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BMI AND HBA1C LEVELS OF PATIENTS AFTER ROUX-EN-Y GASTRIC BYPASS COMPARED TO SLEEVE GASTRECTOMY

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ABSTRACT

Background: Obesity is a chronic condition that is closely linked to type 2 diabetes mellitus. Bariatric surgery is deemed to be an effective method to reduce weight and induce diabetes remission. Laparoscopic Roux-en-Y Gastric Bypass and laparoscopic Sleeve Gastrectomy are the most commonly performed surgical procedures. **Objective**: This study aimed to find out the short-term efficacy of bariatric surgery in lowering BMI and improving HbA1c levels and also determine which procedures between Roux-en-Y Gastric Bypass and Sleeve Gastrectomy give better outcomes within 3 months after surgery. **Methods:** This study is a cohort retrospective study of 64 patients who underwent laparoscopic RYGB and SG with 32 patients in each procedure, in January 2020 – September 2023 in Sumber Waras Hospital. Data regarding BMI and HbA1c pre- and 3 months post-surgery were collected and analyzed using SPSS with statistical significance defined as $p < 0.05$. **Results:** Laparoscopic RYGB causes a greater decrease of IMT (p=0,000) and HbA1c (0,013) within 3 months post-surgery, compared to laparoscopic SG. Meanwhile, in morbidly obese patients (BMI pre-op $\geq$ 35kg/m^2), no significant differences were found in HbA1c changes in both groups (p=0,240). **Conclusion**: Laparoscopic RYGB is more effective in lowering BMI and HbA1c compared to laparoscopic SG. However, this comparison does not apply in morbidly obese patients.

Keywords:, *Bariatric Surgery, Body Mass Index, HbA1c, Roux-en-Y Gastric Bypass, Sleeve Gastrectomy*

INTRODUCTION

Obesity is a chronic condition characterized by the accumulation of excess fat caused by a calorie imbalance. This condition is often associated with increased morbidity and mortality, which can reduce quality of life. According to WHO, a person is defined as obese if they have a BMI of > 30 kg/m^2. As time goes by, the prevalence of obesity continues to increase, making it a global epidemic. In 2035, the global prevalence of obesity and overweight is predicted to reach 51%[1,2].

Type 2 diabetes mellitus is a comorbid disease that is strongly related to obesity. According to the Indonesian Endocrinology Association (PERKENI), diagnosis of type 2 diabetes mellitus is made if the HbA1c examination results is $\geq$ 6.5%. Research shows that BMI has a strong correlation with insulin resistance and diabetes. Therefore, the increasing incidence of type 2 diabetes mellitus may be related to obesity epidemic. Both of these conditions are based on the existence of insulin resistance and can result in hyperglycemia. Besides, several other diseases that can be caused by obesity include cardiovascular disease, hypertension, dyslipidemia, and obstructive sleep apnea (OSA). These comorbidities can be alleviated with weight loss[3,4,6].

Bariatric surgery gives better outcomes for losing weight and improving comorbidities in the long term compared to other weight loss methods. The mechanism of bariatric surgery in reducing weight can be restrictive, namely by reducing the size of the stomach and restricting food intake or by limiting the amount of calories absorbed from food or malabsorption. This operation is generally carried out laparoscopically by making several small incisions in the stomach for the trocar insertion and a laparoscope tube with a camera at the end, which is connected to a video monitor that projects the condition of the internal organs. Roux-en-Y Gastric Bypass (RYGB) and Sleeve Gastrectomy (SG) are the two most used surgical methods of bariatric surgery. Indications for bariatric surgery include BMI > 40 kg/m^2 or morbidly obese people with preoperative BMI of $\geq$ 35 kg/m2 accompanied by serious comorbidities such as type 2 diabetes mellitus, hypertension, and obstructive sleep apnea (OSA)[5, 6,7].

The study conducted by A. Pucci & R.L. Batterham (2018) stated that maximum weight loss post surgery will affect the improvement of health conditions in the long term, thus to assess the effectiveness of the surgery, changes in body weight needs to be measured. Besides, study by Chew et al.

