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# The effect of laparoscopic sleeve gastrectomy on metabolic syndrome parameters during one year of follow-up

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ABSTRACT

Objective: We aimed to evaluate the effectiveness of laparoscopic sleeve gastrectomy (LSG) as a treatment method for morbid obesity and its impact on reducing the incidence of metabolic syndrome and its components.

Patients and Methods: This retrospective and a single-center study included patients with obesity who underwent LSG and were followed up at an endocrinology and metabolism outpatient clinic for at least one year. Anthropometric measurements, blood pressure, and blood examinations including fasting plasma glucose and lipid profile were assessed before the surgery and one year after the surgery. The presence of metabolic syndrome and related comorbidities was documented.

Results: The study included 62 patients, with a mean age of 38.2 ± 8 years and a female predominance (88.7%). At one year post-surgery, significant improvements were observed in body weight, waist circumference, blood pressure, and metabolic parameters (P<0.001 for all). The prevalence of metabolic syndrome decreased from 66.1% to 6.5% (P<0.001). The prevalence of diabetes, hypertension, and hepatosteatosis also decreased significantly (P<0.05).

Conclusion: Laparoscopic sleeve gastrectomy demonstrates substantial weight loss and positive effects on metabolic syndrome components. The procedure appears to be an effective intervention for obese patients with obesity-related comorbidities. Longer-term prospective studies are needed to further validate these promising results.

Keywords: Obesity, Bariatric surgery, Metabolic syndrome

## 1. INTRODUCTION

Obesity, with its multifactorial nature and complex pathogenesis, is notably recognized as a major risk factor for cardiometabolic diseases [1,2].

The widespread adoption of technological advancements and Western lifestyles, the shift towards high-calorie diets combined with a decrease in physical activity and the transition from rural to modern urban living have all contributed to a global rise in obesity prevalance across all age groups [3].

The most recent epidemiological findings reveal concerning patterns, with over 30% of the global population currently classified as overweight or obese. Based on the observed increase in obesity rates, projections suggest that approximately 38% of the population will be overweight and an additional 20% will be obese by the year 2030 [4].

Contemporary medical understanding views obesity not merely as a standalone condition but also as a component and a catalyst of metabolic syndrome, as outlined in the American Heart Association and the National Heart, Lung, and Blood Institute (AHA-NHLBI) joint consensus report of 2009 [5]. Metabolic syndrome is considered a pandemic affecting approximately 20% to 30% of the adult population in many countries, and it is frequently associated with obesity [6]. In our country, the prevalence of metabolic syndrome in the general population has been reported to be 32.9% [7].

Obesity treatment involves employing diverse methods, including diet, exercise, behavioral therapy, medical interventions, and bariatric/metabolic surgery. As obesity is a significant risk factor for cardiometabolic comorbidities such

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as diabetes, hypertension, and coronary artery disease, the methods used in obesity treatment should not only lead to anthropometric improvements but also provide benefits for these comorbidities. One of the bariatric surgery techniques, laparoscopic sleeve gastrectomy (LSG) has shown to be effective in achieving lasting weight loss and improving obesity-related comorbidities [8]. In this study, we aimed to compare the anthropometric measurements and metabolic parameters of obese patients who underwent LSG before the surgery and one year after the procedure.

## 2. PATIENTS and METHODS

### *Study population*

This is a single-center, cross-sectional, and retrospective study conducted on patients who were under follow-up in the endocrinology and metabolism department of our hospital and underwent LSG between January 2018 and January 2022 with a body mass index (BMI) over 40 kg/m², or a BMI between 35 and 40 kg/m² with serious comorbidities, according to the International Federation for the Surgery of Obesity (IFSO) criterion [9].

Patients between the ages of 18 and 65 years who attended regular appointments at our endocrinology and metabolism outpatient clinic for at least 6 months before the surgery and at the 12th months after the surgery were included in the study.

Patients under the age of 18 and over the age of 65, those who did not attend regular appointments at the endocrinology and metabolism outpatient clinic beyond the postoperative 1-year follow-up period, individuals using medications that could affect body weight and metabolic parameters during this time, patients with newly diagnoed endocrinological diseases, and those with incomplete anthropometric measurements or missing information about metabolic parameters in their medical records were excluded from the study.

The study was conducted in accordance with ethical principles outlined in the Helsinki Declaration with the approval of the local ethics committee (Number: 2022/0617). The study protocol ensured the confidentiality of patient information.

