

A Focus on the Impact of Bariatric Surgery on Pregnancy Outcome: Effectiveness, Safety and Clinical Management

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Abstract

Due to the increase in obesity worldwide, nowadays about 1 in 5 women are obese when they conceive. Even if the International recommendations on weight gain during pregnancy recommend to treat obesity before a woman becomes pregnant, these suggestions often results fruitless due to the difficulty of losing weight, especially in cases of morbid obesity. On the contrary, bariatric surgery has proven to be the most effective long-term weight loss strategy in obese women in reproductive age. In this review we analyzed the more recent papers describing pregnancy outcome after bariatric surgery. In particular, we focused on weight loss procedures and their potential effects mainly on maternal complications, so to give a comprehensive view of the benefits and risks of post-surgery pregnancy. The present review is structured introducing the pros and cons associated with various surgical procedures, then analyzing the differences in maternal outcomes among pregnant women previously undergone bariatric surgery or not and finally concluding with a focus on the post-surgery clinical management aimed to reduce surgical complications, which may occur during future pregnancies. We concluded that outcome of pregnancy is favorable after bariatric surgery. However, the low number of patients in some studies and the fact that the vast majority of the observations have been performed retrospectively, resulting in errors in matching with the control groups, severely limits the reliability of the conclusions drawn. We highlighted the risks associated with various types of bariatric surgery, stressing the optimization of the screening procedures for nutritional deficiencies and counseling on correct weight gain and nutrition for a successful pregnancy. This aim needs to be achieved with the collaboration of a multidisciplinary team of specialists that work before, during and after delivery.

Keywords: Pregnancy; Bariatric surgery; Malnutrition

Introduction

Due to the increase in obesity worldwide [1,2], nowadays about

1 in 5 women are obese when they conceive [1-3]. This gives rise to a potential conflict between the need to control obesity and weight gain during pregnancy to avoid offspring suffering from the negative consequences of their mothers' obesity, on the one hand, and the need to prevent the fetal malnutrition and related complications that might arise if a mother's obesity is treated aggressively during her pregnancy [4-6].

Although international guidelines on weight gain during pregnancy recommend treating obesity before a woman becomes pregnant [5,6], these recommendations often prove fruitless due to the difficulty of losing weight, especially in cases of morbid obesity [4-6]. Nonsurgical weight loss options include lifestyle interventions, such as diet and exercise, and medication. These options generally have modest benefits and their efficacy is directly linked to compliance, which wanes over time in most studies. Bariatric surgery has proved the most effective long-term weight loss strategy in obese women of reproductive age, but clinicians should be aware of the effects of bariatric surgery on fertility and future pregnancies [7,8]. We focus particularly on weight loss procedures and their potential effects, especially on maternal complications, to provide a comprehensive overview of the benefits and risks of pregnancy after bariatric surgery.

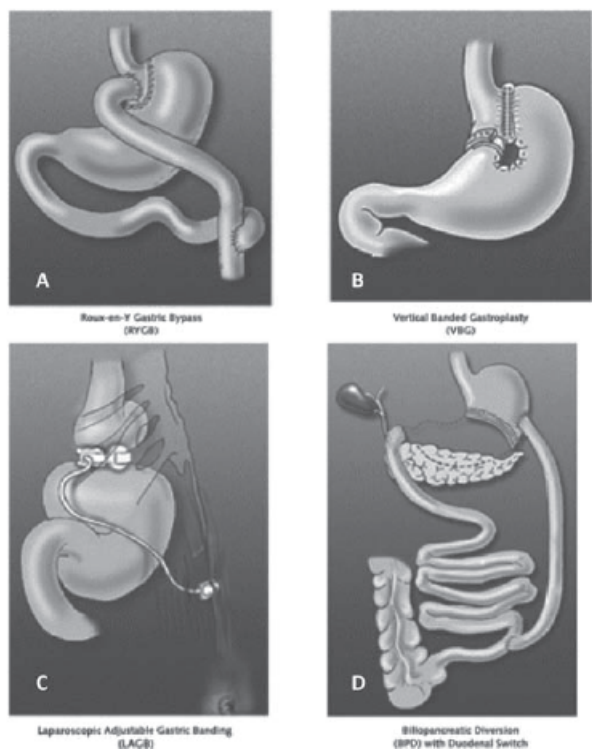


Figure 1: Graphical comparison between malabsorptive (A: Roux-en-Y gastric bypass; D: biliopancreatic diversion) and restrictive (B: vertical banded gastroplasty; C: laparoscopic adjustable gastric banding) procedures used in bariatric surgery.