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also stated that early weight loss within 3 months post laparoscopic SG could predict weight maintenance and commorbidities remission[20]. Since the long-term effect of laparoscopic RYGB and SG with longer follow-up time, had been mentioned a lot in previous studies, hence this study aims to assess the short-term efficacy of bariatric surgery and determine the more effective surgical methods to reduce BMI and improve diabetes comorbidities by looking at BMI and HbA1c changes before and 3 months post laparoscopic Roux-en-Y Gastric Bypass (RYGB) and laparoscopic Sleeve Gastrectomy (SG).

METHODS

This research is a cohort retrospective study in which data was taken from medical records of patients at Sumber Waras Hospital Jakarta after passing an ethical review and obtaining permission and approval from the ethics committee of the Faculty of Medicine, Tarumanagara University with ethical clearance No. 263/KEPK/FK UNTAR/XII/2023 and from Sumber Waras Hospital with ethical clearance number 07/RSSW/KoM.EP/EC/I/2024. The inclusion criteria for this study were patients who underwent bariatric surgery with laparoscopic RYGB and laparoscopic SG procedure at Sumber Waras Hospital from January 2020 to September 2023 with complete preoperative and 3-month postoperative HbA1c and BMI data, while the exclusion criteria for this study are patients with incomplete preoperative and 3 months postoperative data of BMI and HbA1c. Due to the sample limitation, specific criteria, such as patients with diabetes mellitus type 2 were not set in this study. However, considering that the indication for bariatric surgery is a patient with morbidy obesity, or whose BMI preoperative is $\geq$ 35 kg/m^2 accompanied by commorbidites, also the fact that diabetes is one of the most common comorbidities found in obese patient, it is assumed that patient who underwent the surgery might have diabetes melitus type 2. Data were obtained with non-random sampling technique that is based on selecting characteristic or features to obtain samples that are relevant to the objectives of the study. There were total of 64 samples obtained, which fulfilled the inclusion criteria, with each 32 patients who underwent laparoscopic RYGB and SG. Data were processed and analyzed using SPSS version 26 , independent *t*-test were used for variables with a normal distribution which is BMI, while the Mann-Whitney test was used for non-normally distributed variables, HbA1c levels. Correlation between surgical procedures, laparoscopic RYGB and SG towards BMI changes were analyzed using independent *t*-test. Meanwhile, the correlation between laparoscopic RYGB and SG and HbA1c levels changes was analyzed using Mann-Whitney test. Statistical significance is defined as p <0.05.

RESULTS

This study involved 64 samples who matched the inclusion criteria, consisting of each 32 patients who underwent laparoscopic RYGB and laparoscopic SG. Data were taken from medical records of patients who underwent bariatric surgery with laparoscopic RYGB and laparoscopic SG procedures in January 2020-September 2023 at Sumber Waras Hospital Jakarta. Based on the data in Table 1, it was found that most of the samples involved in this study were female, and ranged from under 20 years to over 50 years old, with the largest sample being aged in the range of 41 to 50 years for both surgical methods.

Based on Table 2, the average BMI value before surgery among those who had laparoscopic RYGB was lower compared to patients who underwent laparoscopic SG, which was found to be 37.5 kg/m^2 and 39 kg/m^2, respectively. In three months post-surgery, patients post-laparoscopic RYGB were found to have lower BMI than patients who underwent laparoscopic SG, which was 29.3 kg/m^2 and 32 kg/m^2, respectively. Higher average preoperative HbA1c was seen in patients who underwent laparoscopic RYGB which was 6.8%, compared to laparoscopic SG patients of 6.2%. However, the average HbA1c value within 3 months after laparoscopic RYGB and SG was found to be the same.