### *Clinical assessment*

The data of the participants included in the study were collected through a retrospective examination of the hospital's central information system, e-nabız (electronic health records system), and patient files.

During the pre – and post-operative appointments at the endocrinology and metabolism clinic, each participant responded to a standardized questionnaire, providing details about their sociodemographic background, personal and family medical history (including hypertension, diabetes, coronary artery disease, and hyperlipidemia), and smoking habits.

The participants' height (in centimeters) and weight (in kilograms) were measured using a height scale and weight machine (SECA 799+220, seca GmbH & Co, Germany). The BMI was calculated using the formula: weight in kilograms divided by height in meters squared. Waist circumference was measured with a non-flexible measuring tape at the narrowest point of the abdomen between the lower part of the last rib and the top of the hip at the end of expiration, while hip circumference was measured at the widest part of the hips.

Laboratory examinations were performed after 8-12 hours of overnight fasting, including triglycerides, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, hemoglobin A1C (HbA1C), and thyroid function tests, using the American AU480 automatic biochemical analyzer.

Blood pressure was measured using an electronic sphygmomanometer (HEM-7155, Omron, Japan), after the patients rested for 5-10 minutes.

Individuals with and without metabolic syndrome were identified based on the criteria outlined in The US National Cholesterol Education Programme Adult Treatment Panel III (NCEP-ATP III) [10]. Diagnoses of hypertension, diabetes mellitus, hyperlipidemia, and hepatosteatosis were also documented.

### *Liver imaging*

Before the surgical procedure and at the 12 months post-surgery, an abdominal ultrasound (US) was performed. Hepatosteatosis in the US was classified using the following grading system:

Grade 1 (mild): A slight and diffuse increase in liver echogenicity with normal visualization of the diaphragm and portal vein wall.

Grade 2 (moderate): A moderate increase in liver echogenicity with slightly impaired appearance of the portal vein wall and the diaphragm.

Grade 3 (severe): Marked increase in liver echogenicity with poor or no visualization of the portal vein wall, diaphragm, and posterior part of the right liver lobe.

### Statistical Analysis

Statistical Package for Social Sciences (SPSS) 28.0 software was used for all the analyses. Descriptive statistics of the characteristics measured in the study participants were tabulated as mean, standard deviation (SD), number and % frequencies. The compatibility of the numerical characteristics with the normal distribution was examined with the Kolmogorov-Smirnov test. For the analysis of dependent quantitative data, paired sample t-tests and Wilcoxon tests were used. The McNemar test was used for the analysis of dependent qualitative data. $P<0.05$ was considered statistically significant.

## 3. RESULTS

In this study, we conducted a retrospective review of 144 patients with obesity who underwent LSG surgery at our hospital. Among these patients, 22 did not attend regular endocrinology and metabolism outpatient clinic appointments after the surgery, and 50 could not be reached by phone to obtain their consent, leading to their exclusion from the study. Additionally,


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8 patients were excluded from the study due to the diagnosis of hypothyroidism during follow-up, and 2 died after the surgery.

Finally, the study included 62 patients, with a mean age of 38.2 ± 8 years and a predominance of females (88.7%). During the preoperative period, the patients had a mean BMI of 45.7 ± 4.9 kg/m², a mean waist circumference of 136.6 ± 14.4, and 66.1% of them were diagnosed with metabolic syndrome. Additionally, 22.6% had hypertension, and 12.9% were being followed up for diabetes mellitus. Hepatosteatosis was observed in 77.4% of patients based on US imaging.

When examining Table I, there is a significant decrease in BMI, waist circumference, systolic, and diastolic blood pressure at postoperative 1 year compared with the preoperative period (P<0.001). The frequency of obesity-related comorbidities before the surgery and one year after the surgery is presented in Figure 1. According to the data, the frequency of metabolic syndrome decreased from 66.1% to 6.5% (P<0.001). The prevalence of diabetes (P=0.039), hypertension (P=0.039), and hepatosteatosis (P<0.001) also significantly decreased one year after the surgery compared with the preoperative period.