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Received January 09, 2014; Accepted February 07, 2014; Published February 12, 2014

Citation: Chilelli NC, Burlina S, Dalfrà MG, Lapolla A (2014) A Focus on the Impact of Bariatric Surgery on Pregnancy Outcome: Effectiveness, Safety and Clinical Management. J Obes Weight Loss Ther 4: 210. doi:10.4172/2165-7904.1000210

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Bariatric Surgery: Restrictive Versus Malabsorptive Procedures

Bariatric surgery encompasses a variety of effective procedures, each with its own potential risks to subsequent pregnancies. The procedures are divided into three general categories: restrictive, malabsorptive/restrictive, and malabsorptive [9,10]. Among the malabsorptive/restrictive procedures, the most commonly used in recent years has been the Roux-en-Y gastric bypass (RYGB, Figure 1A), which involves creating a proximal gastric pouch connected to a Y-shaped loop of small bowel so that most of the stomach and duodenum are bypassed, thereby limiting the absorption of fat and calories. RYGB is currently the bariatric surgery procedure most often performed around the world. Malabsorptive procedures are used less frequently and include biliopancreatic diversion (BPD, Figure 1D) and biliopancreatic diversion with duodenal switching (BDS/DS). BPD consists in a partial gastrectomy, creating a small gastric pouch that is connected to the distal small bowel through a portion of the ileum in order to bypass a large part of the small bowel. The mechanisms underlying malabsorptive techniques are not related simply to malabsorption and delayed emptying; there are reports of an increase in the satiety hormone (peptide tyrosine-tyrosine), with effects that last for at least 24 months [11]. These procedures also appear to modify the physiology of other enterohormonal mediators involved in regulating insulin systems and glucose homeostasis (e.g. GLP-1), and these changes would affect satiety and energy balance, with additional effects on weight loss [12]. Both malabsorptive/restrictive and pure malabsorptive procedures are more effective than restrictive solutions as far as weight reduction is concerned, but they are also associated with a number of surgical and metabolic complications. Postoperative complications include dehiscence, ulcers, wound infections, cardiac events, pulmonary embolism and gastric leaks. The increasing body of surgical experience, especially using laparoscopic RYGB, has nonetheless reduced the perioperative mortality rate in recent years to 0.25% of cases [13]. Besides the desired malabsorption effects, procedures like the RYGB and BPD can cause chronic deficiencies in nutrients such as vitamins, folic acid, and albumin. Particular attention has recently been paid to the high prevalence of vitamin A deficiency and D following bariatric surgery procedures. So, given the crucial role of these micronutrients in proper fetal development, their careful monitoring with biochemical tests is recommended for most pregnant women undergoing malabsorptive procedures [14,15].

Restrictive procedures consist in reducing the stomach's capacity so as to induce early satiety and reduce energy intake. While this type of procedure seems to lack the effect on enterohormonal mediators seen after RYGB, the main satiety-inducing mechanism in this case derives from the activation of specific receptors of the myenteric ganglia; and these vagal stimulations are responsible for a smaller appetite [16]. Vertical banded gastroplasty (VBG, Figure 1B) was introduced first but

has since been largely abandoned in favor of laparoscopic adjustable gastric banding (LAGB, Figure 1C) [17]. In the LAGB procedure, an inflatable silicon gastric band is placed horizontally around the proximal part of the stomach. The band's diameter can be adjusted non-invasively after surgery to modify the degree of restriction. This option may be particularly useful during pregnancy to obtain an optimal nutritional status for the mother and a consequently regular fetal growth. Restrictive procedures determine a smaller weight reduction over time than the malabsorptive approach, but are easier to perform and less invasive. Pouch enlargement, band slip, band erosion, port-site infections, and port rupture are the most common complications associated with LAGB [18]. Perioperative mortality is extremely low (0.01%). Postoperative complications of restrictive procedures are infrequent and include gastric obstruction, erosion and necrosis, access port problems, gastric pouch dilation, nausea and vomiting. Nutritional deficiencies are less common with the restrictive approach, while nausea and vomiting are associated with both malabsorptive and restrictive procedures [8,19].

