

# Analysis of Outcomes of Bariatric Surgery for Weight Loss Management and on type 2 Diabetes Mellitus Management: A Systematic Review

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## INTRODUCTION

Obesity is becoming a growing concern worldwide and is now considered to be an epidemic. Health care providers continue to search for a safe and effective treatment to reduce body fat. Obesity is defined as having a body mass index (BMI) over 30 kg/m<sup>2</sup>. Obesity is associated with many negative health and socioeconomic effects. People who have BMI over 30 are at increased risk of developing hypertension, cancer, cardiac events, stroke and particularly type 2 diabetes mellitus.

With the rise of obesity, the incidence of T2DM has also increased, it is estimated by the year 2039 49 million people will have T2DM. In 2016 the WHO reported that 14 million deaths in adults over the age of 15 years were caused by diabetes across the globe. Type 2 diabetes mellitus is the leading cause of blindness, kidney failure and limb amputation worldwide. Though diabetes was once seen as a disease of the middle and late age, rates of children being diagnosed with T2DM has increased. The incidence of T2DM in children and adolescents is now common pointing towards an emerging epidemic and a large public health problem (Wu, Y., Ding, Y., Tanaka, Y., & Zhang, W. 2014).

Type 2 diabetes mellitus is also known as non-insulin dependent diabetes mellitus and is the most common type. It is characterized by hyperglycemia, insulin resistance and reactive insulin deficiency. This disease is caused by factors, both genetic and lifestyle. Although physical inactivity, advancing age, a sedentary lifestyle, smoking and a high fat diet are important driving forces in the development of T2DM, obesity remains the leading predisposing factor in the advancement of the disease (Kohli CR. *Bariatry*, 1994). Over 50% of people diagnosed with T2DM are obese and carry most of their adipose tissue in their central area.

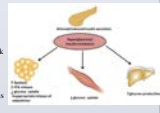
It is important to understand obesity and the associated health risks along with the treatment options in order to effectively manage the disease. Worldwide, an estimated 347 million adults are living with diabetes and almost half of them are undiagnosed (Sjostrom et al., 2014). Furthermore, in patients that absolutely need to undergo surgical intervention due to their BMI and outstanding health conditions, it was shown that the surgery reduced the long-term incidence of diabetes (Sjostrom et al., 2014). Lifestyle changes, such as diet control and exercise can also reduce obesity and T2DM. However, both surgical and non-surgical treatment options are comparable when it comes to losing weight. In this study, we will conduct a systematic review to examine if bariatric surgery produces superior long-term outcomes compared to non-surgical treatment for weight loss in T2DM patients.



Keywords: Obesity, Type 2 Diabetes Mellitus, Weight loss, Health Benefits, Consequences, Treatment, Surgical interventions, Non-surgical interventions, Insulin Resistance, Cohort study, Meta-analysis.

## PATHOPHYSIOLOGY AND TREATMENT

Type 2 diabetes is characterized by reduction in insulin sensitivity, a reduction in insulin production which later progresses to the failure of insulin production by beta cells of the pancreas. Insulin resistance occurs when the effects of insulin on the peripheral tissues in the body are blunted, as well as an impairment of the glycogenesis in the liver. All these changes lead to a reduction in glucose transport from the blood into the liver, muscle and fat cells resulting in an elevated level of glucose in the blood also called hyperglycemia (Skyler et al 2016). Insulin resistance is almost always associated with type 2 diabetes. Obesity is an independent risk factor and a crucial role for the development of insulin resistance. Many of the individuals who have T2DM have a central, visceral fat distribution which plays into the development of insulin resistance. Circulating hormones, cytokines and metabolic fuels, like free fatty acids from all reduced from adipocytes, which can blunt the action of insulin. In overweight and obese patients, fat cells are large making them more resistant to the action of insulin, thus reducing lipolysis and increasing in impaired insulin responsiveness in adipocytes (Cech 2017).



Obesity and central fat distribution have been proven to have an association with the development and progression of T2DM. This associated weight loss management has been a focus in the management of type 2 diabetes. In overweight patients, it has been proven that those diagnosed with diabetes a modest sustained weight loss has been proven to improve glycemic control as well as reduce the need of glucose lowering medications (Patton et al 2012).

Today physicians prescribe weight loss as the first line of intervention in diabetes management. This can be achieved by non-surgical and surgical interventions. Non-surgical interventions include behavioural therapy, dietary changes, increase physical activity and pharmaceuticals. These interventions have few side effects and have proven to work for some patients but can be hard to do sustainably, change habits. The long-term outcomes have been inconsistent. Studies have shown that using lifestyle changes have resulted in 9% of their weight loss (Kohli et al 2014).



Studies indicate that patients who undergo bariatric surgery lose more than 25% of their initial body mass in the first three months post operation (Kohli et al., 2008).

Metabolic surgery is recommended for patients with T2DM with a BMI over 40 (without their level of glycemic control). Bariatric operations also termed metabolic surgery promotes dramatic and long-lasting improvement of type 2 diabetes caused by a dramatic weight loss experienced after the surgery (Diabetes Care 2016). Bariatric surgery is the process of reducing stomach capacity. It can be a restrictive surgery, where the stomach capacity is reduced, or a retractive and malabsorptive surgery where the reduction in stomach capacity is combined with the reduction in digestion area (Pucci and Balthazar, 2019).

