that include SG-TB and compare TSH rates between procedures (14, 26, 30). In the present study, TSH results of three laparoscopic surgical procedures were compared, and the incidence of TSH after SG-TB was found to be significantly higher, and that after SG and OAGB was found to be significantly lower. According to the multiple regression analysis, SG-TB was identified as a risk factor for TSH. Coblijn et al. found no significant difference in TSH rates after laparoscopic Roux-en-Y gastric bypass (RYGB), laparoscopic adjustable gastric band and laparoscopic SG (26). In other similar studies, no significant differences were found in terms of TSH frequency after laparoscopic RYGB and laparoscopic SG (14, 30). A higher incidence of TSH can be expected after laparoscopic SG and SG-plus procedure because the sleeve material is usually taken out of the abdomen through the umbilical trocar site, and therefore, the incision of this site is further widened due to excessive manipulation (25). This hypothesis is supported by the results of studies stating that most TSH cases are seen in the umbilical region and that excessive manipulation of the trocar site to remove samples may be an important risk factor for TSH (31, 32).

Santoro et al. introduced the transit bipartition approach as a metabolic complement to standard SG and stated that they obtained successful results (29). The resulting SG-TB method may provide extra metabolic benefits, but it would not be erroneous to expect a heightened risk for complications as it involves intestinal intervention and anastomosis and increases surgical duration. Although TSH was observed in only 1 patient each after SG and OAGB in this study, lower TSH probability may be expected from the other two procedures, since no specimens were removed from the trocar incisions in OAGB. In the current study, although the sleeve material was removed from the umbilical trocar site in all SG patients, TSH occurred in only 1 patient (umbilical trocar site, SG group). In the SG+TB group, trocar hernia was observed in the umbilical region in 4 patients, although all sleeve materials were removed from the 15-mm left trocar site. Moreover, the incidence of TSH after only SG was found to be quite low compared to the incidence of TSH after SG-TB. All of these contradict the hypothesis that enlargement of the trocar site while removing the sleeve material facilitates TSH development. According to the results of this study, it can be thought that the removal of the sleeve material and related manipulations do not have a significant effect on TSH development. This requires the consideration that other factors contribute to TSH after SG-TB. Age, as another independent variable, may be an effective factor in this situation. In addition, increased duration of surgery, another possible factor not investigated in this study, and more excessive manipulation as a requirement of SG-TB surgery can be considered as other possible causes. Moreover, the fact that all patients who underwent SG-TB had T2DM (and were not administered post-operative protein replacement), and that the number of females and the median number of births were higher in the group with TSH, may suggest that these factors may have influenced TSH likelihood, despite non-significant results in multiple regression analysis. Notably, diabetes mellitus and protein deficiency are factors that negatively affect wound healing (33). Also, the increase in the number of births may facilitate the development of TSH due to the weakness of the abdominal fascia (7). However, more comprehensive studies are needed to clarify factors that have a definite effect on TSH development.

Another issue to consider in a study assessing TSH after BMS is trocar site wound and/or facia closure. In laparoscopic approaches other than BMS, suturing the fascia for trocar incisions larger than 10 mm is recommended, but TSH risk can be seen even in smaller-sized lesions (≤5 mm) (15, 16). In the present study, a significant majority of TSHs (94.4%) occurred at the 15-mm trocar site ve? /whereas? TSH developed in only a single 5-mm trocar site. At this site, it was revealed that cauterization was performed due to bleeding during the operation. Karampinis et al. reported that in their department (where they did not perform fascia closure in trocar sites smaller than 10 mm) overall hernia prevalence was 2.5% in the 5-mm trocar site, 10.6% in the 12-mm site, and 22.4% in the 12-mm trocar site used for stomach extraction. Also in this study, suturing the fascia with interrupted, absorbable sutures did not appear to yield fewer TSHs than leaving the fascia open (3). However, in another study, it was reported that the frequency of TSH was significantly lower when the fascia was closed at the 12-mm epigastric trocar site using a protected port closure device (18). Aly and Lee (34), criticized the statement that the closure of trocar site wound can be omitted because the TSH incidence is 0.5% even when the trocar site wound is not closed as a conclusion of the study by Coblijn et al. (26), and stated that even this rate was rather high. They also stated that trocar site wounds of 10 mm and above should be closed and suggested that the two methods they introduced (Surgicel® and omental plug without fascial closure) could be vital in preventing TSH (30, 34). In general, it can be said that the risk of TSH increases as the size of the trocar and trocar incision increases. In addition, according to our results, we recommend routine fascial closure of trocar sites larger than 5 mm when they are involved in the removal of sleeve material. In addition, we think that fascia closure at the 5 mm trocar site is only necessary if cauterization (or other excessive manipulation) is performed during the operation.

