BARIATRIC SURGERY IN PREGNANCY: BENEFITS, RISKS AND OBSTETRIC MANAGEMENT

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BACKGROUND

Obesity is a growing problem in obstetric practice. A recent study from Glasgow (UK) showed that 50% of women of childbearing age are either overweight (Body Mass Index [BMI] = 24.9–29.9 kg/m²) or obese with 18% starting pregnancy as obese. Obesity prevalence has doubled over a decade from the early 1990’s. In the US it is estimated that 30% of reproductive-age women have a BMI greater than 30 kg/m² while 7% have a BMI > 40 kg/m². A recent report from the UK found that 5% of women had a BMI > 35 kg/m², 2% > 40 kg/m² and 0.2% > 50 kg/m² with an association not only with social deprivation, but also with a higher prevalence of pre-existing medical disorders such as diabetes and hypertension and medical complications of pregnancy such as preeclampsia. Obesity was also associated with increased rates of macrosomia, operative delivery and postpartum haemorrhage. These data highlight the fact that obesity is an increasing health concern particularly in young women of childbearing age. Obesity will expose them to significant pregnancy complications ranging from miscarriage and fetal abnormality through to operative delivery and thromboembolism. There are also challenges for the delivery of maternity care to meet the needs of these women. As obesity is associated with significant pregnancy complications it is important that women enter pregnancy with an optimum body weight. Many complications, such as fetal abnormality occur in the first trimester and so pre-pregnancy weight reduction is preferred. Further, there is insufficient evidence to recommend specific dietary and/or physical activity interventions to reduce weight or moderate weight gain during pregnancy.

Weight reduction through diet and exercise may be regarded as optimal, but increasingly women are turning to bariatric surgery to lose weight quickly. One study reviewing published reports in this area showed that in the 3 years leading up to November 2008, 150,000 women of reproductive age were reported to have...
undergone bariatric surgery with evidence of good perinatal outcome\textsuperscript{5}. It is estimated that approximately 100,000 surgical procedures for obesity were performed in the US alone in 2004, with more than 50\% being performed in women of childbearing age\textsuperscript{6}. During the same period it was also estimated that 600 such procedures were performed in the UK.

The criteria for funding surgery in health care systems, such as the National Health Service in the UK, have become more favourable for such patients in recent years. Furthermore more surgeons are performing weight-loss surgery, and new less invasive surgical procedures are emerging. A recent systematic review from the USA suggests that a significant number of patients are undergoing outpatient bariatric surgery such as laparoscopic adjustable gastric banding (LAGB)\textsuperscript{5}, making such procedures more easily available to the wider population. Management of obesity related health problems centres on weight loss and many women, having tried dietary and medical weight loss unsuccessfully, will opt for weight loss surgery with its rapid and effective impact on weight, rather than prolonged dieting. Thus obstetricians are increasingly likely to encounter women who have undergone bariatric surgery in their routine practice.

As noted above, obesity is a serious challenge to health and is often associated with comorbid conditions such as diabetes mellitus and chronic hypertension. The risks associated with obesity are particularly relevant in pregnancy. More than half of all women dying from direct or indirect causes in the most recent triennial report in the UK were either overweight or obese.\textsuperscript{7} Compared to women with a normal BMI, obese women who become pregnant are more likely to develop maternal complications including pregnancy induced hypertension (PIH) and pre-eclampsia, gestational diabetes, and venous thrombosis.\textsuperscript{8–10} Intrapartum problems including dysfunctional labour and cephalopelvic disproportion are more common. Obesity is an independent risk factor for caesarean section and greater weight gain predisposes to an even greater risk of caesarean delivery.\textsuperscript{11–14} The fetal outcome is also influenced with higher rates of miscarriage, fetal anomaly and macrosomia,\textsuperscript{10} with associated problems such as shoulder dystocia and birth injury. Pre-pregnancy weight loss should be of benefit and bariatric surgery is one increasingly common option. Indeed it is currently the only treatment for morbidly obese patients, which has been proven effective.\textsuperscript{15,16} Thus it is important to consider whether bariatric surgery brings new problems or benefits to pregnancy management.

