OBES SURG (2008) 18:1023–1027
DOI 10.1007/s11695-007-9389-3

REVIEW

Reproductive Considerations and Pregnancy after Bariatric Surgery: Current Evidence and Recommendations

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Received: 31 October 2007 / Accepted: 28 November 2007 / Published online: 8 April 2008

Abstract Obesity has reached epidemic proportions in the USA. Bariatric surgery is an important and increasingly utilized treatment option for morbid obesity refractory to medical therapy. Approximately half of all bariatric surgery patients are reproductive-aged women and, thus, represent a unique patient population with specific concerns. This manuscript focuses on issues of increased postoperative fertility, nutritional monitoring and supplementation, safety of pregnancy after bariatric surgery, and effect of pregnancy on postoperative weight loss. Current recommendations regarding management of patients both before and during pregnancy are provided. In addition, we highlight areas where more research on this issue is needed and advocate for a multidisciplinary approach to patient care.

Keywords Morbid obesity · Bariatric surgery · Weight loss · Fertility · Pregnancy · Prenatal nutrition physiology

Introduction

Obesity represents a serious public health concern in the USA and throughout the world. An estimated 1.7 billion people worldwide are overweight or obese, and more than 30% of American women have a BMI≥30 kg/m^2, illustrating the vast scope of this problem [1, 2]. Obesity is associated with numerous comorbidities affecting virtually every organ system, including hypertension, type II diabetes mellitus, coronary artery disease, dyslipidemia, certain cancers, and ultimately increased mortality [3]. Obese women of reproductive age are a specific group at risk for a host of obesity-related reproductive and obstetric complications, such as infertility, early miscarriage, neural tube defects, gestational hypertension and diabetes mellitus, pre-eclampsia, preterm birth, and intrauterine fetal demise (IUFD) [4].

Obesity is notoriously difficult to manage. Diet, behavioral therapy, exercise, and pharmacologic intervention have been traditionally used but generally yield modest results, and weight regain is common [5]. In cases of failed medical therapy, bariatric surgery is a promising treatment for severe obesity, defined as BMI ≥40 kg/m^2 or ≥35 kg/m^2 with obesity-related comorbidities [6]. Data indicate that weight loss surgery is highly effective in the management of severe obesity, resulting in long-term excess weight loss of greater than 60%, often with complete resolution or improvement of diabetes, hyperlipidemia, hypertension, and obstructive sleep apnea [7]. Bariatric surgery has been recently proven to decrease mortality in postoperative patients when compared to obese controls and is, thus, a promising weapon in the fight against obesity [8, 9]. To combat reproductive complications of obesity, the American College of Obstetrics and Gynecology (ACOG) advocates weight loss prior to conception and acknowledges bariatric surgery as preliminarily promising in prepregnancy obesity treatment [10].

Bariatric surgical procedures are generally categorized as restrictive or malabsorptive. Restrictive approaches like vertical banded gastroplasty and laparoscopic adjustable gastric banding are designed to limit caloric intake, whereas primarily malabsorptive procedures such as biliopancreatic diversion with or without duodenal switch promote weight loss by decreasing nutrient absorption. Gastric bypass, the

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most common weight loss operation performed worldwide today, combines both restrictive and malabsorptive principles, although the malabsorption primarily occurs at a micronutrient level following this procedure [11]. Nutritional complications of restrictive procedures are rare but may include iron, calcium, and thiamine deficiencies [12]. Malabsorptive procedures can lead to macronutrient deficiencies like protein–calorie malnutrition and fat malabsorption, as well as deficiencies in fat-soluble vitamins [12]. Finally, both biliopancreatic diversion with or without duodenal switch and gastric bypass may lead to micronutrient malabsorption, causing deficiencies in iron, calcium, and vitamin B12 [12]. Understanding the mechanism of each weight loss surgery is key in counseling patients, especially pregnant and reproductive-aged women, regarding nutritional status and vitamin supplementation.

Estimates indicate that more that 200,000 bariatric surgical procedures were performed in 2006 [13]. Because about half of weight loss procedures are done in women of childbearing age, post-bariatric-surgery reproductive concerns and pregnancy represent important issues for both patient and surgeon [14]. Despite the presence of this ever-growing patient population, concise recommendations for counseling and management of reproductive-aged bariatric surgery patients are lacking. Currently, no succinct formal guidelines outlining the specific interests of the bariatric surgeon exist in the literature. In this article we summarize the current evidence on this issue, with a focus on the phenomenon of increased postoperative fertility, safety of pregnancy after weight loss surgery, nutritional concerns preconception and during pregnancy, potential benefits of bariatric surgery on future pregnancy, and the influence of pregnancy on the efficacy of weight loss surgery. In turn, we make specific recommendations for patient care, which will serve to guide the surgeon in the management of the reproductive-aged and pregnant bariatric surgery patient.