The results demonstrate that there was a decrease in BMI and HbA1c within 3 months after surgery. Table 3 shows that post-laparoscopic RYGB patients experienced an average decrease of BMI of 21.8%, while post-laparoscopic SG patients showed an average decrease in BMI of 17.7% with a mean difference of 4.09 % and p-value = 0.000, p = <0.05, this shows a significant correlation between changes in BMI and laparoscopic RYGB and laparoscopic SG. In addition, reduction of HbA1c was seen in post-laparoscopic RYGB and post-laparoscopic SG

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patients with an average decrease of 17.4% and 10.2%, respectively, p-value = 0.013, p = <0.05, which means a significant correlation between changes in HbA1c and laparoscopic RYGB and laparoscopic SG are present.

Per the research objectives, namely to see the efficacy of bariatric surgery in reducing weight and improving diabetes comorbidities, also to determine the more effective surgical methods between laparoscopic RYGB and laparoscopic SG, a subgroup analysis was conducted to see the average value of HbA1c pre-operatively and 3 months post-operatively in patient with preoperative BMI $\geq$ 35 kg/m^2 or morbidly obese patient. The underlying reason for this is the indication for bariatric surgery, which includes patients with morbid obesity or with a pre-operative BMI of $\geq$ 35 kg/m^2 with comorbidities or patients with pre-operative BMI of > 40 kg/m^2. In morbidly obese patients with preoperative BMI of $\geq$ 35 kg/m^2, the average preoperative HbA1c was found to be slightly higher in patients who underwent laparoscopic RYGB compared to patients who underwent laparoscopic SG. There were 10 patients in this group who had HbA1c $\geq$ 6.5%, including 6 laparoscopic RYGB patients and 4 laparoscopic SG patients, while the average HbA1c value 3 months after surgery for both surgical methods was found to be the same.

Table 4 shows an average decrease of HbA1c in the morbidly obese patient with 15.1% and 11.9%, respectively, in post laparoscopic RYGB and SG patients, p-value = 0.240, p>0.005, which indicated no significant difference of HbA1c changes was present between morbidly obese patient who underwent laparoscopic RYGB and laparoscopic SG.

Table 1. Sample Characteristics

Characteristics	Surgery methods		Overall	*p* value
	RYGB (n =32)	SG (n =32)		
Gender, Frequency (%)				
Male	7 (21.9)	2 (6.3)	9 (14.1)	> 0.05
Female	25 (78.1)	30 (93.8)	55 (85.9)	
Age, Mean (SD)	39.5 (1.6)	39.4 (1.6)	39.4 (8.9)	
Age, Frequency (%)				
< 20	0 (0)	1(3.1)	1 (1.6)	
20-30	6 (18.8)	3 (9.4)	9 (14.1)	
31-40	10 (31.3%)	13 (40.6)	23 (35.9)	> 0.05
41-50	13 (40.6)	13 (40.6)	26 (40.6)	
>50	3 (9.4)	2 (6.3)	5 (9.0)	
BMI, Mean (SD)	37.5 (6.3)	39.0 (9.8)	38.2 (8.3)	
BMI, Frequency (%)				
< 35	13 (40.6)	8 (25)	21 (32.8)	> 0.05
$\geq$ 35	19 (59.4)	24 (75)	43 (67.2)	
HbA1c , Mean (SD)	6.8 (1.8)	6.2 (1.2)	6.5 (1.5)	
HbA1c , Frequency (%)				
< 6.5%	20 (62.5)	27 (84.4)	47 (73.4)	< 0.05
$\geq$ 6.5 %	12 (37.5)	5 (15.6)	17 (26.6)	

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Table 2. BMI and HbA1c pre-operative and 3 months post-operative

	RYGB (n = 32)			SG (n = 32)		
	Frequency (%)	**Mean (SD)**	**Median**	**Frequency (%)**	**Mean (SD)**	**Median**
BMI (pre-op)		37.5 (6.3)	36.3		39.0 (9.8)	36.5
< 35	13 (40.6)			8 (25)		
≥ 35	19 (59.4)			24 (75)		
BMI (3 months post-op)		29.3 (5.2)	28.1		32.0 (7.6)	30.4
< 35	27 (84.4)			26 (81.3)		
≥ 35	5 (15.6)			6 (18.8)		
HbA1c (pre-op)		6.8 (1.8)	6.1		6.2 (1.2)	5.8
< 6.5 %	20 (62.5)			27 (84.4)		
≥ 6.5 %	12 (37.5)			5 (15.6)		
HbA1c (3 months post-op)		5.4 (0.6)	5.4		5.4 (0.4)	5.5
< 6.5 %	30 (93.8)			32 (100)		
≥ 6.5 %	2 (6.3)			0 (0)		