Some limitations of the present study should be taken into account when interpreting the results. The generalizability of the results is limited, as it is a single-center study and the number of participants is small. The small number of participants may also have limited the specific comparisons between the types of surgeries compared. The retrospective nature also carries possible biases concerning patient inclusion/exclusion due to possible problems in data records. In addition, we could not assess additional possible factors such as anemia, ASA score, COPD, etc., which can cause wound healing disorders. The fact that routine imaging methods were not used for TSH screening may have resulted in an underestimation of TSH; however, the frequency reported in this study already demonstrates that TSH is not as rare as suggested by previous short-term studies.

In conclusion, SG-TB and advanced age were found to be the most important risk factors for TSH development after BMS. In order to reduce the risk of TSH development and to increase the chance of early diagnosis of TSH in patients with advanced age or SG-TB recipients, we think that it would be beneficial to take additional pre-and perioperative measures. Also, performing follow-up not only clinically but also with additional imaging methods may be necessary in these patients. We also recommend fascia closure if intraoperative cauterization or excessive manipulation has been performed in the trocar site, regardless of size. However, there is still a need for comprehensive prospective studies in which TSH screening is performed with imaging methods to precisely determine the real-world incidence of TSH after BMS and to identify risk factors specific to BMS procedures.

Conflict of 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.

Funding

No financial support was received for the present study.

Acknowledgments

The study was approved by the Ethics Committee of Büyük Anadolu Hospital (date: 28.07.2021, no: 04). The study was conducted according to the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

Authors' contributions

Concept: M.A., Design: M.A., Data Collection or Processing: M.A., Analysis or Interpretation: M.A., Literature Search: M.A., Writing: M.A.