Impact of Bariatric Surgery on Maternal Outcome During Pregnancy

There is increasing evidence to suggest that weight loss after bariatric surgery may improve maternal outcomes by reducing obesity-associated obstetric risk factors. In particular, a number of positive effects related to bariatric surgery can be closely related to a more limited weight gain during pregnancy.

Weight gain

Weight gain during pregnancy is an important birth weight predictor [20,21], so a maximum weight gain of 5-9 kg is recommended in morbidly obese women [5]. Few measures to achieve this result have proved genuinely effective, however. The National Institute for Health and Clinical Evidence has pointed out that surgery is more effective than nonsurgical approaches in obese people (BMI>38 for women and >34 for men) [22]. Concerning pre-pregnancy weight loss, the available data indicate that non-surgical options, including lifestyle changes and drug therapy, may be effective in the short term, but fail in the long term [23]. In fact, the success of dietary intervention is more closely related to patients' compliance than to the type of diet adopted [24]; and it has been recognized that drug therapy has several side effects that have limited its clinical use.

Bariatric surgery has proved successful in containing weight gain during pregnancy by comparison with pregnancies in women not treated surgically, or with matched control groups of pregnancies not complicated by obesity (Table 1). In a study conducted by Wittgrove et al. [25], weight gain during pregnancy tended to be lower in patients who had previously undergone gastric bypass surgery, whose average weight gain was 12.7 kg as opposed to the 20.4 kg of pregnancies occurring before such surgery. These data were confirmed by Dixon et

Author	Wittgrave 1998	Shneider 2004	Skull 2004	Marceau 2004	Dixon 2005	Ducarme 2007	Lapolla 2010
Bariatric surgery	RYGB	All	LAGB	BPD	LAGB	LAGB	LAGB
Weight gain	↓		↓	=	↓	↓	↓
Gestational hypertension		↑	↓		↓		↓
Gestational diabetes mellitus	↓	↑	↓		↓	↓	↓
Caesarean section rate	↓	↑	↑			↓	↑

LAGB = laparoscopic adjustable gastric binding
 RYGB = Roux-en-Y gastric bypass
 BPD = biliopancreatic diversion

Table 1: Maternal outcome after bariatric surgery treatment for maternal obesity.

CLINICAL COMPLICATIONS	METABOLIC COMPLICATIONS
Internal hernias	Severe anemia
Bowel obstruction	Calcium deficiency
Band erosion	Folate deficiency
Band migration	Vitamin D deficiency
Cholelithiasis	Vitamin B12 deficiency
Hyperemesis	Caloric malnutrition

Table 2: Bariatric surgery complications during pregnancy.

al. [26,27], and by Skull et al. [28] in patients treated with LAGB, so it seems that bariatric surgery is able to induce an appropriate weight gain during pregnancy.

