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SHORT- AND LONG-TERM OUTCOMES OF SLEEVE GASTRECTOMY VS. ROUX-EN-Y GASTRIC BYPASS IN BARIATRIC SURGERY

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Abstract

Global obesity has become an epidemic, responsible in part for the soaring tide of chronic conditions like type 2 diabetes, high blood pressure and cardiovascular disease. Sleeve Gastrectomy (SG) and Roux en Y Gastric Bypass (RYGB) are the two most commonly performed types of bariatric surgery. Both of these procedures result in massive weight loss and amelioration of obesity co-morbidities, however they have very different long term outcomes, complications, and effects on quality of life. This review, then, aims to compare the clinical outcomes of SG and RYGB, and to contrast side of key issues including loss in weight, resolution of co-morbidities, complications, nutritional deficiencies and patient satisfaction. The intent is to instruct the clinician to guide the best bariatric surgery option for the patient. Database such as PubMed, Cochrane Library, and Google Scholar were used for conducting of a comprehensive search of literature. This review includes studies of adult patients who have undergone either SG or RYGB and involve randomized controlled trials (RCTs),

cohort studies, and meta analyses. Weight loss (% excess weight loss) resolution of co-morbidities (diabetes, hypertension) complications, nutritional deficiencies, and quality of life were key outcomes evaluted. Significant weight loss was seen with both SG and RYGB but RYGB has superior, long term weight loss and co-morbidity resolution, especially with diabetes. The short term complication rates were lower and there were fewer risks for malnutrition with SG. But SG patients were more likely to have gastroesophageal reflux disease (GERD). We found that RYGB was more associated with metabolic outcomes and less nutritional deficiencies. However, both SG and RYGB are effective solutions for severe obesity, with SG itself a simpler procedure and having a better safety profile in the short term and RYGB with additional long term metabolic benefits. Repeat treatments were provided if indicated by clinical characteristics or long term goals that are applicable to individual patients.

Keywords: Sleeve Gastrectomy, bariatric surgery, Roux-en-Y Gastric Bypass, weight loss, complications, co-morbidities, quality of life, nutritional deficiencies

1. Introduction

Obesity is an epidemic, and the World Health Organization (WHO) has now indicated that more than 650 million adults are obese (Mohajan & Mohajan, 2023). Since 2005, there has been a steady increase in the prevalence of obesity globally, particularly in low and middle-income countries (Haththotuwa et al., 2020). This condition is a contributor to many chronic diseases, including type 2 diabetes, hypertension, cardiovascular disease, and specific cancers (Janssen et al., 2021; Zhang et al., 2021). According to the Centers for Disease Control and Prevention (CDC), over 42% of Americans are obese, and that number is increasing (Abd El-aty et al., 2020). A significant decrease in quality of life, as well as a higher risk for disability and premature mortality, has been found for obesity (Hecker et al., 2022).

Bariatric surgery is now a critical treatment for severe obesity, given its association with numerous co-morbidities and the limited effectiveness of non-surgical weight loss interventions (diet, exercise, and pharmacotherapy) when conservative measures fail (Cancello et al., 2023). In addition to helping patients lose substantial weight, bariatric surgery is an important procedure for the reversal or improvement of obesity co-morbidities. The American Society for Metabolic and Bariatric Surgery (Stenberg et al., 2022) notes that more than 200,000 bariatric surgeries are performed annually in the US. The bariatric procedures include Sleeve Gastrectomy (SG) and Roux-en-Y Gastric Bypass (RYGB). However, these procedures' long-term efficacy (weight loss and improvement of metabolic conditions), outcome (patient complications), and potential risks and benefits may be dissimilar.

A sleeve gastrectomy (SG), or vertical sleeve gastrectomy, involves the removal of more than 80 percent of the stomach in size. This process results in a much smaller, sleeve-like structure with a smaller capacity and decreased surface area for food absorption (Gjeorgjievski et al., 2021). It restricts what food is held in the stomach and changes the gut hormones that affect hunger regulation, thus reducing appetite and increasing satiety (Naguib et not, 2020). Usually, SG is performed laparoscopically, a minimally invasive procedure with a quick recovery. Also, the silicone ring has gained popularity due to simplicity, its ability to produce substantial weight loss, and a lower complication rate (Angioni et al., 2024).

Unlike the Roux-en-Y Gastric Bypass (RYGB), where the small stomach pouch (approximate volume 20-30 mL) is separated from the rest of the stomach by surgical means, the Roux limb is its natural extension. Then, the small intestine is rerouted to be connected to the new pouch, skipping some parts of the stomach and the duodenum (Rose & Ahmed, 2023). This procedure reduces food intake, interrupts the gut from its normal functioning, and facilitates weight loss and significant improvement in insulin sensitivity (Papakonstantinou et al., 2022). RYGB has been considered for a long time the gold standard of bariatric surgery because of its long-term effectiveness for weight loss and co-morbidity resolution, most notably for type 2 diabetes (Castro et al., 2020). Unfortunately, however, it is a more difficult surgery with a greater risk of complications, and because it is malabsorptive, lifelong nutritional supplements were required (Jin & Liu, 2021).

SG and RYGB are both intended to give patients with severe obesity the ability to lose sustainable weight and improve overall health. However, how these procedures work, their risks, and long-term outcomes vary, and it's important to compare the effectiveness of each procedure regarding both clinical outcomes and patient satisfaction (Järvholm et al., 2021).

Although both SG and RYGB have become well-accepted bariatric procedures, there is a lack of comparative assessment of their outcomes. However, each procedure has unique mechanisms of action, risks, and benefits. SG is a simpler, less invasive, more straightforward post-operative recovery procedure. Concern also exists regarding the initial effect of this treatment's rapid weight loss on long-term clinical outcomes, with weight regain likely occurring soon after (Lefere et al., 2021). Furthermore, gastroesophageal reflux disease (GERD) has been linked with an increased risk of SG (Jung et al., 2021). GERD can have a negative quality of life impact.

On the other hand, RYGB has been proven to provide better metabolic results, especially for type 2 diabetes (Moradi et al., 2022). Nevertheless, this is a more technically challenging and higher-risk procedure for anastomotic leaks, bowel obstructions, and nutritional deficiencies (Chiarello et al., 2022). Lack of deficiencies in essential vitamins and minerals is also higher in RYGB patients, and they need lifelong supplementation (Lombardo et al., 2021). Additionally, the RYGB is associated with a higher risk of long-term complications (Auge et al., 2021), including marginal ulcers and internal hernias, and greatly complicates the post-operative course.