***Table I.*** *Comparison of anthropometric measurements and blood pressure measurements before and 1 year after LSG*

| Variable | Preoperative (Mean ± sd) | Postoperative (Mean ± sd) | P |
|---|---|---|---|
| Systolic blood pressure (mmHg) | 129.4 ± 18.9 | 117.6 ± 16.8 | <0.001 |
| Diastolic blood pressure (mmHg) | 81.6 ± 12.10 | 72.8 ± 10.4 | <0.001 |
| Weight (kg) | 122.6 ± 18.2 | 79.0 ± 14.7 | <0.001 |
| Body mass index (kg/ m²) | 45.7 ± 4.9 | 29.6 ± 5.3 | <0.001 |
| Waist circumference (cm) | 136.6 ± 14.4 | 95.4 ± 13.4 | <0.001 |

***Table II.*** *Comparison of laboratory values before and 1 year after LSG surgery*

| Variable | Preoperative (Mean ± sd) | Postoperative (Mean ± sd) | P |
|---|---|---|---|
| Fasting glucose (mg/dl) | 99.2 ± 16.7 | 86.5 ± 10.6 | <0.001 |
| HOMA-IR | 4.3 ± 2.3 | 1.6 ± 1.5 | <0.001 |
| Triglyceride (mg/dl) | 166.2 ± 77 | 103.8 ± 42.5 | <0.001 |
| HDL-cholesterol (mg/dl) | 44.3 ± 10.5 | 62.3 ± 10.5 | <0.001 |
| LDL-cholesterol (mg/dl) | 110.8 ± 32.8 | 106.2 ± 35.2 | <0.001 |
| AST(U/L) | 24.7 ± 15.8 | 15.2 ± 3.8 | <0.001 |
| ALT (U/L) | 31.2 ± 24.1 | 12.3 ± 7.8 | <0.001 |
| GGT (U/L) | 26.5 ± 25.9 | 11.4 ± 6.3 | <0.001 |
| ALP (U/L) | 74.2 ± 18.7 | 65.4 ± 20.0 | <0.001 |
| Creatinine (mg/dl) | 0.8 ± 0.7 | 0.7 ± 0.5 | 0.002 |
| Uric acid (mg/dl) | 5.0 ± 1.6 | 4.0 ± 1.1 | <0.001 |
| Sodium (mmol/L) | 139.3 ± 1.8 | 140.6 ± 2 | 0.001 |

*HOMA-IR: Homeostatic Model Assessment of Insulin Resistance, AST: Aspartate Aminotransferase, ALT: Alanine Aminotransferase, ALP: Alkaline Phosphatase, GGT: Gamma-Glutamyl Transferase*

Laboratory values before the surgery and one year after the surgery are presented in Table II. When comparing the laboratory findings related to metabolic syndrome, there was a significant decrease in fasting blood glucose and triglycerides, as well as a significant increase in HDL-cholesterol (P<0.001). Further biochemical test results are provided in Table II for comparative analysis.

When evaluating postoperative complications, 1 (1.6%) patient had anastomotic leakage, 1 (1.6%) had fever, and 1 (1.6%) had haemorrhage. There was no detection of stenosis in any of the patients.

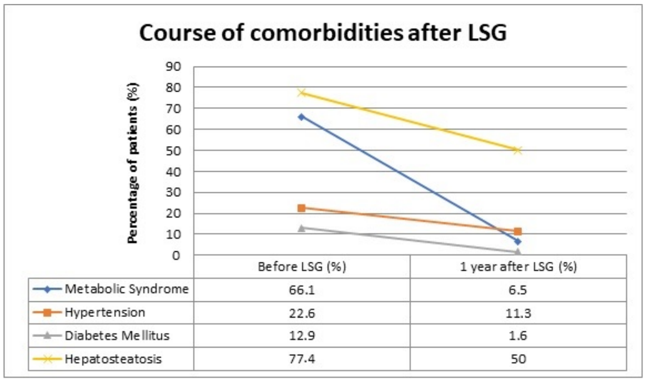


***Figure 1.*** *Comparison of comorbidity prevalence before and after laparoscopic sleeve gastrectomy (LSG)*

## 4. DISCUSSION

In this study, patients with obesity who underwent LSG at our hospital and followed up by the endocrinology and metabolism clinic were retrospectively evaluated. After a 1-year follow-up period, improvements were observed in anthropometric measurements, blood pressure, and metabolic parameters compared with the preoperative period. Additionally, the frequency of patients being followed up for hepatosteatosis, metabolic syndrome, diabetes, and hypertension decreased.