**BARIATRIC SURGERY**

A recent systematic review and meta-analysis demonstrated the effectiveness of bariatric surgery in achieving weight loss and reducing co-morbidities.\textsuperscript{17} In this report, the mean percentage loss of excess weight were 47.5\%, 61.6\%, 68.2\% and 70.1\% for gastric banding, gastric bypass, gastroplasty and biliopancreatic diversion and duodenal switch respectively, with an overall mean excess loss of 61.2\%. Diabetes was completely resolved in 76.8\% with resolution or improvement in 86\%; hyperlipidemia improved in 70\%; hypertension resolved in 61.7\% and resolved or improved in 78.5\%.
Furthermore, 85.5% of patients with sleep apnoea had resolution of this problem after surgery. These data are supported by more recent studies confirming reduced incidences of problems such as preeclampsia and gestational diabetes following bariatric surgery. The impact of weight loss following LAGB placement on type 2 diabetes mellitus and impaired glucose tolerance is widely accepted. Resolution or remission of diabetes occurs in about 66% of patients with improvement of blood glucose control in the remainder. Weight loss surgery slows the progression of impaired glucose tolerance to type 2 diabetes mellitus and also reduces the risk of developing type 2 diabetes mellitus de novo in obese patients as evidenced in a follow-up study of 3000 patient-years of non-diabetic severely obese patients. Studies have also shown that blood pressure (BP) falls after LAGB placement. Hypertension is easier to control and many patients can stop their antihypertensive medication. About 55% of patients have normal BP and are not taking treatment and 31% are improved with easier BP control and less medication at 12 months after surgery with only 15% remaining unchanged. This effectiveness is emphasised by a large, prospective, 12 year follow up, observational study of 43,457 women, controlling for unintentional weight loss and for smoking status, which showed that a weight loss of at least 9 kg was associated with a 53% reduction in all obesity related deaths. In addition the Swedish Obesity Subjects study in diabetic patients reported an 80% reduction in annual mortality in their bariatric surgery group. One study also reported an improvement in mortality when comparing 1035 patients undergoing bariatric surgery with 5746 controls with a 5-year follow-up period; the relative risk of death was reduced by 89% (95% CI, 73%-96%), with an absolute mortality reduction of 5.49%.

**Types of surgery**

The principles of bariatric surgery are two-fold; to reduce the capacity of the stomach and give a sense of fullness after a small meal; and/or bypass the duodenum and proximal jejunum reducing absorption of food. These take the form of restrictive or malabsorptive interventions. The preferred surgery varies from surgeon to surgeon and from country to country. Gastric banding (Figure 1) procedures tend to be preferred in Europe, especially in France where most bariatric surgical interventions are performed in Europe. In the US, surgeons tend to prefer the Roux-en-Y gastric bypass (Figure 2) procedure. The commonest procedure worldwide in 2004 was laparoscopic gastric bypass (25.6%) followed by LAGB (24.2%).

The **Roux-en-Y gastric bypass (RYGB)**

This procedure, previously used for the management of peptic ulcer prior to the identification of Helicobacter pylori as the causative agent, achieves both mechanisms promoting weight loss namely restriction of the stomach size and bypassing part
of the small intestine resulting in malabsorption. A small gastric pouch is created in the upper part of the stomach with a small outlet restricting the amount of food that can be consumed. The procedure bypasses the rest of the stomach, the entire duodenum and a large section of the jejunum, up to 150 cm. Ingested food does not pass through the lower stomach and duodenum even though these continue to secrete digestive components such as gastric acid. This creates a degree of maldigestion and malabsorption leading to weight loss and reduction of obesity associated morbidities. The average weight loss is up to 70% of excess body weight (~35% of BMI) within 1–2 years of the procedure. This procedure results in profound changes in digestive anatomy and physiology, therefore long term follow-up is required. Surgical complications of this operation include anastomotic leaks, fistulae, obstruction and anastomotic stenosis. The mechanisms of nutritional deficiencies include:

1. Reduced food intake.
2. Reduced gastric secretions. Because the lower stomach is excluded, there is reduced gastric acid secretion, which is required for vitamin (especially B₁₂) and mineral (such as iron) absorption.
3. Exclusion of the duodenum and jejunum leading to malabsorption. The duodenum is the main site for the absorption of calcium, iron and vitamin B₁. This short-circuiting also results in dietary restrictions.
4. Asynergia between food bolus and bilio-pancreatic secretions.
The most common deficiencies therefore are iron, vitamin B$_1$, B$_{12}$, folate, vitamin D and calcium. Malabsorption of protein, carbohydrates and lipids can occur as 50% of protein is absorbed in the duodenum and the remainder in the small intestines. However, the commonest mechanism for protein deficiency, which can be severe, is reduced intake particularly as patients often have a dislike for meat. Severe iron deficiency resulting from malabsorption can fail to respond to oral iron therapy in which case intravenous iron infusion or blood transfusion may be required. Other micronutrient deficiencies that have been described include magnesium, potassium, zinc and selenium. A deficiency of zinc has been associated with excessive maternal hair loss. Neither zinc nor selenium deficiency have yet been associated with specific pregnancy complications. They are both difficult to supplement and monitor and it is unknown how much would be absorbed, therefore a pre-pregnancy global nutrient deficiency evaluation in these patients is recommended. Intensive nutritional monitoring is generally not required in patients whose weight is stable, which is generally achievable in the 2 years after bariatric surgery.

*Gastric banding*

This procedure has evolved from the 1971 gastroplasty procedure performed by Printen and Mason, which divided the stomach horizontally from the lesser curvature...
to the greater curvature leaving a small conduit at the greater curvature, through several other procedures namely; horizontal gastric stapling, total gastric stapling and anterior gastrogastrostomy, vertical gastroplasty, silastic ring vertical gastroplasty to the modern day least invasive gastric banding. Laparoscopic adjustable gastric banding is the commonest restrictive procedure performed today. It is a purely restrictive procedure which can be performed through open or laparoscopic surgery. These procedures are ‘more physiologic’ as there is no part of the intestinal tract that is bypassed. This procedure creates a small 20–30ml proximal gastric pouch with a band through an access port which can be inflated or deflated with saline to achieve variable degrees of constriction of the stomach. The weight loss achieved at 2 years after surgery is approximately 25% of the BMI. Long-term complications include gastric prolapse, stomal obstruction, oesophageal and gastric pouch dilatation, gastric erosion and necrosis.32

Other Procedures

Other procedures, which could be considered experimental, that are performed less frequently are vertical banded gastroplasty (restrictive), biliopancreatic diversion and duodenal switch, which are both primarily malabsorptive procedures.

MANAGEMENT OF PREGNANCY IN WOMEN WHO HAVE HAD WEIGHT-LOSS SURGERY

In the management of pregnancy in women following bariatric surgery it is important to consider the following questions:

1 Should women postpone pregnancy after bariatric surgery and if so for how long?
2 What type of bariatric surgery has the woman had?
3 Can the potential complications of the surgery adversely affect pregnancy outcome?
4 Is the risk of complications such as pre-eclampsia, gestational diabetes, and congenital abnormalities etc., reduced in women who have undergone bariatric surgery compared to those obese women who do not undergo surgery?
5 Is there an optimum weight that must be achieved between surgery and pregnancy and during pregnancy?
6 Is specific dietary management necessary, as nutritional deficiencies (hypoglycaemia, iron, folate, vitamin B₁₂ and calcium) may occur and how should these women be monitored during pregnancy?
7 Is specific surgical follow-up required, as gastric bands may need to be adjusted?

Pre-pregnancy management

Women who have had bariatric surgery should be seen prior to conception. It is generally considered that they should be advised to avoid pregnancy during the period of rapid weight loss, which usually occurs during the first 12–18 months following
surgery. Although there is no conclusive evidence to show that conception during the first postoperative year is associated with adverse outcomes.\textsuperscript{33} Indeed, a recent study has shown similar outcomes for those conceiving during the first postoperative year compared to those who waited until after the first postoperative year to conceive (Table 1)\textsuperscript{18}. One concern is that pregnancy during the period of rapid loss of maternal weight may result in poor fetal growth or that deficiency in key nutrients might adversely affect fetal development. Reliable contraception should therefore be advised, but it is important to note that the effectiveness of the oral contraceptive pill may be restricted by malabsorption\textsuperscript{34} and non-oral routes of hormonal contraception may be preferred\textsuperscript{35}. During this period of rapid weight loss, most women will experience resolution of obesity-related anovulation and improved fertility. Women who previously found it difficult conceiving may rapidly become more fertile.\textsuperscript{36} In one study, 76\% of patients who had irregular periods regained their normal menstrual pattern.\textsuperscript{37} Delayed conception also has the advantage in allowing the woman to lose sufficient weight to benefit from reduction of the obesity related risks in pregnancy.