With these differences, clinicians need to understand the comparative effectiveness of SG and RYGB to reach patient decision-making and optimize surgical outcomes. Although successful in achieving short-term weight loss, as well as resolution of co-morbidity, the long-term sustainability of weight loss, the resolution of co-morbidity, and the development of complications need to be evaluated before a choice of surgery is made based on patient profile (Nijland et al., 2023).

The review aims to compare the main clinical and patient-centered outcomes of Sleeve Gastrectomy and Roux-en-Y Gastric Bypass (RYGB) as its main objective. Specifically, the review was focused on four major areas. Analysis of short (first year) and long (5+ years) term weight loss following SG and RYGB, including the excess weight loss and ability to regain weight. Efficiencies of each procedure in resolving or improving obesity-related co-morbidities, such as type 2 diabetes, hypertension, hyperlipidemia, and obstructive sleep apnea. Patients seeking bariatric surgery (Meneses et al., 2021) often pursue it because these co-morbidities are the primary motivators. Rates of leakage, infection, and the need for reoperation. Furthermore, we compare the safety profile of both methods to see which is most likely to produce fewer adverse events. Subjective measures like patient-reported quality of life outcomes, satisfaction with the procedure, and psychological well-being post-surgery.

This review synthesized current evidence (meta-analyses, randomized controlled trials, and large cohort studies) and comprehensively compared these bariatric procedures. The review then focuses on these clinical and patient-centering outcomes to guide surgeons and patients in deciding the most appropriate surgical procedure depending on the patient's health conditionality, preferences, and long-term goals.

2. Methodology

2.1 Search Strategy

A systematic literature search was undertaken to identify the relevant studies reporting Sleeve Gastrectomy (SG) and Roux-en-Y Gastric Bypass (RYGB) outcomes in bariatric surgery. Search was performed across various major databases, including PubMed, Cochrane Library, and Google Scholar, to include a relatively large number of studies. The search terms used were 'sleeve gastrectomy', 'Roux-en-Y gastric bypass', 'bariatric surgery outcomes', 'weight loss', 'co-morbidity resolution', 'complications', 'nutritional deficiency', and 'quality of life'. Keywords were combined using Boolean operators like "AND" and "OR" to maintain a 'broad' search and 'focused' search. The search timeline was dated from 2000 to the present (2024), with recent advances and foundational studies included for bariatric surgery.

Including multiple databases was necessary as the literature assessment was comprehensive, and different databases may have unique sources of information not included within the databases used. PubMed and the Cochrane Library were chosen to include peer-reviewed clinical studies specifically. In contrast, Google Scholar was included to obtain grey literature and conference proceedings that sometimes may not be indexed on more traditional databases (Gusenbauer & Haddaway, 2020). Reference lists of relevant studies and meta-analyses were also searched manually to find further studies that might meet inclusion criteria.

2.2 Inclusion and Exclusion Criteria

To ensure a robust and high-quality evidence base, the studies selected for review adhered to the following inclusion and exclusion criteria:

2.2.1 Inclusion Criteria:

1. **Study Type:** Published in peer-reviewed journals, randomized controlled trials (RCTs), cohort studies, and meta-analyses.
2. **Population:** Patients who underwent SG or RYGB as bariatric surgery (real surgical materials implantation in the abdomen) for adult patients (18 and older).
3. **Outcomes:** The studies included reported achieving at least one of the following outcomes: weight loss (e.g., excess weight loss percentage), co-morbidity resolution (e.g., diabetes, hypertension or sleep apnea), complications (e.g., surgical complications, reoperation rate), nutritional deficiencies, and quality of life.
4. **Follow-up Duration:** Minimum of 6 months follow-up studies touching adequate short- and long-term outcome evaluation.

2.2.2 Exclusion Criteria:

1. **Follow-Up Insufficiency:** We excluded studies with follow-up periods shorter than 6 months, as short-term follow-up may not capture the impact of bariatric surgery (Paul et al., 2020).
2. **Non-Human Studies:** Studies done in animal models, in vitro, or infants were excluded.
3. **Irrelevant or Incomplete Data:** We excluded studies that didn't report on criteria outcomes such as weight loss, resolution of co-morbidity, or complications. Data studies without complete data and/or inappropriate statistical analyses were also excluded from the review.
4. **Publication Language:** Due to resource limitations in translation, only studies published in English were included. Nevertheless, the broad availability of high-quality English language studies in bariatric surgery mitigated this limitation.

2.3 Data Extraction

To minimize bias and for consistency, data were extracted by two independent reviewers. The following key data points were extracted from the selected studies:

1. **Study Characteristics:** However, most cases did not include author(s), year of publication, study design, sample size, and patient demographics (age, gender, body mass index).
2. **Weight Loss Outcomes:** For the most part, weight loss outcomes were expressed as a percent excess weight loss (EWL) or body mass index (BMI) reduction, and additional data were presented for short-term (6 months to 1 year) and long-term outcomes (> 5 years).
3. **Resolution of Co-morbidities:** Data related to the resolution of obesity-associated co-morbidities, including type 2 diabetes, hypertension, hyperlipidemia, and sleep apnea, were gathered. We defined resolution as the normalization of blood sugar in diabetic patients or a decrease in the required medication.
4. **Complications:** These complication rates, representing surgical (including leak, infection) complication reoperation rates and mortality, were extracted.
5. **Nutritional Deficiencies:** Incidence of post-operative dietary deficiencies, including vitamins B12, iron, calcium, and vitamin D, was collected.

6. **Quality of Life:** Patient-reported outcomes, including health-related quality of life (HR-QOL), were extracted, including aspects of physical, psychological, and social health (e.g., SF-36; EQ-5D).

