DOI: 10.14739/mmt.2024.1.298490 Оригінальні дослідження / Original research
UDC 616.33-056.257-072.1-089.87-089.84-039.71

Prevention of the stapler line leak after laparoscopic sleeve gastrectomy in patients with morbid obesity

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

Keywords:
staple line leak, surgical stapler, gastrectomy, morbid obesity.

Ключові слова:
неспроможність, степлер, рукавна резекція шлунка, морбідне ожиріння.

Надійшла до редакції / Received: 20.11.2023

Після доопрацювання / Revised: 15.12.2023

Схвалено до друку / Accepted: 09.01.2024

Конфлікт інтересів:
відсутній.

Conflicts of interest:
authors have no conflict of interest to declare.

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Obesity has become a global pandemic, leading to increased morbidity and mortality among patients, both young and old. Bariatric surgery is the most effective method for treating pathological obesity. Laparoscopic sleeve gastrectomy has become the most popular bariatric procedure worldwide.

However, staple line leak is the most dreaded postoperative complication following laparoscopic sleeve gastrectomy. In order to reduce the incidence of this complication, most surgeons prefer to reinforce the staple line. However, there is no compelling evidence to suggest that peritonealization of the staple line or the use of coated stapler cartridges during laparoscopic sleeve gastrectomy reduces the risk of leakage. Therefore, we conducted a retrospective analysis to assess the impact of coated stapler cartridges on preventing staple line leaks.

The aim of the study. To evaluate the effect of using stapler with coating on preventing staple line leaks during laparoscopic sleeve gastrectomy in patients with morbid obesity.

Materials and methods. This was a retrospective analysis of 45 patients who underwent laparoscopic sleeve gastrectomy using endostapler from Medtronic (Endo GIA™) without additional reinforcement (Group I) and 46 patients who underwent a similar procedure using endostapler from Medtronic (Endo GIA™) stapler with coating (Group II). Both patient groups were homogeneous in terms of demographic characteristics. We compared the duration of surgery, intraoperative blood loss, length of hospital stay, and the incidence of staple line leak.

Results. The incidence of staple line leak was statistically significantly higher in Group I compared to Group II (5/40 vs. 0/46; $\chi^2 = 5.4$, $p = 0.021$). This resulted in a statistically significant increase in blood loss ($U = 706$; $p = 0.006$), prolonged total operation time ($U = 310$; $p = 0.001$), and extended postoperative hospital stay ($U = 245$; $p = 0.001$) in Group I. The median time to healing of the leak was 32 [20; 59] days. No patient died.

Conclusions. Using the endostapler with purple cartridges with coating from Medtronic during laparoscopic sleeve gastrectomy significantly reduced postoperative leak rate and significantly decreased postoperative hospital stay.

Modern medical technology. 2024;(1):26-31

Профілактика неспроможності лінії степлерного шва при виконанні лапароскопічної рукавної резекції шлунка у пацієнтів із морбідним ожирінням

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Ожиріння стало всесвітньою пандемією, яка призвела до збільшення захворюваності, смертності і серед молодих пацієнтів, і серед хворих похилого віку. Баріатрична хірургія є найефективнішим методом лікування патологічного ожиріння. Лапароскопічна рукавна резекція шлунка стала найпопулярнішою баріатричною операцією в усьому світі.

Неспроможність лінії степлерного шва – найскладніше післяопераційне ускладнення після лапароскопічної рукавної резекції шлунка. Для зменшення поширеності цього ускладнення більшість хірургів вживають заходів з додаткового захисту лінії степлерного шва. Проте немає переконливих доказів, що перитонізація лінії степлерного шва або використання касет із покриттям при виконанні лапароскопічної рукавної резекції шлунка зменшує рівень неспроможності. Відтак здійснили ретроспективний аналіз, щоб оцінити вплив касет із покриттям на запобігання неспроможності лінії степлерного шва.

Мета роботи – оцінити вплив використання касет із покриттям на профілактику розвитку неспроможності лінії степлерного шва при виконанні лапароскопічної рукавної резекції шлунка у пацієнтів із морбідним ожирінням.