Obesity is a chronic, systemic disease that requires a multidisciplinary approach for both diagnosis and treatment. It rarely resolves spontaneously and is associated with increased morbidity, mortality, and decreased quality of life [11].

The initial treatment typically includes diet modifications, behavioral adjustments, regular exercise, and, if necessary, medical interventions [12]. However, a significant number of patients who lose weight through these methods tend to regain weight over time. A meta-analysis of 29 long-term weight loss studies found that more than half of the lost weight was regained within two years, and by five years, more than 80% of the lost weight was regained [13].

Bariatric surgery is widely recognized as the most effective method for the sustainable weight loss today. Among the various bariatric surgical techniques, LSG is considered the most commonly used approach due to its ease of application from a


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surgeon's perspective, minimal impact on nutrient absorption, and absence of dumping syndrome induction [14].

In our study, a significant reduction in body weight was observed after 1 year postsurgery, consistent with previous studies [15,16]. However, the aim of bariatric surgery is not only to achieve weight loss but also to reduce obesity-related cardiometabolic risks. Therefore, in our study, we examined the effects of LSG on metabolic syndrome components. Before the surgery 41 patients (66.1%) had metabolic syndrome, while in our postoperative 1-year evaluation, only 4 patients (6.5%) were found to have metabolic syndrome ($P<0.001$). In a study by Péquignot et al., where they evaluated 241 patients with a preoperative BMI mean of 47.2 kg/m², they observed metabolic syndrome in 36 patients before LSG, and at postoperative 1 year, 17 patients had metabolic syndrome, showing a significant difference [15]. Similarly, in the retrospective study conducted by Wojciak et al., involving 211 patients, it was observed that one year after LSG, there was improvement in all metabolic syndrome parameter [17].

In our study, the preoperative prevalence of diabetes mellitus was 12.9%, which dropped to 1.6% ($P=0.039$). In a study conducted by Smeu et al., on early glycemic control after LSG, they found a significant improvement in glycemic control from 6 months postoperatively compared with the preoperative period [18]. These findings provide support for the therapeutic effect of LSG on type 2 diabetes.

Systolic and diastolic hypertension are components of metabolic syndrome. According to the NCEP/ATP-III criteria, having a blood pressure of ≥130/85 mmHg is a diagnostic criterion for metabolic syndrome. Therefore, a decrease in blood pressure is expected as an outcome of obesity treatment. In our study, it was observed that the prevalence of hypertension significantly decreased one year after the surgery compared with the preoperative period. In a review by Graham et al., involving 14 studies and a total of 3550 patients, the prevalence of hypertension among patients in the preoperative period was 36.5%, which decreased to 14.79% in the 5th postoperative year [19]. In the study conducted by Samson et al. with 870 patients who underwent LSG, they observed a significant decrease ($P<0.001$) in both diastolic and systolic blood pressure levels during the postoperative period compared with the preoperative period, which is consistent with the findings of our study [20]. Considering these results together, it becomes evident that LSG is an effective intervention for obese people with hypertension.

Dislipidemia is an atherosclerotic risk factor, making it an important component of metabolic syndrome. In our study, a significant decrease in triglycerides and a significant increase in HDL-cholesterol were observed, but no significant changes were found in LDL-cholesterol. Sharma et al., conducted a study involving 134 patients with similar characteristics, out of which 71 underwent LSG, while the remaining 63 were followed up as the control group. After a 3-year follow-up, they found a significant ($P<0.01$) decrease in plasma triglyceride levels and a significant ($P<0.001$) increase in HDL-cholesterol levels among those who underwent LSG compared to the control group [21]. In a systematic review involving 3997 patients, Shabbir et al., demonstrated that LSG had a significant effect on HDL-cholesterol and triglyceride levels, while it did not show a significant impact on LDL-cholesterol levels [22].

Hepatosteatosis is frequently associated with obesity and is evaluated using USG in clinical practice. In our study, hepatosteatosis was detected at various stages in 48 patients (77.4%) during the preoperative period. At the end of the first year postoperatively, hepatosteatosis was not observed in 17 of these patients. Additionally, none of the patients who had normal US imaging during the preoperative period were found to have hepatosteatosis in the postoperative period. In a study involving 67 morbidly obese patients, Salman et al., found a significant reduction in the degrees of hepatic steatosis, hepatocellular ballooning, and lobular inflammatory changes following LSG [23]. In a study conducted by Elyasinia et al., it was demonstrated that in 50% of the patients who underwent LSG, the levels of hepatosteatosis significantly decreased [24]. These findings support the therapeutic effect of LSG on hepatosteatosis.