References

1. Welbourn R, Pournaras DJ, Dixon J, Higa K, Kinsman R, Ottosson J, et al. Bariatric Surgery Worldwide: Baseline Demographic Description and One-Year Outcomes from the Second IFSO Global Registry Report 2013-2015. Obes Surg. 2018; 28(2): 313-22.
2. Bjørklund G, Semenova Y, Pivina L, Costea D-O. Follow-up after bariatric surgery: A review. Nutrition. 2020; 78: 110831.
3. Mingrone G, Panunzi S, De Gaetano A, Guidone C, Iaconelli A, Nanni G, et al. Bariatric-metabolic surgery versus conventional medical treatment in obese patients with type 2 diabetes: 5 year follow-up of an open-label, single-centre, randomised controlled trial. Lancet. 2015; 386(9997): 964-73.
4. Chang SH, Freeman NLB, Lee JA, Stoll CRT, Calhoun AJ, Eagon JC, et al. Early major complications after bariatric surgery in the USA, 2003-2014: a systematic review and meta-analysis. Obes Rev. 2018; 19(4): 529-37.
5. Livingston EH. Complications of bariatric surgery. Surgical Clinics. 2005; 85(4): 853-68.
6. Karampinis I, Lion E, Grilli M, Hetjens S, Weiss C, Vassilev G, et al. Trocar Site Hernias in Bariatric Surgery-an Underestimated Issue: a Qualitative Systematic Review and Meta-Analysis. Obes Surg. 2019; 29(3): 1049-57.
7. Üstünyurt E, Taşgöz FN, Tiğrak S. Asymptomatic trocar site hernias: An underestimated complication of laparoscopy. Turk J Obstet Gynecol. 2020; 17(3): 202-8.
8. Scozzari G, Zanini M, Cravero F, Passera R, Rebecchi F, Morino M. High incidence of trocar site hernia after laparoscopic or robotic Roux-en-Y gastric bypass. Surg Endosc. 2014; 28(10): 2890-8.
9. Rebibo L, Dhahri A, Chivot C, Cyril C, Yzet T, Regimbeau J-M. Trocar site hernia after laparoscopic sleeve gastrectomy using a specific open laparoscopy technique. Surg Obes Relat Dis. 2015; 11(4): 791-6.
10. Pilone V, Di Micco R, Hasani A, Celentano G, Monda A, Vitiello A, et al. Trocar site hernia after bariatric surgery: our experience without fascial closure. Int J Surg. 2014; 12: S83-S6.
11. Ahlqvist S, Björk D, Weisby L, Israelsson LA, Cengiz Y. Trocar Site Hernia After Gastric Bypass. Surg Technol Int. 2017; 30: 170-4.
12. Ahlqvist S, Björk D, Weisby L, Israelsson LA, Cengiz Y. Trocar Site Hernia After Gastric Bypass. Surg Technol Int. 2017; 30: 170-4.
13. Ciscar A, Badia JM, Novell F, Bolívar S, Mans E. Incidence and risk factors for trocar-site incisional hernia detected by clinical and ultrasound examination: a prospective observational study. BMC Surg. 2020; 20(1): 330.
14. Karampinis I, Lion E, Hetjens S, Vassilev G, Galata C, Reissfelder C, et al. Trocar Site HERnias After Bariatric Laparoscopic Surgery (HERBALS): A Prospective Cohort Study. Obes Surg. 2020; 30(5): 1820-6.
15. Bergemann JL, Hibbert ML, Harkins G, Narvaez J, Asato A. Omental herniation through a 3-mm umbilical trocar site: unmasking a hidden umbilical hernia. J Laparoendosc Adv Surg Tech A. 2001; 11(3): 171-3.
16. Buffone A, Lo Bianco S, Cavallaro D, Caglià P, Basile G, Cannizzaro MA. Epigastrium: unusual site of incisional hernia from a 5 mm trocar. Ann Ital Chir. 2017; 6: S2239253X17027074.
17. Ciscar A, Badia JM, Novell F, Bolívar S, Mans E. Incidence and risk factors for trocar-site incisional hernia detected by clinical and ultrasound examination: a prospective observational study. BMC Surg. 2020; 20(1): 1-7.
18. Rebibo L, Demouron M, Dembinski J, Dhahri A, Yzet T, Regimbeau JM. Impact of routine 12 mm epigastric trocar site closure on ıncisional hernia after sleeve gastrectomy: A prospective before/after study. Obes Surg. 2019; 29(11): 3500-7.
19. De Santé HA. Obésité: prise en charge chirurgicale chez l'adulte. Recommandations de bonne pratique Saint-Denis La Plaine: HAS. 2009.
20. Iranmanesh P, Rivera AR, Bajwa KS, Alibhai M, Snyder BE, Wilson TD, et al. Trocar site closure with a novel anchor-based (neoClose(®)) system versus standard suture closure: a prospective randomized controlled trial. Surg Endosc. 2020; 34(3): 1270-6.
21. Lessing Y, Pencovich N, Khatib M, Meron-Eldar S, Koriansky J, Abu-Abeid S. One-Anastomosis Gastric Bypass: First 407 Patients in 1 year. Obes Surg. 2017; 27(10): 2583-9.
22. Swank HA, Mulder IM, La Chapelle CF, Reitsma JB, Lange JF, Bemelman WA. Systematic review of trocar-site hernia. Br J Surg. 2012; 99(3): 315-23.
23. Helgstrand F, Rosenberg J, Bisgaard T. Trocar site hernia after laparoscopic surgery: A qualitative systematic review. Hernia. 2011; 15(2): 113-21.
24. Chang W-T, Yu F-J, Hsieh M-Y, Huang M-C, Lee K-T, Chen J-S, et al. Laparoscopic cholecystectomy in aged patients. Hepatogastroenterology. 2009; 56(93): 950-5.
25. Ahlqvist S, Edling A, Alm M, Dackhammar JB, Nordin P, Cengiz Y. Trocar site hernia after gastric sleeve. Surg Endosc. 2022; 36(6): 4386-91.
26. Coblijn UK, De Raaff CA, Van Wagensveld BA, Van Tets WF, De Castro SM. Trocar port hernias after bariatric surgery. Obes Surg. 2016; 26(3): 546-51.
27. Raziel A, Goitein D, Sakran N, editors. Safety and Effectiveness of One Anastomosis Gastric Bypass. Obes Surg; 2018: Springer 233 Spring St, New York, NY 10013 USA.
28. Durmus A, Mutlu T, editors. Should Trocar-Site Be Closed Routinely After Laparoscopic Sleeve Gastrectomy; Teaching Of 10 Years' Experience. Obes Surg; 2018: Springer 233 Spring St, New York, NY 10013 USA.
29. Santoro S, Klajner S, Sampaio R. Sleeve gastrectomy and transit bipartition. Obesity and Diabetes: Springer; 2015, p. 89-110.
30. Chiu C-C, Lee W-J, Wang W, Wei P-L, Huang M-T. Prevention of trocar-wound hernia in laparoscopic bariatric operations. Obes Surg. 2006; 16(7): 913-8.

31. Zhu Y-P, Liang S, Zhu L, Sun Z-J, Lang J-H. Trocar-site hernia after gynecological laparoscopic surgery: a 20-year, single-center experience. Chin Med J. 2019; 132(22): 2677-83.

32. Comajuncosas J, Hermoso J, Gris P, Jimeno J, Orbeal R, Vallverdú H, et al. Risk factors for umbilical trocar site incisional hernia in laparoscopic cholecystectomy: a prospective 3-year follow-up study. Am J Surg. 2014; 207(1): 1-6.

33. Beyene RT, Derryberry SL, Barbul A. The effect of comorbidities on wound healing. Surg Clin North Am. 2020; 100(4): 695-705.

34. Mohammed Y, Aly F, Lee W-J. trocar site hernia prevention in laparoscopic bariatric surgery. Obes Surg. 2016; 26(9): 2227.