Матеріали і методи. Виконали ретроспективний аналіз 45 пацієнтів, яким здійснили лапароскопічну рукавну резекцію шлунка за допомогою ендоскопічного степлера фірми Medtronic (Endo GIA™) без додаткового захисту (група I), і 46 пацієнтів, яким виконано аналогічну операцію за допомогою ендоскопічного степлера фірми Medtronic (Endo GIA™) із покриттям (група II). Групи пацієнтів зіставні за демографічними

показниками. Порівнювали тривалість операції, інтраопераційну крововтрату, тривалість перебування в стаціонарі та рівень неспроможності.

Результати. Рівень неспроможності лінії степлерного шва статистично достовірно вищий у групі I порівняно із групою II (5/40 порівняно з 0/46; $\chi^2 = 5,4$, p = 0,021). Це призвело до статистично значущого збільшення об'єму крововтрати (U = 706; p = 0.006), подовження загальної тривалості операції (U = 310; p = 0,001) та пролонгації післяопераційного перебування у стаціонарі (U = 245; p = 0.001) у групі I. Медіана часу загоєння неспроможності становила 32 [20; 59] дні. Жоден пацієнт не помер.

Висновки. Використання касет із покриттям фірми Medtronic дає змогу статистично достовірно запобігти розвитку неспроможності лінії степлерного шва при виконанні лапароскопічної рукавної резекції шлунка та скоротити термін перебування пацієнтів у стаціонарі.

Сучасні медичні технології. 2024. № 1(60). С. 26-31

According to the World Health Organization, obesity has long become a global epidemic that affects people regardless of age, gender, race, or geographical location. Excess weight is a key factor in the development of insulin resistance and, subsequently, Type 2 diabetes. In addition, obesity associated with metabolic syndrome exacerbates the course of musculoskeletal, cardiovascular, respiratory, digestive, and reproductive system disorders [1].

Numerous meta-analyses and randomized clinical trials have demonstrated the advantages of bariatric surgery over conservative methods for treating obesity and its associated metabolic disorders [2,3].

Bariatric surgery has made a profound breakthrough in the last decade, and its popularity continues to grow with each passing year. This is evident from the increasing number of surgeries performed on every continent. For instance, in 2003, there were 146,000 such surgeries performed worldwide, but by 2016, this number had exceeded 685,000. Among the wide spectrum of bariatric procedures, laparoscopic sleeve gastrectomy (LSG) has confidently taken the lead as the most frequently performed bariatric operation globally [4]. A substantial body of literature attests to its effectiveness and safety in both the early and late postoperative periods, providing sustained and long-term weight loss and the mitigation of associated metabolic disorders, notably Type 2 diabetes [2,3].

Despite the positive outcomes in terms of reducing excess weight and managing obesity-related comorbidities, like all surgical procedures, it is not without its risks and complications.

One of the most serious early complications in the perioperative period is staple line leak (SLL). Although the literature reports varying incidence rates of SLL ranging from 0.7 % to 6.9 %, the mortality in this group of patients can reach up to 60 % [5].

Numerous publications in the literature discuss methods for preventing complications following LSG in the perioperative period. However, there is still no standardized approach to the optimal methodology for prevention.

Aim

The aim of the research is to evaluate the effect of using stapler with coating on preventing staple line leaks during laparoscopic sleeve gastrectomy in patients with morbid obesity.

Materials and methods

This retrospective study was based on the analysis of treatment outcomes in 91 patients who underwent LSG.

Inclusion criteria were as follows: patients aged 19 to 70 years, body mass index (BMI) ranging from 35 to 70 kg/m^2 and obtained written consent for data processing.

Exclusion criteria included: patients who underwent simultaneous surgery; LSG performed through open access; revisional sleeve gastrectomy following a previously performed bariatric surgery.