Bariatric Surgery and Obesity-related Infertility

There is a strong association between obesity and infertility, and weight loss can result in increased fecundity in obese women [15]. Polycystic ovarian syndrome (PCOS), a common cause of anovulation, represents an important link between obesity and infertility. Although PCOS embodies a wide spectrum of disease with unclear pathophysiology, it is commonly defined as oligo- or anovulation, hyperandrogenism, and polycystic ovaries by ultrasound. Notably, at least half of women with PCOS are obese and thus require special attention, as they represent potential bariatric surgery patients [16].

The effects of bariatric surgery on PCOS and obesity-related infertility in general have been explored recently, and results are preliminarily promising. In 2005, Eid et al. demonstrated resolution of anovulation, infertility, and hirsuitism in 24 patients with PCOS after Roux-en-Y gastric bypass [17]. Subsequently, Teitelman et al. found that about half of women undergoing bariatric surgery at the Hospital of the University of Pennsylvania were anovulatory preoperatively [18]. Interestingly, 71.4% of the study participants resumed normal menses after bariatric surgery (mostly Roux-en-Y gastric bypass), and the amount of weight loss was associated positively with resolution of menstrual dysfunction. Thus, weight loss surgery may improve obesity-related infertility. The bariatric surgeon is therefore advised to counsel patients of reproductive age that increased fertility may occur in concert with postoperative weight loss. Reliable contraception should in turn be a mainstay of postoperative care of the reproductive-aged female.

Safety of Pregnancy Following Bariatric Surgery

Because patients generally undergo a period of rapid weight loss after bariatric surgery, there is a theoretical concern that either the mother or fetus may become malnourished during postoperative pregnancy. Furthermore, specific nutritional deficiencies in iron, folate, B12, calcium, and vitamin D following malabsorptive procedures may potentially lead to fetal complications, including preterm birth, low birthweight, neonatal hypocalcemia or rickets, maternal osteomalacia, fetal mental retardation, and neural tube defects [19]. Nutritional supplementation and close monitoring of nutritional status both preconception and during pregnancy is therefore a crucial element of patient care by the bariatric surgeon and high-risk obstetrician.

Currently, there is no consensus regarding nutritional management of reproductive-aged and pregnant women after bariatric surgery. In our practice, we recommend daily oral supplementation with an iron-fortified multivitamin to all patients after Roux-en-Y gastric bypass along with 50 g of dietary protein intake. In addition, we prescribe calcium supplementation and monthly vitamin B12 intramuscular injections to our postbypass patients, although weekly nasal spray B12 supplementation may be just as effective [20]. Guidelines on specific vitamin dosages have been minimally studied and remain largely theoretical. Based on a compilation of evidence and recommendations from both the obesity surgery and obstetrics literature, we suggest 400 μg of folic acid daily for postbypass reproductive-aged and pregnant women to protect against fetal neural tube defects [21]. Although it is generally agreed that pregnant women need 30 mg of elemental iron daily to prevent deficiency, postbypass patients have been shown to have increased iron requirements due to decreased absorption

[19, 22]. Therefore, we recommend at least 50–100 mg of elemental iron daily for our menstruating and pregnant patients, with close monitoring of serum iron indices [19, 22].

Pregnant women require 1,000 mg of calcium daily, which represents only a slight increase over the needs of their nonpregnant counterparts [19]. Furthermore, supplementation of calcium and vitamin D is not generally recommended in pregnancy [23]. Therefore, we recommend continuing our usual postbypass calcium supplementation regimen of 500 mg twice per day in concert with monitoring of parathyroid hormone and vitamin D levels to ensure adequate intake and absorption. In addition, we advise an increase in dietary protein intake to 60 g per day in pregnant patients to allow for the protein requirements of the developing fetus [23]. Finally, as vitamin A has been shown to be teratogenic at high levels, we recommend that pregnant and reproductive-aged women take just one prenatal vitamin daily and avoid over supplementation.

Of note, these recommendations mainly refer to nutrition in post-gastric bypass patients. Nutritional requirements of patients after biliopancreatic diversion with or without duodenal switch would also include close monitoring for macronutrient deficiency early on and throughout pregnancy with careful supplementation of fat-soluble vitamins.