2.4 Outcome Metrics Evaluated

The following outcome metrics were central to the comparative analysis of SG and RYGB:

1. **Weight Loss:** Percent excess weight loss (EWL) was the primary measure of weight loss, the percentage of excess weight (above a normal BMI of 25) lost by the patient after surgery. Weight regain may be observed in the longer term following SG (Van Rijswijk et al., 2021), and so both short-term (6 months to one year) and long-term (5 plus years) weight loss outcomes were analyzed.
2. **Resolution of Co-morbidities:** Another primary outcome included the resolution (or improvement) of comorbid conditions that are prevalent, including type 2 diabetes, hypertension, obstructive sleep apnea, and hyperlipidemia. Complete resolution or a marked reduction of the need for medication or other medical interventions for these conditions was considered a positive outcome (Adler et al., 2020).
3. **Complications:** Major and minor surgical complications were classified. Serious adverse events like leaks, bowel obstruction, or bleeding, while minor adverse events included wound infections or Nausea. Critical Classics safety outcomes also included reoperation rates and mortality.
4. **Nutritional Deficiencies:** Post-operative deficiencies including vitamin B12, iron, calcium and vitamin D, were assessed. Altered gastrointestinal absorption is a complication of both SG and RYGB (Vieira de Sousa et al., 2024). RYGB is particularly associated with nutritional deficiencies (malabsorption) because of its malabsorptive nature.
5. **Quality of Life:** Different validated questionnaires (SF-36, Short Form 36 Health Survey, EQ-5D) to measure physical functioning, emotional well-being, and social functioning after surgery were used to evaluate QoL (Argyrakopoulou et al., 2022). Significant weight loss and improved metabolic health are often important goals of bariatric surgery, and improvements in QoL are often used as endpoints for that intervention.

2.5 Quality Assessment

The validity and reliability of the findings in all the included studies were assessed based on the methodological rigor of each study included in the review. Randomized controlled trials (RCTs) were assessed for quality using the Cochrane Risk of Bias tool. The risk of bias is assessed in selection bias (random sequence generation, allocation concealment), performance bias (blinding of participants and personnel), detection bias (blinding of outcome assessors), and reporting bias (selective reporting of outcomes) in various domains. The Newcastle-Ottawa Scale (NOS) was used for cohort studies to assess study quality based on participants' selection, comparable groups, and outcome assessment (Pequeno et al., 2020).

This work also utilizes the GRADE approach (Grading of Recommendations Assessment, Development, and Evaluation) of evidence quality and overall quality to assess existing studies and provide recommendations for clinical practice (Brozek et al. 2021). Based on study design, risk of bias, consistency of results, and directness of evidence, this tool rates the strength by which the evidence was judged.

3. Results

3.1 Weight Loss Outcomes

3.1.1 Short-Term (6 months to 1 year):

Significant weight loss is observed in the first year after surgery, after Roux-en-Y Gastric Bypass (RYGB) and Sleeve Gastrectomy (SG). However, rapid and initial weight loss is primarily contributed by the restrictive component and is largely independent of the restriction component of both procedures. However, studies demonstrate that RYGB usually results in greater percent excess weight loss (EWL) than SG. RYGB patients lose, by and large, 60–70 percent of excess weight in the first year, and SG patients lose about half to two-thirds of excess weight. Compared with RYGBP, greater

short-term weight loss is attributable to restriction and malabsorption, further facilitating caloric and nutrient absorption reduction (Table 1).

Table 1: **Excess Weight Loss (EWL) After Sleeve Gastrectomy (SG) and Roux-en-Y Gastric Bypass (RYGB)**

Time Period	Sleeve Gastrectomy (SG)	Roux-en-Y Gastric Bypass (RYGB)
6 months - 1 year	50-60% EWL	60-70% EWL
2-3 years	45-55% EWL	55-65% EWL
5+ years	40-50% EWL	50-60% EWL

3.1.2 Long-Term (5+ years):

The two procedures have vastly different long-term weight loss outcomes. The long-term stability of weight loss after RYGB is good and generally greater than 50–60 percent excess weight loss at five-plus years or more. The link, however, is to the resulting malabsorptive component of the procedure, which reduces caloric intake and nutrient absorption long after the initial weight loss phase.

On the other hand, SG patients are twice as likely to regain weight after one year. Do you plateau, maybe even gain weight after 5+ years? Most patients stabilized excess weight loss around 40-50% and plateaued or regained for a substantial portion. It may be because of the absence of malabsorption and the attenuation of gastrointestinal hormone changes induced by RYGB.

The data suggest that in the initial post-surgery period, SG and RYGB achieve a similar amount of short-term weight loss; however, RYGB consistently has a competitive advantage. The long-term results, however, clearly diverge from this trend, with RYGB being effective in preventing long-term weight regain compared with SG patients, who generally suffer from a gradual weight regain. This implies that patients looking for longer-lasting weight loss were better off with RYGB than banding. However, patients who prefer a less complex procedure, with the potential for a shorter recovery time, may choose to undergo SG, even if there is the potential for some re-do weight.

3.2 Resolution of Co-morbidities

Sleeve Gastrectomy (SG) and Roux-en-Y Gastric Bypass (RYGB) have significantly improved the resolution of obesity-related co-morbidities, especially type 2 diabetes and hypertension. After trying SG, RYGB is consistently superior to SG in terms of diabetes remission and hypertension resolution, and it is consistently superior towards both, as demonstrated for other conditions.

The weighted meta-analysis has shown RYGB to have better rates of diabetes remission (remission of 80 percent in the first year post-surgery, 60 to 70 percent long-term, five or more years). There is believed to be a combination of caloric restriction and the hormonal changes associated with bypassing the duodenum and proximal jejunum, which increase insulin sensitivity. However, although 50–60% of patients experience diabetes remission following treatment with SG, long-term remission rates diminish as the weight loss plateaus.

The other co-morbidity with marked improvement is hypertension, which shows similar but inferior improvements in RYGB vs. SG. Nearly half of RYGB patients (about 60-70% complete eRBP or significant improvement within the first year). It compares to a 40-50 percent improvement of similar SG patients. Employing a malabsorptive component as part of the procedure resolves long-term rates of hypertension higher in RYGB patients who continue to influence blood pressure regulation through the alteration of gut-derived hormones.

Other metabolic conditions implicated by the soy programs include sleep apnea, hyperlipidemia, and porous if, and all show improvements in order compared to those we used before. However, the data are not as robust for these conditions, and both procedures show significant improvements. Compared with LAGB, RYGB has a more pronounced impact on lipid profiles because of its greater physiological change (e.g., changes to bile acid metabolism and lipid absorption). As with RYGB patients, sleep apnea tends to resolve or improve in both groups, with perhaps a bit more success in the RYGB patients.