The patients included in this study were divided into two groups based on the type of cartridges used with endoscopic linear stapler device from Medtronic during the resection phase of LSG. The first group consisted of 45 patients who had used cartridges without additional reinforcement during the resection phase. The second group included 46 patients who used purple cartridges with stapler with coating with polyglycolide during the same phase of the operation.

In addition to age and gender, the following anthropometric parameters were assessed: body weight (kg), BMI (kg/m^2), and excess body weight (kg). The physical status of the patients was evaluated using the ASA classification.

The results of the surgical treatment were assessed based on the following criteria: duration of the operation, volume of blood loss, incidence of SLL, and length of hospital stay after the surgery.

The technique for performing LSG in both study groups was similar, except for the resection phase. The surgery was carried out following the traditional arrangement of trocars. After establishing pneumoperitoneum, the first step involved mobilization of the stomach. Using an electrosurgical instrument, LigaSure, with a 12 mm (36 Fr) calibrating probe, mobilization of the greater curvature and the fundus of the stomach was performed, including the electric ligation of the right and left gastroepiploic vessels, short gastric vessels, and the posterior gastric artery, with mandatory division of the gastrodiaphragmatic ligament and visualization of the left diaphragmatic crus. The latter serves as a criterion for the adequacy of mobilization in the fundus area. The initial level of mobilization along the greater curvature was located at a distance of 4 cm from the gastroesophageal junction. Afterward, the calibrating probe was passed into the duodenum and positioned along the lesser curvature. In the first group, the sequential vertical resection of the stomach was performed using the endoscopic linear

Table 1. Characteristics of patients included in this research

Indicator, units of measurement	M ± SD [min; max]
Age, years	40.6 ± 11.6 [19; 67]
Gender (male/female)	49/42
Body weight, kg	146.1 ± 27.5 [100; 240]
BMI, kg/m^2	48.4 ± 7.7 [37; 70]
Overweight, kg	78.6 ± 23.4 [43.0; 154.2]
Comorbidities, n (%)	
Type 2 diabetes mellitus	36 (39.6 %)
Arterial hypertension	71 (78 %)
Non-alcoholic fatty liver disease	62 (68.1 %)
Dyslipidemia	73 (80.2 %)
Obstructive sleep apnea syndrome	66 (72.5 %)

stapler device from Medtronic with cartridges without additional reinforcement. In the second group, a similar procedure was performed, but the resection phase was carried out using the endostapler device with purple cartridges coated with polyglycolide from Medtronic. The stomach resection was performed on a 12 mm (36 Fr) calibrating probe, starting from a point 4 cm from the pylorus (the initial point of mobilization) to the angle of His. This was done to ensure a stomach tube width of 2 cm and a controlled 1 cm distance of the staple line from the esophagogastric junction. The resection phase was conducted with the condition of moderate lateral traction by an assistant along the greater curvature of the stomach strictly along the line of its mobilization.

In the first group, the staple line was peritonized on the calibration probe with a continuous serosa-to-serosa suture. In the second group, peritonealization was not performed. During the surgery, a leak test was conducted for each patient using a methylene blue solution through a nasogastric tube, and the operation was completed with abdominal cavity drainage.

Statistical data analysis was conducted using methods of descriptive and inferential statistics with the SPSS Statistics software, version 23, by IBM. Before beginning data analysis, all variables were checked for normal distribution using the Shapiro–Wilk test and for homogeneity of variances using the Levene's test. In this study, descriptive statistical measures such as the mean (M) and standard deviation (SD) were used for normally distributed data, and the median (Me) and interquartile range [Q1; Q3] were used for non-normally distributed data. Statistically significant differences between relative indicators were assessed using the Pearson χ^2- (chi-squared) test with Yates' correction and two-tailed Fisher's exact test.

To assess statistically significant differences in the means of quantitative variables that follow a normal distribution, parametric methods were applied for independent groups, such as the Student's t-test. For non-normally distributed data, the significance of differences in means between two independent groups was assessed using non-parametric methods, specifically the Mann–Whitney U test. Differences in results were considered statistically significant at $p < 0.05$, which provides a 95 % confidence level.