Table 3. BMI and HbA1c changes

	RYGB	**SG**	***p value***	***Mean difference***
BMI changes (%), mean (SD)	- 21.8 (5.1)	- 17.7 (3.3)	0.000	4.09
HbA1c changes (%), mean (SD)	- 17.4(12.6)	- 10.2 (13)	0.013	

Table 4. HbA1c in morbidly obese patients with IMT pre-op ≥ 35 kg/m^2

	RYGB (n = 19)			SG (n = 24)		
	Frequency (%)	**Mean (SD)**	**Median**	**Frequency (%)**	**Mean (SD)**	**Median**
HbA1c (pre-op)		6.3 (1.4)	5.9		6.2 (1.4)	5.7
< 6.5 %	13 (68.4)			20 (83.3)		
≥ 6.5 %	6 (31.6)			4 (16.7)		
HbA1c (3 months post-op)		5.3 (0.5)	5.2		5.3 (0.5)	5.3
< 6.5 %	19 (100)			24 (100)		
≥ 6.5 %	0 (0%)			0 (0)		

DISCUSSION

This study involved 64 samples with each 32 samples undergoing laparoscopic RYGB and laparoscopic SG from January 2020 to September 2023 at Sumber Waras Hospital Jakarta. Most of the samples obtained were female, and the majority of patients were between 41 and 50 years old in both surgical methods, with an average age of 39.4 years. Patients who underwent laparoscopic RYGB and laparoscopic SG had an average age of 39.5 years old and 39.4 years old, respectively. The sample characteristics in this study are similar to study by Yang J et al. (2015), which also involved 64 patients,

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with 32 patients in each RYGB and SG group, with the majority of patients being female and having an average age of 40.4 years in RYGB patients and 41.4 years in SG patients.

In this study, both surgical methods were proven to reduce BMI and HbA1c. However, laparoscopic RYGB was superior in reducing BMI and HbA1c, which can be seen from the greater percentage of reductions in BMI and HbA1c in patients who underwent laparoscopic RYGB. The data analysis findings show a strong association between changes in BMI and laparoscopic RYGB and laparoscopic SG with a p-value = 0.000. These results are consistent with study conducted by McTigue KM et al. as well as a study by Lee WJ et al., which stated that a greater weight loss was seen in patients who had laparoscopic RYGB ($p < 0.05$). However, these results are contrary to a previous study by Maffazioli, et al. in the United States, which stated that within one to six months following surgery, no significant differences were found in the reduction of BMI between patients who underwent laparoscopic RYGB and laparoscopic SG ($p > 0.05$). It was also reported that a significant difference in BMI reduction between the two groups was found within seven to eighteen months post-surgery[18].

The data in Table 3 showed a significant correlation between changes in HbA1c and laparoscopic RYGB and laparoscopic SG, with a p-value = 0.013. This study shows that post-laparoscopic RYGB patients experienced a greater reduction in HbA1c compared to post-laparoscopic SG patients, this result is consistent with study by Lee WJ et al. and study by McTigue KM et al., which also stated that the reduction in HbA1c and diabetes mellitus type 2 remission were found to be higher in patients post-laparoscopic RYGB. In addition, study by Zhang et al. stated that the laparoscopic RYGB was associated with discontinuation of diabetes treatment within 24 months postoperatively, as well as diabetes remission and dyslipidemia remission. Meanwhile, study by Pham, et al. stated that within one year, the resolution rate of diabetes in patients post-laparoscopic SG was higher compared to patients post-laparoscopic RYGB, even though no significant differences were found between the two groups [19].