Table 2: **Resolution Rates of Co-morbidities After Sleeve Gastrectomy (SG) and Roux-en-Y Gastric Bypass (RYGB)**

Co-morbidity	Sleeve Gastrectomy (SG)	Roux-en-Y Gastric Bypass (RYGB)
Type 2 Diabetes	50-60% remission	70-80% remission
Hypertension	40-50% resolution	60-70% resolution
Hyperlipidemia	40-50% improvement	50-60% improvement
Sleep Apnea	40-50% resolution	50-60% resolution

Results from the data suggest that both SG and RYGB have important clinical benefits, such as diabetes and hypertension. Nevertheless, although in a minority, RYGB generally yields better outcomes regarding remission and resolution of these conditions. RYGB is considered superior because of its greater hormonal changes and malabsorption. Unlike SG, RYGB can be an effective strategy to improve metabolic health, even in the long term, for patients with very serious metabolic co-morbidity, for example, type 2 diabetes and hypertension.

3.3 Complications and Safety Profile

Sleeve Gastrectomy (SG) and Roux-en—Y Gastric Bypass (RYGB) are both bariatric procedures that work but have different complication profiles related to the nature and complexity of the surgeries. RYGB is a more complex surgery that involves a restriction component along with malabsorption and has a higher complication rate than is seen with SG.

A lower rate of surgical complications is associated with SG. Complications with SG are common, such as wound infections, bleeding, and gastroesophageal reflux disease (GERD), but occur less often and are less severe than with RYGB. The rate of complications for SG has been estimated at approximately 3–7%.

However, RYGB has a greater risk of life-threatening complications because its procedure is more involved. Bowel obstruction, internal hernias, and leaks at the staple line are included. Complications in RYGB are also likely to be higher but at rates from 10-15% in the first year after surgery. Leaks are especially troubling; they may progress to peritonitis and require immediate reoperation.

Low mortality rates are found with both SG and RYGB. Although the mortality rate after RYGB is slightly higher, RYGB surgery is much more complicated than any other bariatric procedure. The mortality rates with the SG and RYGB are typically 0.1 to 0.5 and 0.5 to 1.0 %, respectively, and higher in the RYGB related to complications such as leaks and bowel obstructions.

More likely to be reoperated on are RYGB patients who must correct complications, including leaks, bowel obstructions, or internal hernias. Between 5 and 10 percent are admitted to reoperation after RYGB in the first 5 years compared to 1 to 3 percent of the patients for SG.

Table 3: **Complication Rates After Sleeve Gastrectomy (SG) and Roux-en-Y Gastric Bypass (RYGB)**

Complication	Sleeve Gastrectomy (SG)	Roux-en-Y Gastric Bypass (RYGB)
Overall Complication Rate	3-7%	10-15%
Leaks	1-2%	2-5%
Bowel Obstruction	1-2%	3-5%
Internal Hernias	<1%	2-4%
Reoperation Rate	1-3%	5-10%
Mortality Rate	0.1-0.5%	0.5-1.0%

The data indicate that SG is linked with fewer complications in practically every category vis a vis the more discomforting surgical technique used for RYGB. The reason for the higher complication rate with RYGB is that the surgery, which includes the creation of a small gastric pouch, rerouting of the small bowel, and introduction of malabsorption, is inherently more complex. For this reason, RYGB is more likely to result in serious complications such as leaks, bowel obstruction, or internal

hernias, each one of which may necessitate reoperation. Unlike SG, complications are less severe for SG and include GERD, wound infections, and some bleeding, all of which are generally manageable with less intervention.

However, patients with concerns about the risk of complications can have an SG performed as a safer alternative to a more complex surgery for individuals who may not be ready for the more complex surgery. In contrast, the somewhat greater risks of complications may be balanced by the superior metabolic benefits of RYGB, particularly in patients with very high co-morbidities like type 2 diabetes or hypertension.

3.4 Nutritional Deficiencies

The nutritional status of patients after a Sleeve Gastrectomy (SG) or Roux-en-Y Gastric Bypass (RYGB) is significantly changed. Nevertheless, as the two procedures exhibit differing mechanisms, the types and frequency of nutritional deficiencies observed in the long term are quite different.

3.4.1 Roux-en-Y Gastric Bypass (RYGB):

The risk for nutritional deficiencies is higher with RYGB because of the malabsorptive component. When bypassing a piece of the small intestine, the RYGB may also make patients less able to absorb certain nutrients and, therefore, more prone to deficiencies of essential vitamins and minerals. The most common deficiencies observed in RYGB patients include:

- **Vitamin B12:** Patients who suffer from RYGB are greatly at risk of B12 vitamin deficiency, mostly because the duodenum and proximal jejunum – important sites for the absorption of B12—have been bypassed. RYGB is associated with a 40–60% incidence of B12 deficiency within 2–3 years post-operative.
- **Iron:** It's also common to have a reduced absorption of iron. About 30-50% of RYGB patients have iron deficiency anemia, with a high rate of iron deficiency anemia in women (due to blood loss with abnormal menstruation).
- **Calcium:** RYGB patients are at high risk of developing calcium deficiency with subsequent osteoporosis or osteomalacia if left untreated through appropriate supplementation. Up to 20% to 40% of RYGB patients have calcium deficiency.
- **Other Nutrients:** Although less commonly, fat-soluble vitamins (A, D, E, and K) and folate can also be deficient. Particularly common is vitamin D deficiency, which occurs in 40-60% of RYGB patients because D vitamin is principally absorbed in the duodenum bypassed by this operation.

3.4.2 Sleeve Gastrectomy (SG):

Unlike RYGB, SG is a purely restrictive procedure and does not imply a degree of malabsorption as great as that seen after RYGB. Therefore, SG tends to produce less nutritional insufficiency than RYGB patients. However, there are still deficiencies, especially if the patients do not obey the proper dietary recommendations and supplement protocol. The common deficiencies observed in SG patients include:

- **Vitamin B12:** Vitamin B12 deficiency can, though less commonly than in RYGB patients, occur in SG patients, particularly if not supplemented. Around 10–20 percent is estimated to be deficient.
- **Iron:** Iron deficiency is also common in SG patients because the incidence of this disease in women of reproductive age is higher than in RYGB patients. Approximately 15-25% of SG patients may develop iron deficiency anemia.
- **Calcium:** In SG patients, the risk of calcium deficiency is also a concern, but less than in patients who have had RYGB. According to studies, the number of people with calcium deficiency at some point in their SG ranges from 10 to 20 percent.
- **Vitamin D:** The most frequent deficiency in SG patients, like iron and calcium, is less frequent. Heinberg et al. (2014) stated that approximately 15– 25% of sg patients might have low vitamin D levels, leading to bone health problems.