Results

The characteristics of anthropometric parameters and comorbidities of the 91 patients included in this study are presented in *Table 1*.

The age of patients in the first group ranged from 20 to 64 (median 35 [26.5; 46.0] years), while in the second group, it ranged from 19 to 67 (median 44 years [35.5; 51.0] years). Patients in the first group were statistically significantly younger compared to patients in the second group ($U = 692.5$; $p = 0.007$).

The gender distribution in the first group was 20 males and 25 females, while in the second group, it was 29 males and 17 females. This distribution was the same in both study groups ($\chi^2 = 3.16$, $p = 0.08$). The median body weight in the first group was 130 [124; 156] kg, which was slightly lower compared to the median body weight of patients in the second group, which was 153 [125.8; 174.5] kg ($U = 777$; $p = 0.04$). However, there was no statistically significant difference in BMI and excess body weight between the two groups. In the first group, the median BMI was 45.6 [41.1; 50.3] kg/m^2, and in the second group, it was 47.75 [42.90; 56.70] kg/m^2 ($U = 792.5$; $p = 0.058$). The median excess body weight in the first group was 68.0 [58.5; 84.5] kg, and in the second group, it was 73 [59.0; 92.6] kg ($U = 796$; $p = 0.06$).

Despite the fact that patients in the first group were younger than those in the second group, when analyzing the frequency distribution of patients based on the nature of comorbidities and physical status (ASA), no statistically significant differences were observed between the groups ($p > 0.05$). In all patients, the resection phase of the surgery was performed using endoscopic linear stapling devices from Medtronic. In the first group, cassettes without additional protection were used, while in the second group, cassettes with coating were used. There was no statistically significant difference in the number of cassettes used during the operation, as the average value in the first group

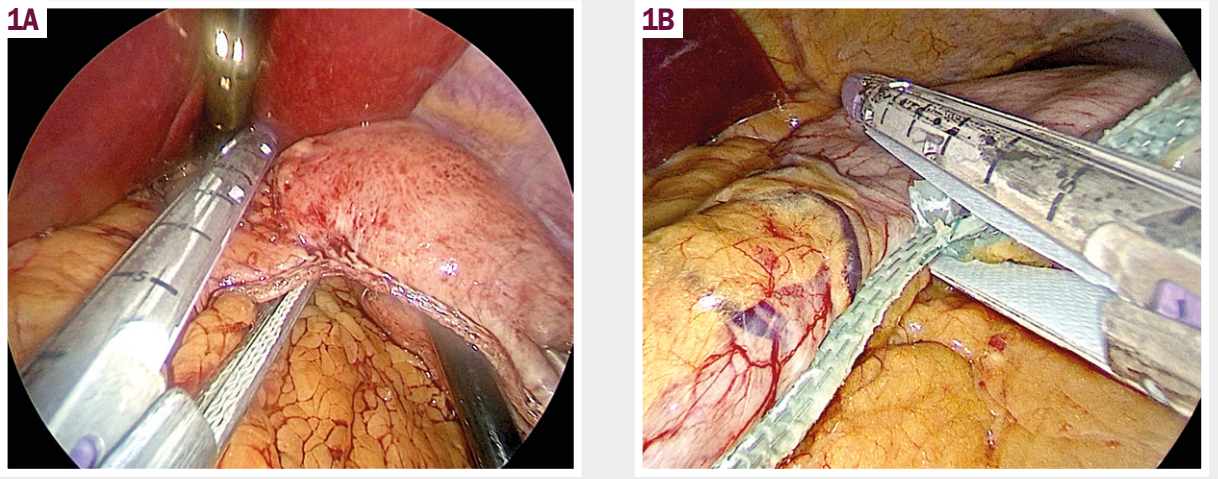

Fig. 1. Intraoperative view of the methods of the sequential vertical resection of the stomach. **A:** The endostapler device from Medtronic with cartridges without additional reinforcement; **B:** The endostapler device with the purple cartridges with coating polyglycolide from Medtronic.

was 6.7 ± 0.9 pieces, and in the second group, it was 6.5 ± 0.7 pieces (t = 0.87; p = 0.38).