Nutritional status and surgical complications

The positive effect of bariatric surgery in preventing an excessive weight gain during pregnancy in obese women may be counterbalanced by certain negative aspects, however, relating to surgical complications during the pregnancy and the effects of nutritional deficiencies (Table 2). Several case reports have described nutritional deficiencies in women becoming pregnant after bariatric surgery [29-32]. In particular, Bebbler et al. [33] reported that such women had frequently had low levels of vitamin B12 (in 53.4% of cases), folic acid (16%), ferritin (41.7%), calcium (16.7%) and albumin (10%), that the authors attributed to the women's considerable weight loss before their pregnancy (47.8 ± 22.2 kg). In a small study on 32 pregnant women previously treated with bariatric surgery, Millene Dell'Agnoletto et al. [34] reported a high rate of anemia, with blood transfusions being required in 17% of cases. Systematic studies have failed to confirm this association, however [31,35]. Although these iron, fat-soluble vitamin and mineral deficiencies are more common after RYGB (because most of the stomach and the duodenum are bypassed), they can also occur after restrictive procedures such as LAGB [36]. It is highly likely that the risk of maternal and fetal malnutrition can be balanced in such cases by a careful follow-up for the mothers and the use of suitable nutritional supplements during their pregnancy (see above). As for the complications relating to bariatric surgery in pregnancy, there have been reports of one case of gastrointestinal bleeding after VBG and nine of bowel obstruction after RYGB [37,38], with two maternal deaths and one fetal death. These findings warrant a few further comments, however. It is worth bearing in mind that pregnant women are at risk of bowel obstruction due to the increased abdominal pressure associated with the enlargement of the uterus during pregnancy, so a close follow-up to ensure the prompt recognition of any signs of bowel obstruction is essential in women who have undergone bariatric surgery to prevent this complication. Care must also be taken over the band itself when monitoring pregnant women with a history of LAGB: as Dixon suggested [26,27], we do not routinely deflate the band as soon as a woman becomes pregnant, but we do monitor patients throughout their pregnancy and we deflate the band percutaneously in cases of poor nutrition or vomiting [39]. While this approach enables patients to benefit from the effect of the band in controlling their food intake during their pregnancy, it also reduces the risk of nutritional deficiencies potentially associated with LAGB.

Risk of gestational diabetes mellitus (GDM) and related comorbidities

GDM is a significant cause of maternal and neonatal morbidity. GDM rates were found lower in patients who had undergone bariatric surgery than in their obese counterparts who had not [40] (though the former rates were still higher than in the general population). This positive effect of surgery may coincide, however, with an increase in small for gestational age (SGA) neonates.

As for other important pregnancy outcomes, there is a well-known correlation between obesity and the risk of gestational hypertension and preeclampsia [41]. Studies comparing pre- and post-bariatric surgery pregnancies showed a consistent reduction in the incidence of hypertensive disorders after bariatric procedures [26,28,39,42]. In a study of ours [42], however, when pregnancy outcomes in LAGB-treated women were compared with findings in a population of normal-weight women, the former still had significantly higher rates of gestational hypertension, pre-eclampsia/eclampsia and preterm delivery, and meaning that pregnancy still carries a higher risk of complications in such patients. Conversely, when women treated with LAGB before pregnancy were compared with a group of unoperated morbidly obese women, the former had significantly lower rates of gestational hypertension and pre-eclampsia/eclampsia than the latter. It is worth emphasizing that patients in the present study treated with LAGB were compared with unoperated morbidly obese women being monitored during their pregnancy in terms of their adherence to dietary recommendations, weight gain and obstetric and metabolic complications. In another study, Patel et al. reported finding no differences in the above-mentioned outcomes between RYGB-treated, non-obese and severely obese pregnant women [43].

Delivery

No definitive conclusion can be drawn as concerns the mode and complications of delivery (cesarean section rate, labor induction, postpartum hemorrhage) in women who have had bariatric surgery because their incidence has reportedly been lower [39], higher [35] or the same [44], as in unoperated obese mothers.

Publications on these aspects have often been underpowered or even generated conflicting results, due mainly to the fact that almost all such studies were retrospective case-control observations or cohort studies, or case reports. To date, no randomized controlled trials have been performed in this field, and this explains the enormous limitations of the conclusions that can be drawn.

Clinical management of pregnant women with a history of bariatric surgery

The rate of complications related to bariatric surgery is approximately 5%, with no significant differences emerging between restrictive and malabsorptive procedures.

Intestinal obstruction

Small bowel obstruction is one of many recognized postoperative complications. For such a serious condition, its onset can be remarkably deceptive and it is easily misdiagnosed, particularly in pregnant women [45]. Intestinal hernias are more common, severe surgical complications, though hernias can also occur in the abdominal wall. The pathophysiological mechanism underlying these events relates on the one hand to the greater space in which the intestinal loops can engage during rapid weight loss, due to the increase in intra-abdominal pressure caused by the expanding uterus; on the other hand, any adhesions developing after the surgical procedure may per se increase the risk of intestinal hernias. In the postpartum period too, the sudden reduction in the volume of the uterus raises the risk of intussusception and intestinal obstructions [46]. The above-mentioned complications should always be suspected in women reporting severe symptoms such as abdominal pain (especially postprandial, intermittent, and at mesogastric level), nausea or vomiting. Although computed tomography is a non-invasive investigation, laparoscopic surgical exploration is considered the gold standard diagnostic procedure in

these cases. The most frequent complication after LAGB in pregnancy is band slippage, which occurs with intermittent nausea, vomiting and progressive dysphagia. The preferable diagnostic test is x-ray with barium, though – here again – if the symptoms are severe and slippage is strongly suspected, laparoscopy is nullifying [46].