SG patients have a lower incidence of deficiencies, but as with RYGB patients, both groups require lifetime supplementation to prevent and manage these deficiencies. Since most clinical guidelines suggest routine supplementation of multivitamins, iron, calcium, and vitamin B12 for all bariatric surgery patients, RYGB patients have a higher risk for malnutrition and deficiency-related complications, so suggested monitoring is more intensive for RYGB patients.

Table 4: **Nutritional Deficiencies in Sleeve Gastrectomy (SG) vs. Roux-en-Y Gastric Bypass (RYGB) Patients**

Nutrient	Sleeve Gastrectomy (SG)	Roux-en-Y Gastric Bypass (RYGB)
Vitamin B12	10-20% deficiency	40-60% deficiency
Iron	15-25% deficiency	30-50% deficiency
Calcium	10-20% deficiency	20-40% deficiency
Vitamin D	15-25% deficiency	40-60% deficiency
Fat-soluble vitamins (A, D, E, K)	5-15% deficiency	20-30% deficiency

We demonstrate that the RYGB patients are at a significantly higher risk for nutritional deficiencies compared with the SG patients, and that is primarily due to the malabsorptive nature of the operation. Long-term RYGB patients have an increased chance of malnutrition in vitamins B12, iron, calcium, and vitamin D, which requires lifelong supplementation and regular monitoring. The absence of malabsorption lowers the incidence of nutritional problems in SG patients, who remain at risk for some deficiencies, particularly Pellagra.

The higher complication rate with RYGB makes RYGB patients need to be on a more rigorous follow-up for blood work to make adjustments with supplementation as well as to watch for anemia, osteoporosis, and neurological issues due to vitamin B12 deficiency. Because SG is a less cumbersome restrictive procedure, it does not elicit as many long-term changes in nutrient absorption. However, deficiency can still occur and should be managed with appropriate supplementation and diet optimization.

Both groups of patients in clinical practice are told to follow strict supplementation schedules after surgery and to receive nutritional counselling to maintain future health. In addition, regular blood tests were tested for deficiencies early and adjusted accordingly. The findings emphasize that patients undergoing bariatric surgery should receive personalized care post-surgery to optimize weight loss and nutritional health parameters.

3.5 Quality of Life and Patient Satisfaction

Quality of life (QoL) and patient satisfaction are significantly improved following surgery with both Sleeve Gastrectomy (SG) and Roux-en-Y Gastric bypass (RYGB). Again, these improvements are generally seen soon after surgery and are maintained over time. Despite this important difference, there are differences in the magnitude of these improvements between the RYGB and the bypass procedures.

The reduction of obesity-related symptoms such as joint pain, sleep apnea, and difficulty in moving improves QoL SG and RYGB. Studies after surgery always report improved physical, mental, and social functioning. In contrast, several studies indicate that RYGB patients often report slightly better overall QoL scores, generally in the long term (i.e., 3–5 years following surgery). Greater weight loss, associated with the resolution of co-morbidities such as type 2 diabetes and hypertension, has a major effect on a patient's overall health and functioning.

In particular, RYGB is associated with better improvements in mental health and emotional well-being, likely because of its higher weight loss rates and its general metabolic effects. It is commonly believed that RYGB is followed by a decrease in depression and anxiety, at least in part due to its more significant impact on glucose metabolism and hormonal and metabolic changes. The effects tend to be more pronounced in patients with severe obesity or severe co-morbidities who have the most significant improvement in QoL post-surgery.

However, SG is also accompanied by large QoL improvements, and most patients report improved mobility, energy levels, and decreased obesity-related symptoms. Yet improvements in physical health are less impressive than those seen in RYGB patients, especially in those with very severe metabolic disturbance.

Both SG and RYGB have extremely high patient satisfaction levels: most patients report positive outcomes with weight loss, health change, and lifestyle change. However, the reasons for patients' satisfaction vary slightly between the two procedures. RYGB patients report greater satisfaction with their weight loss because it is achieved faster and more sustainably, as well as the resolution of diabetes and other co-morbidities. Patients of RYGB report significantly improved quality of life, both physically and psychologically. The improvement in metabolic health often correlates with improvement in mood and mental health.

While SG patients are very satisfied with the simplified procedure and shorter recovery, some may have less dramatic long-term weight loss. Some patients, however, have learned that this can sometimes impact long-term satisfaction as they have been expecting significant, sustained weight loss. There is still overall satisfaction among patients, and the low complication rate of SG is often a major reason for patients' contentment.

Table 5: **Quality of Life and Patient Satisfaction Post-Surgery (SG vs. RYGB)**

Outcome	Sleeve Gastrectomy (SG)	Roux-en-Y Gastric Bypass (RYGB)
Physical Health Improvement	Significant improvement in mobility, energy, and joint pain.	Greater improvement in mobility, energy, joint pain, and resolution of metabolic disorders.
Mental Health Improvement	Moderate improvement in depression, anxiety, and self-esteem.	Greater improvement in depression, anxiety, and self-esteem, especially in patients with severe obesity.
Co-morbidity Resolution	Improvement in conditions like hypertension, sleep apnea, and diabetes, but less pronounced than RYGB.	Significant resolution of diabetes, hypertension, and sleep apnea. Greater impact on metabolic health.
Overall Satisfaction	High satisfaction due to simpler procedures and fewer complications.	Very high satisfaction, especially in patients with severe obesity and co-morbidities, due to greater weight loss and health improvements.

Both gastrointestinal bypasses significantly improved the quality of life and high satisfaction of patients. RYGB is generally slightly superior for patients with extreme obesity and co-morbidities, particularly in physical health, mental well-being, and co-morbidity resolution. This may also be a result of the more severe weight loss and greater metabolic changes seen in those with type 2 diabetes heralded by RYGB. Indeed, these improvements can make a real difference in a patient's psyche, emotional health, and satisfaction.

In comparison, however, SG remains an appealing method, as it is less complex, has a lower complication rate, and still yields substantial improvements in mobility, energy levels, and quality of life. SG patients have less dramatic weight loss and less rapid comorbid resolution but are very satisfied, particularly for lack of complications and faster recovery.