The Fourth International Consensus Summit on Sleeve Gastrectomy, involved a survey of 46133 cases, which revealed favorable complication rates, including a 1.1% incidence of high leaks, 1.8% for hemorrhages, and 0.9% for stenosis [25]. In our study, among the 62 patients who underwent LSG, leakage was recorded at a rate of 1.6%, bleeding at a rate of 1.6%, and fever at a rate of 1.6%. There were no cases of stenosis observed as a postoperative complication. When compared to the literature, our complication rates were found to be at an acceptable level. While two patients excluded from the study due to mortality were known to have experienced postoperative complications, further detailed information could not be obtained.

The main limitation of our study is the relatively short follow-up period, which was limited to 1 year after the LSG procedure. However, data collection is still ongoing for many patients who participated in this study and newly recruited patients, which will be assessed in future studies. Another limitation of our study is the retrospective design, which resulted in the inability to access the data of some patients who underwent surgery at the 1-year follow-up. As a consequence, the number of eligible patients included in the study was relatively small.

In conclusion, LSG proves to be an effective treatment for morbid obesity. Our study results suggest that LSG is promising also in reducing the incidence of metabolic syndrome and its components. Nevertheless, further studies with a longer follow-up period and prospective design are required to validate the findings of this study.

## Compliance with the Ethical Standards

**Ethics Committee approval:** The study was conducted in accordance with ethical principles outlined in the Helsinki Declaration with the approval of the local ethics committee (approval number: 2022/0617). The study protocol ensured the confidentiality of patient information.

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**Conflict of interest:** The authors have no potential conflicts of interest to disclose.

**Authors contributions:** MB: Study design, literature review, MT: Literature review, supervision, CT: Data analysis, writing, MS: Research, study design. All authors approved the final version of the manuscript.

## REFERENCES

[1] Powell-Wiley TM, Poirier P, Burke LE, et al. Obesity and cardiovascular disease: a scientific statement from the American Heart Association. Circulation 2021; 143:e984-e1010. doi: 10.1161/CIR.000.000.0000000973.

[2] Leitner DR, Frühbeck G, Yumuk V, et al. Obesity and type 2 diabetes: two diseases with a need for combined treatment strategies – EASO can lead the way. Obes Facts 2017; 10:483-92. doi: 10.1159/000480525.

[3] Kopp W. How Western diet and lifestyle drive the pandemic of obesity and civilization diseases. Diabetes Metab Syndr Obes 2019; 12:2221-36. doi: 10.2147/DMSO.S216791.

[4] Hruby A, Hu FB. The epidemiology of obesity: a big picture. Pharmacoeconomics 2015; 33:673-89. doi: 10.1007/s40273.014.0243-x.

[5] Alberti KG, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome. A joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute, American Heart Association, World Heart Federation, International Atherosclerosis Society and International Association for the Study of Obesity. Circulation 2009; 120:1640-5. doi: 10.1161/CIRCULATIONAHA.

[6] O'Neill S, O'Driscoll L. Metabolic syndrome: a closer look at the growing epidemic and its associated pathologies. Obes Rev 2015; 16:1-12. doi: 10.1111/obr.12229.

[7] Abacı A, Kılıçkap M, Göksülük H, et al. Türkiye'de metabolik sendrom sıklığı verileri: Kardiyovasküler risk faktörlerine yönelik epidemiyolojik çalışmaların sistematik derleme, meta-analiz ve meta-regresyonu [Data on prevalence of metabolic syndrome in Turkey: Systematic review, meta-analysis and meta-regression of epidemiological studies on cardiovascular risk factors]. Turk Kardiyol Dern Ars 2018; 46:591-601. Turkish. doi: 10.5543/tkda.2018.00878.

[8] Shi X, Karmali S, Sharma AM, Birch DW. A review of laparoscopic sleeve gastrectomy for morbid obesity. Obes Surg 2010; 20:1171-7. doi: 10.1007/s11695.010.0145-8.