Nutritional deficiencies

Screening for nutritional complications, such as micro- and macronutrient deficiencies, has been very little explored in the literature. Only one study assessed the differences before and after pregnancy in women who had previously undergone bariatric surgery [47], which was RYGB in all cases: this study showed that protein (71 g) and iron (60 mg) intake barely met the recommended nutritional standards, while calcium and vitamin B12 levels were below the standard recommendations, whereas glucose, lipid and uric acid levels were markedly better than before surgery. Although this was not quantified, all the women had been on vitamin supplementation before pregnancy, indicating the essential role of careful nutritional assessment prior to conception, and the feasibility of supplementation to avoid major deficiencies in pregnancy. Clinical providers should assess a woman's hemoglobin, iron, and vitamin status at least at the beginning of the pregnancy and, where appropriate, in each subsequent trimester (depending on her preconception and/or initial pregnancy status). Women who have had restrictive surgery should be monitored more closely, since the prevalence of anemia in such cases is reportedly nearly 50% [48,49].

Dumping syndrome

One last condition that should be considered, especially in women who have undergone restrictive surgery, is the risk of dumping syndrome. This is caused by the rapid passage of glucose into the small intestine, and it becomes manifest with symptoms resulting from hyperinsulinemia and hypoglycemia (palpitations, fatigue, irritability, sweating) typically within 30 minutes of eating a meal. It is important to provide patients with appropriate dietary guidelines to prevent this condition, stressing the importance of eating complex rather than simple carbohydrates, and drinking between meals rather than during meals. Screening for GDM with the oral glucose tolerance test (OGTT) using 75 g of glucose is not to be recommended in such cases; these patients should undergo fasting and postprandial blood glucose monitoring instead [48].

Timing for conception

One of the main factors to consider in the clinical management of obese women who undergo bariatric surgery is the best timing for conception. The rapid weight loss that commonly occurs in the months following any bariatric surgery can cause problems, especially in the newborn, which may have a low birth weight or develop malformations [50]. The adjustments the body has to make in response to a major weight loss are physiologically unsuited to pregnancy, which coincides with a natural increase in nutritional requirements [51]. Some recommendations thus suggest that women delay pregnancy for 24 months after bariatric surgery, while others recommend delaying pregnancy until the patient's weight has become stable (usually 12-18 months after surgery) [33,52].

Despite such recommendations, the latest recommendations of the American College of Obstetricians and Gynecologists (ACOG) say nothing about the best timing of conception for patients undergoing bariatric surgery [53]. This is probably due to the lack of data in the literature, which makes it hard to say how patients should be advised

on this issue. Thus, for the time being, while we await studies with more reliable data on maternal-fetal outcomes, the general recommendation is to procrastinate conception for at least a year, which is the average time it takes for a patient's weight to stabilize [50,54].

Conclusions

Several studies have reported that the outcome of pregnancy after bariatric surgery is favorable, but the small numbers of patients involved in some studies, and the fact that the vast majority of them were performed retrospectively, resulting in errors in the matching of patients with control groups, severely weakens the reliability of the conclusions drawn. The data available in the literature on pre-pregnancy weight loss indicate that bariatric surgery works better than the usual dietary recommendations for morbidly obese women. It is nonetheless important not to underestimate the risks associated with various types of bariatric surgery. Optimized screening procedures need to be implemented by a multidisciplinary team of specialists working before, during and after delivery to detect nutritional deficiencies and counsel women on an appropriate weight gain and nutrition for a successful pregnancy. Randomized controlled trials are needed to establish the safety of bariatric surgery procedures in relation to pregnancy outcome, the ideal calorie and protein intake, and weight gain during pregnancy for women who have undergone bariatric surgery.

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