In all patients in the first group, the entire line of the stapler seam was additionally peritonealized with a continuous sero-serosal suture. In the second group, due to the use of the purple cartridges with coating, peritonealization was not performed in any case. This, in turn, led to a statistically significant reduction in the duration of the operation. The median duration of the operation in the first group was 135 [125; 140] minutes, while in the second group, it was 125 [105; 135] minutes (U = 310; p = 0.001).

The methods of the sequential vertical resection of the stomach are shown in *Fig. 1*.

Although clinically not significant, a statistically significantly higher blood loss was reported in patients in the first group. The median blood loss in the first group was 200 [100; 300] ml, while in the second group, this indicator was 200 [100; 200] ml (U = 706; p = 0.006).

The management strategy for patients in the postoperative period was the same. Enteral nutrition was started from the first postoperative day, and the volume of infusion therapy, antibiotics, and thromboprophylaxis were carried out according to the protocol of fast recovery after laparoscopic Roux-en-Y gastric bypass (LRYGB).

Incapacity of the stapler line occurred in 5 patients in the first group, while among patients in the second group, there were no cases of this complication. The use of cassettes with coating significantly reduces the likelihood of developing anastomotic leakage (p = 0.026).

Four patients from the first group who developed anastomotic leakage underwent repeated surgery for abdominal cavity sanitation, and three of them additionally underwent endoscopic stent placement in the gastric tube. This, in turn, led to a statistically significant prolongation of hospital stay. Thus, the median length of stay in the first group was 8 [7; 9] days, while in the second group, the corresponding indicator was 5 [4; 6] days (U = 245; p = 0.001).

The SLL healed in all patients with conservative therapy, with the median healing time of 32 [20; 59] days, ranging from 10 to 83 days. There were no fatalities among the patients included in this study.

Discussion

Starting from 2014, LRYGB has become one of the most widely performed bariatric procedures. While in 2011, it accounted for only 17.8 % of all bariatric surgeries, by 2018, this figure had risen to 61.4 % [4].

However, like all surgical interventions, LRYGB is not without complications in the postoperative period. One of the life-threatening complications for patients is SLL. In the early stages of the technique's development, studies reported SLL rates reaching 6.9 % [6].

Although the publication of the latest consensus summit, during which every stage of the operation and all key moments that could influence the development of SLL were analyzed, has led to a reduction in the SLL rate, recent data still indicate an average incidence of 1.35 % [7,8].

On modern forums, the etiology and pathogenesis of SLL remain topics for discussion. This is supported by numerous publications dedicated to this issue [9]. For example, T. Delko and colleagues, in their work, intraoperatively analyzed the microperfusion of the stomach wall during LRYGB. The authors found that microperfusion in the upper third of the stomach was significantly lower than in other regions [10]. The obtained results may explain the ischemic theory of SLL development, especially in cases of excessive devascularization of the stomach wall during mobilization at the gastroesophageal junction.

Among other factors that can influence the development of SLL, there are mechanical factors directly related to the technical execution of LRYGB. One of the key elements in the successful execution of LRYGB is the choice of cartridges with an optimal staple height. It has already been proven that the thickness of

the stomach wall differs in various sections and can also depend on gender and BMI [9]. This is evidenced by numerous studies that have focused on the role of stomach wall thickness in the development of SLL. For instance, in their research, C. Boeker and colleagues found that stomach wall thickness can influence the occurrence of SLL [11]. Therefore, the modern medical industry has developed endoscopic staplers with cartridges of varying staple heights. It is objectively challenging to determine stomach wall thickness during surgery, and it can only be reliably assessed using endoscopic sonographic examination. However, the choice of cartridge before stapling typically relies on the surgeon's subjective assessment of stomach wall thickness and their experience.