Many procedures of bariatric surgery have been developed since its invention in the 1950's. The most common procedure used in obese patients with diabetes is Roux-en-Y gastric bypass (RYGB) (Corcos et al., 2014). In this procedure the stomach is cut down to generate a small pouch on one end and a free end. The small intestine is also cut in the mid-jejunum area and divided into a Roux limb and biliopancreatic limb. The small stomach pouch created from the stomach is anastomosed with the Roux limb of the small intestine while the biliopancreatic limb is anastomosed with the jejunum. The new pathway ensures that food passing through the small stomach can be further digested in the small intestine with the help of bile and pancreatic juices (Pucci and Balthazar, 2019).

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## METHODS

Study	Year	Age	Sex	Weight	BMI	HbA1c	Prevalence
1	2014	30-60	M	100	35	8.5	15%
2	2015	30-60	F	110	38	9.2	20%
3	2016	30-60	M	120	40	9.8	25%
4	2017	30-60	F	130	42	10.5	30%
5	2018	30-60	M	140	45	11.2	35%
6	2019	30-60	F	150	48	12.0	40%
7	2020	30-60	M	160	50	12.8	45%
8	2021	30-60	F	170	52	13.5	50%
9	2022	30-60	M	180	55	14.2	55%
10	2023	30-60	F	190	58	15.0	60%

After conducting a systematic literature search through PubMed and EMBASE on electronic databases. In order to analyze the different procedures from weight loss and consequent effect on type 2 diabetes, a total of 8 randomized controlled trials were reviewed. Most of these studies were conducted in the United States except for Mangione et al, which was conducted in Italy. In the study conducted by Brumadam et al, randomly assigned 120 patients, 60 of those patients assigned to lifestyle and medical management the other 60 assigned to gastric bypass. As in our focus on the outcome of type 2 diabetes control and treatment risks 2 years after adding Roux-en-Y gastric bypass to lifestyle and medical management. The focus is on weight endpoint of control of glycaemia, systolic blood pressure, and LDL cholesterol, which is better achieved with Roux-en-Y gastric bypass compared with the randomly assigned treatment with intensive lifestyle and medical management. Eligible participants must have HbA1c of 8%, BMI 30.0-39.9, age being between 30-61 years, and type 2 diabetes for at least 6 months. In the study "Bariatric Surgery versus Intensive Medical Therapy for Obesity: 3-Year Outcomes" Randomization of 150 obese patient with uncontrolled type 2 diabetes receive intensive medical therapy or intensive medical therapy plus Roux-en-Y Gastric Bypass or sleeve gastrectomy. Main focus is to focus on patients who significantly reduced or maintained hypoglycemia level of 6.0% or less than by using either intensive medical therapy only or by undergoing gastric bypass or sleeve gastrectomy. Both HbA1c and P value are used for the comparison between the medical therapy group and each of the surgical groups.

In the study done by Courcoulou et al, 61 randomized obese participants with Type 2 diabetes Mellitus were in the intensive lifestyle weight loss intervention for one-year, lower lifestyle weight loss intervention (LLI) for 2 years, or surgical treatments followed by LLI in two to three years. Patient's age between 25 to 65 with a BMI of 30 to 40. This study focuses on the long term follow up of 3 years of surgical treatment or lifestyle intervention along for the remission of T2DM in obese patients. Focusing on the comparison of P values, HbA1c and fasting plasma glucose for surgical treatment patients and the lifestyle intervention. The study conducted by Mangione, randomly assigned 60 patients, aged between 30 and 60 with BMI of 35 and a history of type 2 diabetes. This study focuses on 5 years outcomes to compare surgery with conventional medical treatment for comparison type 2 diabetes in obese patients. Focusing on glycemic HbA1c, fasting plasma concentration and the P value.

The study done by Lucotelli et al, a case-controlled trial with 10 years follow up, 10 randomized obese patients within BMI greater than 35 that are newly diagnosed type 2 diabetes. The focus on this study is to measure the long-term effects of Biliopancreatic diversion (BPD) versus those associated with conventional therapy on macrovascular, maculovascular, microvascular, and glomerular filtration rate (GFR). The study done by Hsu et al, compares the long-term outcomes between medical treatment with 299 patients and gastrointestinal metabolic surgery with 52 patients. The objectives of this study are to compare the study obese patients with type 2 diabetes mellitus and BMI less than 35. The measurements that are going to be looked at are HbA1c, BMI, and P value.

## RESULTS



FIGURE 1

In all the studies analyzed in this review, patients lost more weight with bariatric surgery as compared to the non-surgical lifestyle management group. The average weight of participants in the pre-surgery group was 108.74 kg, average post-surgery weight was 80.25 kg and the average weight for pre-lifestyle change and post-lifestyle change was 108.51 kg and 102.97kg, respectively. The total average weight loss between pre and post surgical intervention was 28.49 kg and the total average weight loss between pre and post lifestyle intervention was 5.54 kg. Figure 1 shows the body weight trends associated with each treatment method. Figure 2 shows the average weight of the participants pre and post surgery lifestyle intervention. There was a significant difference between post surgery weight and post lifestyle intervention weight is -22.72%. Confidence interval level was 95% (P<0.05), therefore the results are significant.