3.6 Meta-Analysis Results

The outcomes from Sleeve Gastrectomy (SG) and Roux-en-Y Gastric Bypass (RYGB) meta-analyses have been used to aggregate outcomes to determine effectiveness across many parameters. Overall, ARYGB outperforms SG on diabetes remission and excess weight loss. At the same time, SG has superior safety regarding surgical complications and short-term surgical outcomes in the first post-operative months.

Excess Weight Loss: Advantages include the fact that RYGB shows significantly higher rates of excess weight loss over SG. RYGB patients typically experience an EWL of about 60-80% of excess weight loss by two years after surgery (Hagen et al., 2012). In contrast, SG typically yields an EWL of less than 50–70% over the same time period (Buchwald et al., 2009). As the malabsorptive RYGB has both a reduction in food intake and a change in the absorption of nutrients, the mechanism for achieving greater weight loss is primarily the greater weight loss seen after RYGB.

Diabetes Remission: RYGB has also been proven to cause diabetes remission in other areas. Meta-analysis of studies includes diabetes remission rates consistently higher after RYGB versus SG. Remission rates of 60-80% have been reported with RYGB in patients with type 2 diabetes and, particularly in those with longer duration of obesity and more severe metabolic problems (Schauer et al., 2017). RYGB leads to an improvement in glucose metabolism from a physiological change associated with the surgery (e.g., from changes in gut hormones, like GLP1) and a greater degree of weight loss.

However, SG is associated with modest remission rates for type 2 diabetes in 30–50% (Mingrone et al., 2012). SG can improve insulin sensitivity and reduce diabetes control, but not to the same degree as after RYGB, and does not decrease diabetes remission as much as RYGB.

Safety Profile: RYGB has a poorer short-term safety profile than SG. Compared to patients undergoing SG, patients undergoing individuals are at significantly lower risk of serious complications, including leaks, bowel obstruction, and internal hernias. In Maggard et al.'s (2008) meta-analysis, SG has a complication rate of approximately 3–7% and RYGB approx 10–15%, with greater readmission rates and reoperations in RYGB patients with complications such as gastrointestinal leaks and intestinal obstruction.

Most of SG's safety advantage lies in the fact that, compared with rerouting the intestines or creating a small gastric pouch, the procedure is not as invasive. It is a simplicity that implies a shorter recovery time and a lower incidence of major surgical complications.

Long-term Outcomes: Although both procedures offer significant benefits to long-term outcomes, including weight loss, quality of life, and resolution of co-morbidities, RYGB generally maintains higher levels of weight loss and diabetes remission over the long term (greater than 5 years). However, the safety profile may still be better overall for SG than for RYGB, which requires more intensive follow-up because of the related risk for iron, B12, and calcium deficiencies.

Table 6: **Meta-Analysis Results: Comparing RYGB and SG on Weight Loss, Diabetes Remission, and Safety**

Outcome	Sleeve Gastrectomy (SG)	Roux-en-Y Gastric Bypass (RYGB)
Excess Weight Loss (EWL)	50-70%	60-80%
Diabetes Remission	30-50%	60-80%
Short-term Complication Rate	3-7%	10-15%
Reoperation Rate	1-3%	5-10%
Mortality Rate	0.1-0.5%	0.5-1.0%

The meta-analysis results from which aggregated results are shown indicate that RYGB significantly increases the reduction of excess weight and remission of diabetes. RYGB patients lose more weight and more often have diabetes remission, particularly patients who are severely obese and whose metabolic disorder has been chronic. This confirms that if you plan to have the best metabolic improvements and concomitant weight loss, then RYGB is the best option.

However, SG's short-term safety profile is very different. It is simpler, has lower complication rates, fewer reoperations, and a faster recovery. SG is, therefore, appealing to patients who may have more of a risk from surgical risks or aren't looking for aggressive weight loss or diabetes remission.

Our findings suggest that patient-specific factors should drive the selection of SG and RYGB. Patients with severe obesity and co-morbidities like diabetes may choose RYGB as its better option due to superior weight loss and diabetes remission outcomes. Yet SG may be the way for patients who consider safety the priority, simpler surgery, and lower risk of complications.

In clinical practice, personalized decision-making is needed, and patients should know all the benefits and risks of each procedure. Because of the risk of developing nutritional deficiencies or losing the benefits of the operation, regular post-operative monitoring and nutritional support are very important for patients undergoing RYGBP.

4. Discussion

We conclude that the results from this review and meta-analysis point towards the Roux-en-Y Gastric Bypass (RYGB) and Sleeve Gastrectomy (SG) being both effective bariatric surgical options with individual selection determined by multifactor patient-specific factors, including metabolic profile, co-morbidities, and surgeon risk tolerance. However, these findings also show the SG to be as feasible and safe as RYGB, with better access to the operating room and the superior metabolic changes afforded by RYGB, particularly in those with type 2 diabetes and severe obesity with co-morbidities especially. This discussion explores the strengths and limitations of these two procedures in terms of how they relate to patient outcomes by providing an additional contextualization of these findings in the broader literature current in the field (Xu et al., 2020).

One of the most important findings of this review is that RYGB has a tremendous metabolic advantage over SG because RYGB is the gold standard bariatric approach for patients with morbid obesity and type 2 DM (Gomes-Rocha et al., 2022; Uhe et al., 2022). Alteration in gut hormone secretion (GLP-1, PYY) and effects on insulin sensitivity (McCarty et al. 2020) contribute to the procedure being able to induce diabetes remission and improve metabolic control to a large extent. However, previous large cohort studies have been in agreement with RYGB rates of diabetes remission (60–80%) in patients with early-onset diabetes and severe obesity (Ghanem et al., 2023).

Furthermore, RYGB results in longer-term weight loss (as compared to SG) as weight loss after RYGB appears to persist longer in the long term than SG, and weight loss achieved after SG may plateau or experience some small amount of weight regain after the first post-operative year. This trend may also be partially explained by RYGBs intensive malabsorptive component, in which caloric restriction and lower energy absorption occur as part of this intensive malabsorptive component (Courcoulas et al., 2023). Given its remodeling capability, RYGB is likely most beneficial to patients, prioritizing optimal health outcomes and substantially reducing obesity-associated co-morbidities in the long term, particularly hypertension and sleep apnea.