In morbidly obese patients with preoperative BMI $\geq$ 35 kg/m^2, although a greater reduction in HbA1c was found after laparoscopic RYGB, the results of the study showed no significant correlation between changes in HbA1c with the laparoscopic RYGB and laparoscopic SG was found ($p = 0.240$). These results are aligned with study by Peterli et al., which compares the reduction in BMI in morbidly obese patients who underwent laparoscopic RYGB and laparoscopic SG within 5 years after surgery. Peterli et al. stated that there was no significant difference between the two surgical methods, laparoscopic RYGB and laparoscopic SG in reducing weight and improving diabetes comorbidities[14].

The weight loss mechanism post-bariatric surgery is caused by anatomical and hormonal changes. In patient post-laparoscopic RYGB, the food that enters the stomach will pass through or "bypassing" most of the intestine part and goes straight to the distal, shortening the digestive process and reducing the calories absorbed from food. Although SG is more frequently used because its simplicity and causes fewer complications, RYGB remains the gold standard for bariatric surgery[7]. Hormonal changes following bariatric surgery include an increase in anorexigenic hormone (GLP-1, peptide YY (PYY)), leptin and a decrease in the ghrelin hormone. GLP-1 and PYY are hormones which function in suppressing appetite that is secreted in the ileum or the distal part of the small intestine. Post-laparoscopic RYGB patients have more increased GLP-1 and PYY hormones than post-laparoscopic SG patients, this is influenced by anatomical changes in the stomach, where in the RYGB method, food that enters the stomach will go directly to the distal small intestine. Apart from that, a decrease in ghrelin or hunger hormone following bariatric surgery will result in reduced appetite and, eventually, weight loss, this mechanism makes bariatric surgery more reliable and efficient for losing weight than dieting. This is because, bariatric surgery can suppress hunger and induce a feeling of fullness more quickly so that patients eat less, whereas with only dieting, the feeling of hunger will remain. In addition, the mechanism of bariatric surgery in lowering blood sugar is supported by the GLP-1 hormone. An increase in the GLP-1 hormone after bariatric surgery will trigger an improvement in blood sugar levels. Even though both surgical methods showed a decrease in ghrelin, post-laparoscopic SG patients experienced a greater decrease compared to patients who underwent laparoscopic RYGB, and this

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is because ghrelin is produced in the gastric fundus, whereas in SG, the gastric fundus is removed, therefore resulting in a significant decrease in ghrelin. Besides that, bariatric surgery can also improve leptin resistance and improve quality of life[6,8.9,10,15]. According to study by Fiorani et al., the laparoscopic RYGB method is more effective in improving quality of life at 1 year and 8 years after surgery compared to laparoscopic SG, although patients who undergo laparoscopic RYGB tend to have a lower quality of life before surgery[15].

Several other factors that can also affect weight loss after bariatric surgery include age, gender, ethnicity, presence of diabetes, psychological problems and surgical methods, while factors that can influence diabetes remission are the usage of insulin and antidiabetic drugs, the duration of diabetes before surgery, BMI before surgery, HbA1c and C-peptide value[16,17]. Unfortunately, in this study, these factors was not analyzed, therefore their effect on weight loss process following bariatric surgery can not be validated.

Complications that may arise from the SG method include stapler leakage, bleeding and narrowing of the sleeve, while RYGB can cause complications such as narrowing or leakage of the anastomosis and small bowel obstruction. Iron deficiency anemia and low hemoglobin are often found in patients after laparoscopic RYGB because the small intestine, which is the site of iron absorption, is "bypassed" in this method. However, the rate of remission of hypertension, diabetes and dyslipidemia was found to be higher in patients who had RYGB[10,11].

Data regarding patients' comorbidities before surgery were not obtained in this study, therefore in subsequent studies, this data is needed to give more detailed outcomes on the improvement of those comorbidities.