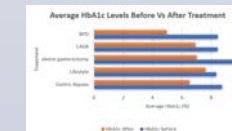
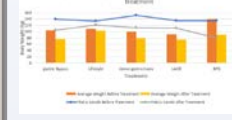


FIGURE 3

A trend that was apparent in the studies was that irrespective of the treatment choice for weight loss, when a patient lost weight the HbA1c levels also decreased. The main difference was that participants who used surgical methods to obtain weight loss had an easier time managing their weight. Another main result was that people who used surgical means had overall lower HbA1c levels compared to the lifestyle management group. The average HbA1c levels after surgical intervention was 7.28%, significantly reduced from the average HbA1c level pre-surgery of 10.2%. The average of the non-surgical group post implementing the changes in their lives was 7.00%, down from the pre-intervention average of 8.33%. Figure 3 shows the HbA1c levels for each treatment method included in the review. Figure 4 shows the average HbA1c levels was 9.5% (P<0.05), prepost surgery and postpost lifestyle. The overall mean difference between post surgical and post lifestyle intervention was -1.32%. Confidence interval level was 95% (P<0.05), therefore the results are significant.

## DISCUSSION

Comparison of Body Weight and HbA1c Levels before and After



In all types of bariatric surgery examined, there is a significant difference in the weight of patients after the procedure compared their weight before surgery. As seen in the cluster graph, a greater difference in before and after weight is observed in the surgical procedures, the same pattern is observed when HbA<sub>1c</sub> vs fasting plasma glucose levels are compared before and after surgery or lifestyle intervention. The surgical interventions yield greater difference when compared to lifestyle changes.

Examining the results obtained, bariatric surgery produces a better outcome in weight loss than lifestyle changes.

The studies included in this research performed follow-ups at 1 year, 2 years, 5 years and 10 years after surgical procedures. A pooled analysis indicates that the weight loss is better implemented in the surgical group. The analysis also suggests that HbA<sub>1c</sub> vs fasting plasma glucose levels are lower after surgery than when only lifestyle changes are implemented. Thus, diabetes is more likely to be in remission in the surgical group than the non-surgical group. Our review focuses on studies that defined diabetes remission as patients who have maintained a lower HbA<sub>1c</sub> vs fasting plasma glucose levels and have been off medication for 12-24 months. This definition is based on the American Association of Diabetes. Mangione et al reported that 50% of surgical patients maintained weight loss and remission 5 years in our review vs none for the non-surgical group (Mangione et al., 2015).

While Roux-en-Y gastric bypass (RYGB) is the most common bariatric procedure and most of the studies included in our review use the method, further approach to studying bariatric surgery can include comparing the different procedures and their effect on T2DM. The cluster graph can include a comparison between the four different bariatric procedures used in the eight studies analyzed in this research. The bariatric methods include: RYGB, vertical sleeve gastrectomy, Laparoscopic adjustable gastric banding (LAGB), and biliopancreatic diversion (BPD). The results indicate that there is a greater weight loss and reduction in HbA<sub>1c</sub> levels obtained with BPD. However, Lucotelli et al mentions that the BPD procedure has both surgical and medical complications like a higher operative mortality rate, incisional hernia, malabsorption amongst others. Consequently, BPD is less frequently performed. Patients choosing to undergo the BPD procedure must therefore be warned of the risks involved.

## CONCLUSION

Courcoulou et al suggests that remission could be influenced by the amount of years that patients were diabetic before surgery (Courcoulou et al., 2015). Thus, patients are more likely to benefit from surgery if they had a shorter duration of diabetes. This is further supported by the Swedish study by Jans et al, which states that remission is greatest in patients who undergo surgery almost immediately after being diagnosed with diabetes. Jan et al, also supports that although the mechanism for bariatric surgery's improvement of T2DM may not be completely understood, the weight loss experienced with surgery is associated with other factors promotes insulin sensitivity and increases functioning of pancreatic beta cell post operation.

Furthermore, each of the studies included in our review were collected from one country and limited by small sample size and many of them had short follow up periods. While obesity continues to rise at an alarming rate, the practice of bariatric surgery as a weight loss and obesity approach may present a challenge for many individuals studies as well as a pooled analysis of all eight studies suggesting the efficacy of bariatric surgery with regards to weight loss and reduction in glycemic index, more investigation using larger sample sizes and non-randomization size may help solidify bariatric surgery as an effective treatment for obesity and T2DM.

Over the last decade, the indication of bariatric surgery to treat obesity has continued to soar. This study indicates that while the procedure is mainly used in obese patients who have been diagnosed with T2DM, patients who undergo the procedure have greater results with weight loss and reduced blood sugar. Bariatric surgery may potentially go with them with an attainable path to remission.

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