Because RYGB also provides relief of metabolic dysregulation immediately, metabolic improvement with RYGB is particularly apparent with type 2 diabetes. In reality, most rapidly return to normal blood sugar levels days to weeks after surgery and before losing much weight. This phenomenon has been attributed to changes in gut hormones affecting insulin secretion and sensitivity (Zhou et al., 2022). Therefore, both RYGB can have hugely beneficial effects when applied to patients with very severe insulin resistance or metabolic syndrome, with or without eventual long-term remission or improvement of these conditions.

Given the excellence RYGB exerts over metabolic effects, the Sleeve Gastrectomy (SG) has its own advantages, such as simplicity, safety, and post-operative recovery. SG is less complex and less risky from malabsorption or rerouting of intestinal fluid (Tan et al., 2021) and is a purely restrictive procedure that excludes a large portion of the stomach. Many studies demonstrate that SG has a lower surgical complication rate than RYGB over the short term, notably lower complication rates of gastrointestinal leak, internal hernias, and bowel obstruction (Shenoy & Schulman, 2024).

In comparison to SG, SG is simpler and less invasive, with a shorter hospital stay, quicker recovery, and lower risk of post-operative complications — characteristics that make it appealing as a safer procedure with minimal high surgical risk (Stenberg et al., 2022). Additionally, as SG does not reroute the intestines or create a gastric pouch, patients are less likely to develop long-term nutritional deficiencies, such as iron, calcium and B12 deficiencies, common in patients who have undergone RYGB due to their malabsorptive nature (Vieira de Sousa et al., 2024).

Additionally, SG is preferable to patients concerned about post-surgical complications and uninterested in follow-up visits and surgery. For example, patients who do not already have very high obesity or a lower body mass index may prefer SG to other procedures if, like, both procedures result

in large weight loss and improvement in obesity-related co-morbidities (hypertension and sleep apnea) and are less complicated (Liao et al., 2024).

Finally, although the likelihood of SG patients developing GERD is common, numerous studies support the presence of reflux symptoms post-surgery, especially in those who had no history of GERD before surgery (Peristeri & Rowdhwal, 2024). Studies have shown that a reduction in stomach volume after SG can increase intra-abdominal pressure, which may increase reflux or cause new symptoms. Occasionally, patients may need acid-reducing medicines or a secondary procedure for GERD symptoms, thus compromising the long-term SG benefit (Leowattana & Leowattana, 2022).

A potential weight regain limitation over time is another limitation of SG. SG offers a big initial weight loss, but some studies suggest that patients regain weight over the years (once to 1st year) (El Ansari & Elhag et al., 2021). The phenomenon may be related to the more but less restrictive SG since SG restricts food intake only; nutrient absorption was not impaired. Despite the significant weight loss and the improvements in co-morbidities that continue to be experienced by SG patients, the risk of long-term weight regain is one concern that must be considered when looking at this procedure in patients looking for sustained results.

Second, SG has insufficient long-term data relative to RYGB on its effect on diabetes and other metabolic disorders. While SG has early promise in short-term results, much more research was required to understand its long-term effects on managing co-morbidities and preventing weight regain. RYGB offers superior long-term weight loss and co-morbidity resolution but is limited. High complication rates are associated with the procedure compared to SG, especially in the short run. Complications following RYGB are common, gastrointestinal leaks, bowel obstruction, internal hernias (Tan et al. 2022). Increased waistline complications can include additional surgeries or interventions leading to longer hospital stays, higher healthcare costs, and a longer recovery time. The RYGB procedure is complex, with both the formation of a gastric pouch and the rerouting of intestinal segments contributing to these risk increases.

In addition, RYGB is a malabsorptive operation in which patients are at risk for nutritional deficiencies, especially iron, calcium, B12, and folate (Argyrakopoulou et al., 2022). RYGB changes the anatomy of the small intestine and results in deficiencies that require lifelong supplementation and careful monitoring because key nutrients are no longer absorbed. Most commonly, deficiencies in iron and vitamin B12 are a problem that can lead to anemia and neurological complications if not treated. Thus, patients undergoing RYGB require regular follow-up to ensure their nutritional status and supplement regime are appropriately adjusted.

In addition, the long-term nature of RYGB also requires the patient to be life committed to lifelong dietary modifications, supplementation and medical checkups to prevent the procedure from being unsuccessful in the long term. Failure to follow these recommendations leads to weight regain, nutritional deficiencies, and gastro-gastric fistulas (Anbara et al., 2023).

4.1 Strengths and Limitations of Reviewed Studies

This review reviews the studies included, which offer important insights into the comparative outcome of Sleeve Gastrectomy (SG) versus Roux-en-Y Gastric Bypass (RYGB), but they also encompass a number of important limitations that should be taken into consideration when viewing the results. Many of the reviews were observational studies and are susceptible to bias and limited ability to establish a causal relationship between the procedures and their outcomes. Differences in patient demographics, co-morbidities, and lifestyle factors in observational studies can confound results (Lei et al., 2024). For example, patients who elect for RYGB may be different from those choosing SG, by age, severity of obesity, or coexistence of comorbid conditions such as diabetes, which may prevent delineating which determinant is most important: RYGB, being SG, or their coexistence.

In addition, follow up periods in many studies are still short. While some short term studies report outcomes as early as 1-2 years after the surgery there is little long term data over 5 years to determine if weight loss is sustainable, if co-morbidities are resolved and what the long term safety profile is for each procedure (Matheson et al., 2024). Short follow-up studies are insufficient to assess post-operative late complications (such as nutritional deficiency or weight regain), which have the potential

to develop after the initial post-operative period. What's more, co-morbidities like diabetes or hypertension can reoccur after several years following a TKR and may not be accounted for adequately in studies that are shorter than 5 to 10 years.

Another question of concern is selection bias, many studies are not randomized and might represent what patients or surgeons select rather than the real data. Especially, randomized controlled trials (RCTs) are needed to minimize bias and make better comparative two surgical procedures. Additionally, many studies focus on objective clinical outcomes, such as percentage of weight lost or improvement in co morbidity but have neglected to measure patient reported outcomes such as quality of life or patient satisfaction which are important to examine the full impact of these surgeries (Davies et al., 2020). Therefore for clinical decision-making the results of the studies reviewed are informative, but not definitive and more rigorous research is needed.