During LRYGB, green cartridges (staple depth of 4.8 mm) are typically used for the first two to three firings, followed by blue cartridges (3.5 mm). For example, in their study, Q. Sun and colleagues analyzed the treatment results of patients after laparoscopic low anterior resection of the rectum, depending on the type of cartridges used to form the anastomosis. The authors found that the use of stapler with coating statistically significantly reduced the incidence of colorectal anastomotic insufficiency ($p < 0.05$) [12].

Nevertheless, despite the optimal selection of cartridges for stapling during LRYGB, most surgeons tend to use additional reinforcement of the staple line to prevent insufficiency and bleeding. According to a consensus statement published in 2021, which was based on a survey of leading bariatric surgeons worldwide, the majority of respondents prefer additional reinforcement of the staple line. However, none of the currently available reinforcement techniques have sufficient evidence regarding the prevention of SLL [13].

At the same time, there are publications in the literature in which authors, through their own standardized experience in performing LRYGB and adhering to a unified protocol for postoperative patient management, have managed to minimize complications without additional reinforcement of the staple line. Even by implementing early enteral nutrition and avoiding nasogastric decompression of the gastric tube in patients after LRYGB, it is possible to reduce the incidence of SLL [14,15]. Similar results were obtained by W. Lynn and colleagues, who published their experience based on the treatment of 303 patients. By using their own tactical and technical aspects of the surgery and adhering to a patient management protocol, they successfully avoided SLL, and none of the patients experienced this complication [16].

Common methods of SLL prevention include peritonization of the staple line, treatment of the staple line with adhesive mixtures (based on fibrin and cyanoacrylate), and the use of protective plates made of absorbable and non-absorbable materials [9].

One of the most common methods of protection is peritonization of the staple line. For example, G. Özgen and colleagues published the results of using this prevention method in 1008 patients undergoing LRYGB. SLL occurred in 1 patient, which amounted to 0.1 %. However, it is noteworthy that there was a relatively high rate of gastric tube strictures in 17 (1.7 %) patients [17].

In contrast, H. Wang and colleagues obtained different results. They published a meta-analysis examining the utility of peritonization of the staple line in LRYGB. This meta-analysis included 7 randomized clinical trials involving 845 patients. The authors concluded that peritonization of the staple line increases the duration of the surgical procedure and does not affect the risk of SLL (RR: 0.650, 95 % CI: 0.257–1.644, $p = 0.363$) [18]. Similar results were obtained in our study, where the duration of the operation in the group of patients who underwent peritonization was significantly longer ($U = 310$; $p = 0.001$).

Initially, adhesive mixtures were used in herniology to fix mesh prostheses. However, over time, they began to be increasingly used for preventing SLL in gastrointestinal surgery, including bariatric procedures. For example, G. Martines and colleagues published the results of comparing the use of cyanoacrylate-based glue to protect the staple line in LRYGB with a group of patients who did not receive additional protection for the staple line. In the first group (treated with glue), no cases of SLL were observed, while in the second group, insufficiency occurred in 2 (3.6 %) patients. However, according to the results of this study, this difference did not reach statistical significance [19]. Similar results were obtained by D. E. Bellanger and colleagues, who published the outcomes of treating 529 patients after LRYGB. Due to the use of fibrin glue to seal the staple line, no cases of SLL were reported [20].

At the same time, S. Carandina and colleagues came to a slightly different conclusion based on their own randomized clinical trial. This study included 600 patients who were divided according to the method of additional protection for the staple line (150 patients in each group). In the first group, no additional protection was used; in the second group, fibrin glue was used; in the third group, peritoneal closure with MonocrylTM suture was performed, and in the fourth group, peritoneal closure with V-LocTM suture was performed. Cases of SLL were observed in all groups: in the first group (no protection) – in 3 (2 %) patients, in the second group (glue) – in 4 (2.6 %) patients, in the third group (MonocrylTM) – in 3 (2 %) patients, and in the fourth group (V-LocTM) – in 4 (2.6 %) patients. This difference did not reach statistical significance ($p = 0.96$). Similarly, the rates of bleeding and stenosis did not reach statistical significance ($p > 0.05$) [21].