[9] Garvey WT, Mechanick JI, Brett EM, et al. American Association of Clinical Endocrinologists and American College of Endocrinology comprehensive clinical Practice Guidelines for medical care of patients with obesity. Endocr Pract 2016;22 Suppl3:1-203. doi: 10.4158/EP161365.GL

[10] Grundy SM, Cleeman JI, Daniels SR, et al. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. Circulation 2005; 112:2735-52. doi: 10.1161/CIRCULATIONAHA.105.169404.

[11] Sowemimo OA, Yood SM, Courtney J, et al. Natural history of morbid obesity without surgical intervention. Surg Obes Relat Dis 2007 ;3:73-7. doi: 10.1016/j.soard.2006.10.017.

[12] Ruban A, Stoenchev K, Ashrafian H, Teare J. Current treatments for obesity. Clin Med (Lond) 2019; 19:205-12. doi: 10.7861/clinmedicine.19-3-205.

[13] Anderson JW, Konz EC, Frederich RC, Wood CL. Long-term weight-loss maintenance: a metaanalysis of US studies. Am J Clin Nutr 2001; 74:579-84. doi: 10.1093/ajcn/74.5.579.

[14] Palermo M, Gagner M. Why we think laparoscopic sleeve gastrectomy ıs a good operation: step-by-step technique. J Laparoendosc Adv Surg Tech A 2020; 30:615-18. doi: 10.1089/lap.2020.0154.

[15] Péquignot A, Dhahri A, Verhaeghe P, Desailloud R, Lalau J-D, Regimbeau J-M. Efficiency of laparoscopic sleeve gastrectomy on metabolic syndrome disorders: two years results. J Visc Surg 2012; 149:e350-e5. doi: 10.1016/j.jviscsurg.2012.06.005.

[16] Elhag W, El Ansari W, Abdulrazzaq S, Abdullah A, Elsherif M, Elgenaied I. Evolution of 29 anthropometric, nutritional, and cardiometabolic parameters among morbidly obese adolescents 2 years post sleeve gastrectomy. Obes Surg 2018;28:474-82. doi: 10.1007/s11695.017.2868-2.

[17] Wojciak PA, Pawłuszewicz P, Diemieszczyk I, et al. Laparoscopic sleeve gastrectomy: a study of efficiency in treatment of metabolic syndrome components, comorbidities and influence on certain biochemical markers. Videosurgery Miniinv 2020; 15:136-47. doi: 10.5114/wiitm.2019.84718.

[18] Smeu B, Balescu I, Sarbu A, Fica S, Copaescu C. Early improvement in glycemic metabolism after laparoscopic sleeve gastrectomy in obese patients–a prospective study. Chirurgia (Bucur) 2015; 110:430-9.

[19] Graham C, Switzer N, Reso A, et al. Sleeve gastrectomy and hypertension: a systematic review of long-term outcomes. Surg Endosc 2019; 33:3001-7. doi: 10.1007/s00464.018.6566-5.

[20] Samson R, Milligan G, Lewine E, et al. Effect of sleeve gastrectomy on hypertension. J Am Soc Hyperten 2018; 12:e19-e25. doi: 10.1016/j.jash.2018.09.007.

[21] Sharma C, Platat C, Gariballa S, et al. Metabolomic profiling of lipids and fatty acids: 3 years postoperative laparoscopic sleeve gastrectomy. Biology 2021; 10:298. doi:10.3390/biology10040298

[22] Shabbir A, Dargan D. The success of sleeve gastrectomy in the management of metabolic syndrome and obesity. J Biomed Res 2015; 29:93. doi:10.7555/JBR.28.20140107

[23] Salman MA, Salman AA, Omar HS, et al. Long-term effects of one-anastomosis gastric bypass on liver histopathology in NAFLD cases: A prospective study. Surg Endosc 2021; 35:1889-94. doi:10.1007/s00464.020.07725-y.

[24] Elyasinia F, Jalali SM, Zarini S, Sadeghian E, Sorush A, Pirouz A. The effect of laparoscopic sleeve gastrectomy and gastric bypass surgery on non-alcoholic steatohepatitis in Iranian patients with obesity. Middle East J Dig Dis 2021; 13:200-207. doi:10.34172/mejdd.2021.226

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[25] Gagner M, Deitel M, Erickson AL, Crosby RD. Survey on laparoscopic sleeve gastrectomy (LSG) at the Fourth International Consensus Summit on Sleeve Gastrectomy. Obes Surg 2013; 23:2013-7. doi: 10.1007/s11695.013.1040-x.


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