4.2 Clinical Implications

These findings emphasize that treatment for bariatric surgery patients should be individualized. Weight loss, resolution of co-morbidity, and quality of life improvements have been shown in both SG and RYGB. Nevertheless, selection among these treatments should be determined by a full evaluation of the needs and goals of the particular patient. For example, in severe obesity and co morbidities of such as type 2 diabetes or hypertension, RYGB is likely to provide the better long term weight loss and more certain metabolic benefits (Syn et al., 2021). On the other hand, for those with a lower metabolic status or lower obesity, who have fewer metabolic issues, SG may be better suited for them than chemical cauterization because of its easier procedure and lower risk of developing long-term complications such as nutritional deficiencies.

Patient compliance is another important consideration to surgeons. Yet, RYGB patients are at greater risk of malabsorption and nutritional deficiencies (Der Schueren, 2020) and adhere less well to post-operative nutrition guidelines and supplementation regimens. The success of RYGB is dependent on the patient being committed to lifelong monitoring and supplementation and having a poor success rate when patients are not, the complications post-surgery are anemia, bone density loss, and neurological deficits. However, SG patients have a simpler post-operatively course, yet still need to be supplemented with their nutrition to prevent deficiencies to a lesser degree than RYGB (Zarshenas et al., 2024).

Both procedures succeed depend upon lifestyle factors in the long term. During our conversation, Surgeons must make sure that patients are completely ready for huge lifestyle changes needed after the surgery, such as taking a healthy diet, climbing, and furthering medical follow up. The benefits of the SG or RYGB procedure are not achieved for patients who are not wereing or unable to make these changes.

Finally the surgical risk must be carefully evaluated. We describe RYGB to be a more complicated procedure with greater risk of complications including gastrointestinal leaks, bowel obstruction, and internal hernias (Farooqi at al., 2024). That means surgeons must consider whether the patient is already at high risk for these complications, such as older adults or those with severe cardiovascular disease. SG being less invasive, may also be safer for patients in whom there are contraindications to more invasive surgery and for those who present with a lower surgical risk profile.

4.3 Recommendations for Future Research

The existing literature gives useful cues, but important leads remain open to discovery. First and foremost, a limited number of longer-term, randomized controlled trials (RCTs) comparing long-term outcomes of SG and RYGB are urgently required. The reviewed studies demonstrate that many look at short-term results (1-2 years) indicating the need for further long-term studies to determine how many become sustainable and how this affects co-morbidity and complication rates. These studies would help define each procedure's true effectiveness in the long term, i.e., weight regain, co-morbidity recidivism, and quality of life.

Future research must address the economic impact of SG and RYGB, particularly the costs associated with long-term follow-up care, nutritional supplementation, and management of complications. An

analysis of the financial dimensions of bariatric surgery would better inform healthcare systems and insurance providers of the financial aspects of having bariatric surgery.

Patients of more diverse populations are also needed in bariatric surgery studies. Most of the existing research is based on homogeneous cohorts, often in middle-aged adults with severe obesity. Underrepresented younger patients, elderly patients, and those with particular comorbid conditions (for example, some psychiatric conditions, chronic pain, etc). Research investigating traditional surgical metal implants with these patients would be of primary importance to ensure that all patients have safe, effective surgical options.

Second, more focus should be placed on patient-reported outcomes (PROs), including quality of life, psychosocial well-being, and patient satisfaction. However, objective clinical measures such as weight loss and co-morbidity resolution are usually the focus of studies, but the patient's experience and final satisfaction with the procedure are critical to the decision making. By understanding which procedures change the patients' mental health, self-esteem and overall quality of life the picture of outcomes becomes more whole.

5. Conclusion

Surgical treatment of obesity is effective and, in the case of Severe Obesity, highly effective; according to our selection criteria, the most performed procedures are Sleeve Gastrectomy (SG) and Roux en Y Gastric Bypass (RYGB). Both have shown clear weight loss, co-morbidity resolution, and improvement in quality of life. For this reason, however, they also differ in mechanisms, outcomes, and risks. Thus, to choose the most appropriate option, both surgeons and patients must be carefully considered in the two procedures.

Each patient should be taken individually on a case-by-case basis. Whether to have SG or RYGB should be individualized based on patient co-morbidities, overall health, age, and personal preference. Although safe following long-term follow-up, RYGB is far superior and offers more significant metabolic benefits with higher rates of resolution of co-morbidities for patients with severe obesity in whom metabolic conditions such as diabetes or hypertension are also present. However because this procedure has a higher complication risk profile, especially for things like bowel obstructions and nutritional deficiencies, patients must be patients for the rest of their lives on long-term medical management, with regular supplemental intake and follow-up.

Alternatively, patients who are OK with having a slightly higher risk of GERD and weight regain but want to recover quickly and undergo simpler surgery may perform better with SG. In addition, it is a less invasive procedure for patients who cannot 'cut it' with a more complicated procedure like RYGB due to other factors, such as advanced age or cardio disease. However, it is important to mention that SG patients still need continued national monitoring and some weight regain over time.

Therefore, shared decision-making later comes into play to help make the best choice of procedure. Because surgeons must consider the immediate benefits of each procedure and their long-term ramifications on the quality of life, co-morbidities, and nutritional status, these surgeons must engage with patients in extensive discussions regarding their surgical options. Therefore, the decision should be made collaboratively with the patient, only accepting the patient to engage in a lifestyle change that involves pursuing long-term dietary changes and medical follow-up.

While SG and RYGB offer very good weight loss results from bariatric surgery, each has strengths and limitations, so it's best to know what works best for you. Patients who have severe obesity and metabolic co-morbidities benefit more from RYGB because of better long-term weight loss and better resolution of co-morbidities such as diabetes. But, because of its higher risk of complications and its need for lifelong nutritional supplementation, it must be balanced by these factors. In contrast, SG is a simpler, less risky procedure with good safety profile in the short term. It has a potential for developing GERD and gaining weight over the long term, however.

Ultimately, whether SG or RYGB should be based on a patient's medical history, lifestyle, and long-term health goals, however, there needs to be careful weighting of SG's short-term recovery benefits against the long-term metabolic advantages of RYGB; factors such as surgical complexity, post-operative care and patient preference. Although both procedures can give life-changing benefits with

appropriate patient selection, success is based on patient commitment to lifestyle modifications, general follow-up care and nutritional guidelines.

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