Case reports of pregnancy after bariatric surgery demonstrated concerning complications related to poor maternal nutritional status, including anemia, neural tube defects, and intrauterine growth retardation (IUGR) [24–26]. In addition, a case of gastrointestinal bleeding after vertical banded gastroplasty and reports of fatal bowel obstruction secondary to internal intestinal herniation after Roux-en-Y gastric bypass caused further alarm among both bariatric surgeons and obstetricians alike [27, 28]. Although just nine case reports of intestinal obstruction with two maternal deaths and one fetal death after gastric bypass exist in the literature, this is a highly morbid pregnancy complication worthy of specific comment. Pregnant women may be at increased risk of bowel obstruction secondary to increased abdominal pressure associated with gravid uterus. In a recent review article, Wax et al. explored the literature on this subject, ultimately advising the bariatric surgeon to retain a high margin of suspicion and low threshold for surgical exploration in post-bariatric-surgery patients presenting with signs and symptoms of bowel obstruction [14]. Wax et al. further conclude that although CT scan must be used judiciously, especially during early pregnancy, it should be the imaging modality of choice in these women because complications of bowel obstruction are potentially devastating. Prompt recognition of intestinal obstruction may be difficult, however, as patient complaints and clinical findings are often nonspecific. We therefore advise the bariatric surgeon to work closely with the high-risk obstetrician in the management of postsurgical pregnant patients and remain vigilant when bowel obstruction is suspected.

Despite initial concerns regarding safety of pregnancy after weight loss surgery, recent larger studies have demonstrated no association between bariatric surgery and adverse perinatal outcome. Perhaps the most influential research on this issue was conducted Sheiner et al. at a large Israeli medical center [29]. In this study, 298 deliveries post-bariatric-surgery (of unspecified type) were compared with all other hospital deliveries (n=159,210) during the study period between 1988 and 2002. Utilizing multivariate analysis, Sheiner et al. did find association between the history of bariatric surgery and obstetric risk factors including IUGR and premature rupture of membranes. Patients with previous bariatric surgery were, however, more likely to deliver by cesarean section (OR 2.4, 95% CI: 1.9–3.1, p<0.001), and their babies tended to be macrosomic (OR 2.1, 95% CI: 1.4–3.0, p<0.001). Most importantly, there was no association between history of bariatric surgery and adverse perinatal outcome, with no increased incidence of congenital malformations (unspecified) and fetal distress. A smaller study by Dao et al. demonstrated that pregnancy after gastric bypass may even be safe less than 1 year after the procedure [30].

Several studies suggest that a history of bariatric surgery may in fact be associated with decreased obesity-related pregnancy complications when compared to preoperative pregnancies in the same patients. In a study of 36 post-Roux-en-Y gastric bypass pregnancies with 17 preoperative controls, Wittgrove et al. found decreased rates of gestational diabetes mellitus, hypertensive disorders, and fetal macrosomia in the postsurgery group [31]. Similar reductions in incidence of pregnancy-induced hypertension and gestational diabetes have been observed after laparoscopic adjustable gastric banding [26, 27]. Thus, weight loss after bariatric surgery may actually promote improved perinatal and maternal outcomes by reducing obesity-associated obstetric risk factors, although this subject requires more focused exploration.

Pregnancy and the Efficacy of Weight Loss Surgery

Most literature on reproductive concerns and pregnancy after bariatric surgery has focused on obstetrical risks and neonatal outcomes. Questions of import to the bariatric surgeon regarding the effect of pregnancy on postoperative weight loss have been largely ignored. Most investigators have approached this issue by examining pregnancy weight gain and postpartum weight loss in post-bariatric-surgery patients. In the study described above by Wittgrove et al., weight gain during pregnancy tended to be less in postbypass patients, with an average gain of 12.7 kg in

study patients vs. 20.4 kg in the prebypass control group [31]. Interestingly, all but two women in the postbypass group lost pregnancy weight within 5 weeks postpartum, illustrating that pregnancy may have little effect on the efficacy of weight loss surgery. Dixon et al. and Skull et al. confirm these data in patients with lap adjustable gastric banding, demonstrating less weight gain during pregnancy in post-bariatric-surgery patients [32, 33]. According to Martin et al., weight loss during pregnancy may actually be safe for the fetus in women with history of bariatric surgery, although they observed this trend in just five patients [34]. Furthermore, Printen et al. found that postpartum weight loss occurs at a similar rate in postbypass patients when compared to nonpregnant, postoperative counterparts [35]. Thus, a history of bariatric surgery seems to be protective in terms of pregnancy-associated weight gain, although no studies have demonstrated the effect of pregnancy on long-term weight loss after bariatric surgery.