In order to provide additional protection to the staple line, the medical industry began developing coatings (membranes) for cartridges that were intended to prevent complications in the postoperative period. However, not all membranes have give the expected satisfactory results. For instance, M. Gagner and colleagues conducted a systematic review based on 148 studies, including 40,653 patients, to analyze the effectiveness of various methods for protecting the staple line during LRYGB. The first group (no additional protection) included 16,632 patients, the second group (peritoneal closure) included 18,314 patients, the third group (bovine pericardial coverage) included 1,244 patients, the fourth group (glue) included 363 patients, and the fifth group (absorbable polymer membrane) included 4,100 patients. The rate of SLL was highest in the third group (2.7 %), where bovine pericardial coverage was used. The lowest rate (0.7 %) was observed when using the absorbable polymer membrane [22].

Taking into account our own experience and numerous publications, additional protection of the staple line allows for a reduction in the rate of SLL. In our opinion, the most effective method for preventing SLL is the use of purple cartridges with coating. In our study, the use of these cartridges prevented the development of SLL in all patients in the second group.

Conclusions

1. Laparoscopic sleeve gastrectomy has proven to be a safe and effective primary weight loss operation. Still, complications remain the primary concern after this intervention.

2. Staple line leak is the most dreaded postoperative complication following laparoscopic sleeve gastrectomy.

3. The use of cartridges with coating statistically significantly prevents the development of staple line leak during laparoscopic sleeve gastrectomy and reduces the length of hospital stay for patients.

Funding

The study was done according to the scientific research work of the State Scientific Institution "Center for Innovative Medical Technologies of the National Academy of Sciences of Ukraine" on topic "Comprehensive development of innovative minimally invasive techniques in surgery with use in practical and educational programs", state registration № 0120U105160 (2021–2023).