CONCLUSION

In conclusion, surgical methods had a significant correlation with changes in HbA1c and BMI before and 3 months after surgery. Laparoscopic RYGB was proven to have better outcomes in lowering weight, BMI and HbA1c compared to laparoscopic SG. However, in morbidly obese patients, there was no significant difference in the reduction of HbA1c in patients who underwent surgery with both methods. Further study with a larger sample size needs to be carried out to strengthen this study results.

ETHICAL APPROVAL

Ethical Clearance was obtained with the consent and approval of the Health Research Ethics Commission (KEPK), Faculty of Medicine, Tarumanagara University, with ethical clearance No. 263/KEPK/FK UNTAR/XII/2023, as well as the Health Research Ethics Commission (KEPK) Sumber Waras Hospital Jakarta with number 07/RSSW/KoM.EP/EC/I/2024.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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AUTHOR CONTRIBUTIONS

The conceptualization, methodology, data analysis, data curation, writing-original draft preparation and editing was performed by CS,J while supervised by J.

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REFERENCES

1. Obesity [Internet]. [cited 2023 Aug 1]. Available from: https://www.who.int/health-topics/obesity#tab=tab_1.
2. Koliaki C, Dalamaga M, Liatis S. Update on the Obesity Epidemic: After the Sudden Rise, Is the Upward Trajectory Beginning to Flatten? Curr Obes Rep. 2023 Dec;12(4):514-527. doi: 10.1007/s13679-023-00527-y.
3. Al-Goblan AS, Al-Alfi MA, Khan MZ. Mechanism linking diabetes mellitus and obesity. Diabetes Metab Syndr Obes. 2014 Dec 4;7:587-91. doi: 10.2147/DMSO.S67400.
4. Diabetes Tests | CDC [Internet]. [cited 2023 Oct 19]. Available from: https://www.cdc.gov/diabetes/basics/getting-tested.html .
5. The Practical Guide Identification, Evaluation, and Treatment of Overweight and Obesity in

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
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JKD (DMJ), Volume 13, Number 4, July 2024 : 203-210