Traditionally, women have been advised to delay pregnancy at least 12–18 months after bariatric surgery to avoid nutritional complications and promote successful weight loss. The issue of this theoretical effect of early postoperative pregnancy on weight loss is an important one for the bariatric surgeon, who is chiefly concerned with the promotion of patient health through the treatment of obesity with weight loss. Although this question has never been directly explored in the literature, Dao et al. present data on the subject in conjunction with their research on the safety of early post-bariatric-surgery pregnancy [30]. In their study, Dao et al. compared outcomes of 21 pregnancies conceived within 1 year postoperatively with 13 pregnancies conceived greater than 1 year after surgery. The women in the early-pregnancy group gained an average of 4 lb (1.8 kg), whereas the late-pregnancy group gained 34 lb (15.5 kg). These averages, however, represented a wide range of figures, as one woman in the early-pregnancy group lost 70 lb (31.8 kg), whereas another gained 45 lb (20.5 kg). Postpregnancy, the early group lost 14 lb (6.4 kg), whereas the late group averaged a 21-lb (9.5 kg) weight loss. Thus, although early pregnancies are associated with less weight gain, they may be also associated with less postpartum weight loss. Again, we are unable to make a conclusion regarding the effect of pregnancy timing on the efficacy of post-bariatric-surgery weight loss, as long-term data are missing. Therefore, we continue to recommend our patients wait at least 1 year postoperatively before becoming pregnant, as data are inconclusive. In addition, we highlight the need for research directly focused on this area of import to the bariatric surgeon.

Discussion

In general, data regarding reproductive concerns and pregnancy after bariatric surgery are of varying quality, often limited to small case reports and descriptive or retrospective studies. Further research is needed before drawing definitive conclusions regarding management of reproductive-aged post-bariatric-surgery patients. That being said, it appears that pregnancy after bariatric surgery is not only safe for mother and baby but may also be less risky than pregnancy in morbidly obese patients. In caring for post-bariatric-surgery reproductive-aged and pregnant women, specific focus on fertility counseling, nutritional assessment and supplementation, observation for potentially fatal complications like intestinal obstruction, and monitoring for adequate weight management must be diligently maintained by both bariatric surgeons and obstetricians.

Preliminary recommendations for care of these patients are highlighted in Table 1. Contraception is advised specifically during the period of maximum postoperative weight loss (12–18 months) to avoid potential risks of complications secondary to poor maternal nutritional status

Table 1 Reproductive management after bariatric surgery

Management recommendations
Postoperative fertility counseling
Reliable contraception for 12–18 months after surgery
Nutritional monitoring and supplementation tailored to the type of bariatric procedure performed with specific focus on identifying and treating deficiencies in iron, folate, B12, calcium, and vitamin D both pre- and postconception
Recommendations during pregnancy: one standard prenatal vitamin daily, which may include or should be supplemented with the following
400 μg folate daily for all reproductive-aged women
50–100 mg elemental iron daily for menstruating and pregnant women
1,000 mg calcium daily for all postoperative patients
60 g of dietary protein daily for pregnant patients
Low threshold for suspicion of intestinal obstruction during pregnancy. Image via CT scan and surgical exploration as needed
Close follow up of weight changes during pregnancy and postpartum
Cooperation with high-risk obstetrical colleagues in patient management

and promote optimal weight loss in the patient. Of note, some surgeons specify that patients wait a minimum of 18 months before becoming pregnant after malabsorptive procedures, as nutritional deficiencies may be quite severe and may affect the developing fetus. The nutritional status of the pregnant patient should be closely monitored with routine measurements of serum iron indices, as well as folate, parathyroid hormone, and vitamin D levels, with modification of supplementation recommendations as required. Weight changes during pregnancy and in the postpartum period should be followed in an effort to maximize weight loss and ensure fetal health.

Our guidelines generally echo ACOG recommendations for care of post-weight-loss-surgery patients [8]. Coordination between bariatric surgeons and their high-risk obstetrical colleagues is of the utmost importance to promote maternal and fetal wellbeing in concert with continuing postoperative weight loss. In addition, cooperative care by both care providers will ultimately foster the unifying goal of patient health while perhaps stimulating collaborative research and, in turn, further understanding of the issues facing these patients.

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