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References

1. World Health Organization. Obesity and overweight [updated 2021 Jun 9; cited 2024 Jan 2]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
2. Cheng J, Gao J, Shuai X, Wang G, Tao K. The comprehensive summary of surgical versus non-surgical treatment for obesity: a systematic review and meta-analysis of randomized controlled trials. Oncotarget. 2016;7(26):39216-30. doi: 10.18632/oncotarget.9581
3. Gloy VL, Briel M, Bhatt DL, Kashyap SR, Schauer PR, Mingrone G, et al. Bariatric surgery versus non-surgical treatment for obesity: a systematic review and meta-analysis of randomised controlled trials. BMJ. 2013;347:f5934. doi: 10.1136/bmj.f5934
4. Angrisani L, Santonicola A, Iovino P, Vitiello A, Higa K, Himpens J, et al. IFSO Worldwide Survey 2016: Primary, Endoluminal, and Revisional Procedures. Obes Surg. 2018;28(12):3783-94. doi: 10.1007/s11695-018-3450-2
5. Aurora AR, Khaitan L, Saber AA. Sleeve gastrectomy and the risk of leak: a systematic analysis of 4,888 patients. Surg Endosc. 2012;26(6):1509-15. doi: 10.1007/s00464-011-2085-3
6. Stroh C, Birk D, Flade-Kuthe R, Frenken M, Herbig B, Höhne S, et al. Results of sleeve gastrectomy-data from a nationwide survey on bariatric surgery in Germany. Obes Surg. 2009;19(5):632-40. doi: 10.1007/s11695-009-9801-2
7. Hughes D, Hughes I, Khanna A. Management of staple line leaks Following Sleeve Gastrectomy-a Systematic Review. Obes Surg. 2019;29(9):2759-72. doi: 10.1007/s11695-019-03896-3
8. Gagner M, Hutchinson C, Rosenthal R. Fifth International Consensus Conference: current status of sleeve gastrectomy. Surg Obes Relat Dis. 2016;12(4):750-6. doi: 10.1016/j.soard.2016.01.022
9. Iossa A, Abdelgawad M, Watkins BM, Silecchia G. Leaks after laparoscopic sleeve gastrectomy: overview of pathogenesis and risk factors. Langenbecks Arch Surg. 2016;401(6):757-66. doi: 10.1007/s00423-016-1464-6
10. Delko T, Hoffmann H, Kraljević M, Droeser RA, Rothwell L, Oertli D, et al. Intraoperative Patterns of Gastric Microperfusion During Laparoscopic Sleeve Gastrectomy. Obes Surg. 2017;27(4):926-32. doi: 10.1007/s11695-016-2386-7
11. Boeker C, Mall J, Reetz C, Yamac K, Wilkens L, Stroh C, et al. Laparoscopic Sleeve Gastrectomy: Investigation of Fundus Wall Thickness and Staple Height-an Observational Cohort Study : Fundus Wall Thickness and Leaks. Obes Surg. 2017;27(12):3209-14. doi: 10.1007/s11695-017-2755-x
12. Sun Q, Wang A, Wei S, Huang Y, Lu H, Hu Z, et al. Short-Term Outcomes of Tri-Staple Versus Universal Staple in Laparoscopic Anterior Resection of Rectal and Distal Sigmoid Colonic Cancer: A Matched-Pair Analysis. World J Surg. 2022;46(11):2817-24. doi: 10.1007/s00268-022-06704-9
13. Mahawar KK, Omar I, Singhal R, Aggarwal S, Allouch MI, Alsabah SK, et al. The first modified Delphi consensus statement on sleeve gastrectomy. Surg Endosc. 2021;35(12):7027-33. doi: 10.1007/s00464-020-08216-w
14. Kalashnikov OO, Usenko OY, Todurov IM, Plehutsaet OI. [Gastric decompression in patients after laparoscopy sleeve gastrectomy]. Fiziol Zh. 2023;69(2):44-51. Ukrainian. doi: 10.15407/fz69.02.044
15. Kalashnikov OO. Early enteral nutrition in patients after laparoscopy sleeve gastrectomy. Bulletin of problems in biology and medicine. 2023;(1):176-86. doi: 10.29254/2077-4214-2023-1-168-176-186
16. Lynn W, Ilczyszyn A, Aguilo R, Agrawal S. Standardised Sleeve Gastrectomy Without Reinforcement. JSLS. 2018;22(3):e2018.00015. doi: 10.4293/JSLS.2018.00015
17. Özgen G, Çalıkoğlu İ, Acunaş B, Yerdel MA. Staple-line reinforcement using barbed sutures in 1008 sleeve gastrectomies. Langenbecks Arch Surg. 2021;406(5):1683-90. doi: 10.1007/s00423-021-02161-5
18. Wang H, Lu J, Feng J, Wang Z. Staple line oversewing during laparoscopic sleeve gastrectomy. Ann R Coll Surg Engl. 2017;99(7):509-14. doi: 10.1308/rcsann.2017.0074
19. Martines G, Tomasicchio G, Picciariello A, Dibra R, Trigiante G, Lantone G, et al. Staple line reinforcement with nebulized cyanoacrylate glue in laparoscopic sleeve gastrectomy: A propensity score-matched study. Open Med (Wars). 2022;17(1):197-204. doi: 10.1515/med-2022-0426
20. Bellanger DE, Greenway FL. Laparoscopic sleeve gastrectomy, 529 cases without a leak: short-term results and technical considerations. Obes Surg. 2011;21(2):146-50. doi: 10.1007/s11695-010-0320-y
21. Carandina S, Tabbara M, Bossi M, Valenti A, Polliand C, Genser L, et al. Staple Line Reinforcement During Laparoscopic Sleeve Gastrectomy: Absorbable Monofilament, Barbed Suture, Fibrin Glue, or Nothing? Results of a Prospective Randomized Study. J Gastrointest Surg. 2016;20(2):361-6. doi: 10.1007/s11605-015-2999-5
22. Gagner M, Kemmeter P. Comparison of laparoscopic sleeve gastrectomy leak rates in five staple-line reinforcement options: a systematic review. Surg Endosc. 2020;34(1):396-407. doi: 10.1007/s00464-019-06782-2