Adults NHLBI Obesity Education Initiative. [cited 2023 Oct 3]; Available from: https://www.nhlbi.nih.gov/files/docs/guidelines/prctgd_c.pdf .
6. Noria, S. F., & Grantcharov, T. (2013). Biological effects of bariatric surgery on obesity-related comorbidities. *Canadian journal of surgery. Journal canadien de chirurgie*, *56*(1), 47–57. https://doi.org/10.1503/cjs.036111.
7. Bariatric Surgery Procedures | ASMBS [Internet]. [cited 2023 Oct 19]. Available from: https://asmbs.org/patients/bariatric-surgery-procedures .
8. McTigue, K. M., Wellman, R., Nauman, E., Anau, J., Coley, R. Y., Odor, A., Tice, J., Coleman, K. J., Courcoulas, A., Pardee, R. E., Toh, S., Janning, C. D., Williams, N., Cook, A., Sturtevant, J. L., Horgan, C., Arterburn, D., & PCORnet Bariatric Study Collaborative (2020). Comparing the 5-Year Diabetes Outcomes of Sleeve Gastrectomy and Gastric Bypass: The National Patient-Centered Clinical Research Network (PCORNet) Bariatric Study. *JAMA surgery*, *155*(5), e200087. https://doi.org/10.1001/jamasurg.2020.0087.
9. Lee, W. J., Chong, K., Ser, K. H., Lee, Y. C., Chen, S. C., Chen, J. C., Tsai, M. H., & Chuang, L. M. (2011). Gastric bypass vs sleeve gastrectomy for type 2 diabetes mellitus: a randomized controlled trial. *Archives of surgery (Chicago, Ill. : 1960)*, *146*(2), 143–148. https://doi.org/10.1001/archsurg.2010.326 .
10. Seelbach CL, D'Almeida MJ. Postoperative Assessment and Management of Obesity Surgery. StatPearls [Internet]. 2022 Oct 24 [cited 2023 Aug 2]; Available from: https://www.ncbi.nlm.nih.gov/books/NBK563131/ .
11. Zhang, H. W., Han, X. D., Liu, W. J., Yu, H. Y., Zhang, P., & Mao, Z. Q. (2020). Is Roux-en-Y gastric bypass advantageous?-surgical outcomes in obese patients with type-2 diabetes after gastric bypass versus sleeve gastrectomy, a matched retrospective study. *Annals of translational medicine*, *8*(6), 372. https://doi.org/10.21037/atm.2020.02.08.
12. Seelbach CL, D'Almeida MJ. Postoperative Assessment and Management of Obesity Surgery. StatPearls [Internet]. 2022 Oct 24 [cited 2023 Oct 13]; Available from: https://www.ncbi.nlm.nih.gov/books/NBK563131/ .
13. Pucci, A., & Batterham, R. L. (2019). Mechanisms underlying the weight loss effects of RYGB and SG: similar, yet different. *Journal of endocrinological investigation*, *42*(2), 117–128. https://doi.org/10.1007/s40618-018-0892-2.
14. Peterli, R., Wölnerhanssen, B. K., Peters, T., Vetter, D., Kröll, D., Borbély, Y., Schultes, B., Beglinger, C., Drewe, J., Schiesser, M., Nett, P., & Bueter, M. (2018). Effect of Laparoscopic Sleeve Gastrectomy vs Laparoscopic Roux-en-Y Gastric Bypass on Weight Loss in Patients With Morbid Obesity: The SM-BOSS Randomized Clinical Trial. *JAMA*, *319*(3), 255–265. https://doi.org/10.1001/jama.2017.20897.
15. Fiorani, C., Coles, S. R., Kulendran, M., McGlone, E. R., Reddy, M., & Khan, O. A. (2021). Long-Term Quality of Life Outcomes After Laparoscopic Sleeve Gastrectomy and Roux-en-Y Gastric Bypass-a Comparative Study. *Obesity surgery*, *31*(3), 1376–1380. https://doi.org/10.1007/s11695-020-05049-3.
16. Park J. Y. (2023). Weight Loss Prediction after Metabolic and Bariatric Surgery. *Journal of obesity & metabolic syndrome*, *32*(1), 46–54. https://doi.org/10.7570/jomes23008 .
17. Balasubaramaniam, V., & Pouwels, S. (2023). Remission of Type 2 Diabetes Mellitus (T2DM) after Sleeve Gastrectomy (SG), One-Anastomosis Gastric Bypass (OAGB), and Roux-en-Y Gastric Bypass (RYGB): A Systematic Review. *Medicina (Kaunas, Lithuania)*, *59*(5), 985. https://doi.org/10.3390/medicina59050985.
18. Maffazioli, G. D., Stanford, F. C., Campoverde Reyes, K. J., Stanley, T. L., Singhal, V., Corey, K. E., Pratt, J. S., Bredella, M. A., & Misra, M. (2016). Comparing Outcomes of Two Types of Bariatric Surgery in an Adolescent Obese Population: Roux-en-Y Gastric Bypass vs. Sleeve Gastrectomy. *Frontiers in pediatrics*, *4*, 78. https://doi.org/10.3389/fped.2016.00078.
19. Pham, S., Gancel, A., Scotte, M., Houivet, E., Huet, E., Lefebvre, H., Kuhn, J. M., & Prevost, G. (2014). Comparison of the effectiveness of four bariatric surgery procedures in obese patients with type 2 diabetes: a retrospective

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JKD (DMJ), Volume 13, Number 4, July 2024 : 203-210

study. *Journal of obesity*, *2014*, 638203. https://doi.org/10.1155/2014/638203.

20. Chew, C. A. Z., Tan, I. J., Ng, H. J. H., Lomanto, D., So, J., & Shabbir, A. (2017). Early weight loss after laparoscopic sleeve gastrectomy predicts midterm weight loss in morbidly obese Asians. *Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery*, *13*(12), 1966–1972. https://doi.org/10.1016/j.soard.2017.05.016 .