The type of surgery undertaken and its associated problems such as malabsorption should be considered. Relevant micronutrient deficiencies namely iron, folate calcium and vitamin B\textsubscript{12} should be corrected before conception. Theoretically there is a risk of malabsorption of iron, folate and other nutrients, especially in patients who have had malabsorptive procedures such as gastric bypass, with women running the risk of malnutrition. The important role of a dietician as part of a multidisciplinary team therefore cannot be underestimated as suggested by Yeager et al.\textsuperscript{38} Of particular significance is the frequent monitoring and adjustments of diet and supplements for achieving weight loss, weight maintenance and avoiding malnutrition. The active involvement of dieticians often begins prior to surgery and should continue to support these patients during pregnancy.

As a guide, these women should have a pre-pregnancy assessment to include the following: full blood count (FBC), serum ferritin, vitamins A, B\textsubscript{1}, B\textsubscript{6}, B\textsubscript{12}, D, and E, serum calcium, zinc, selenium, magnesium and albumin. There is no evidence to suggest that these women require a higher dose of folate than usual. Although there are limited data, recent reports have not found an association between bariatric surgery and congenital abnormalities, and neural tube defects in particular have not been found

### Table 1

Pregnancy outcome among patients conceived during or after the first postoperative year. (Adapted from Sheiner et al 2011)\textsuperscript{18}

<table>
<thead>
<tr>
<th></th>
<th>INTERVAL 12 MONTHS (N = 104)</th>
<th>INTERVAL &gt;12 MONTHS (N = 385)</th>
<th>SIGNIFICANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI pre-delivery (Kg/m\textsuperscript{2})</td>
<td>35.7 ± 6</td>
<td>35.3 ± 6</td>
<td>nsd</td>
</tr>
<tr>
<td>Hypertensive disorders</td>
<td>15.4%</td>
<td>11.7%</td>
<td>nsd</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>11.5%</td>
<td>7.3%</td>
<td>nsd</td>
</tr>
<tr>
<td>Fetal growth restriction</td>
<td>3.8%</td>
<td>2.3%</td>
<td>nsd</td>
</tr>
</tbody>
</table>

Abbreviation: nsd, no significant difference
to be increased despite the potential risk of folic acid deficiency and the association of neural tube defects with obesity.

**Pregnancy following bariatric surgery**

The majority of bariatric surgical procedures are performed in young women. There is a concern about safety and outcomes of pregnancies after such surgery. Most recent studies support the safety of pregnancy after gastric bypass surgery. Indeed, perhaps unsurprisingly there are reports showing that it is associated with more favourable outcomes in comparison to obese populations who do not undergo weight loss surgery. An interval of 2 years has been recommended from surgery to pregnancy. This delay is thought to avoid most of the potential nutritional complications. However the important aspect of management is not the length of time pregnancy must be postponed, but weight stabilisation and nutritional correction. Studies comparing pregnancy outcomes in those who became pregnant within one year of surgery (early group) compared to after one year (late group) did not find significant differences in maternal and fetal outcomes despite one of these studies reporting that in the late group, the mean BMI at pregnancy was significantly lower than in the early group. However the late group gained more weight during pregnancy. This suggests that patients becoming pregnant soon after surgery may still be in the weight-losing phase, as might be expected, when they become pregnant.

**Obstetric outcomes and management of pregnancy**

Outcomes are difficult to determine with certainty as the evidence is limited consisting of case reports, case series and case control studies. Pregnancy outcomes must also be related to the type of surgery as the complications vary between procedure types. The data shown in Table 2 show no significant differences in outcomes between different types of surgery. However, overall, contemporary reviews, albeit with limited data, show a reduction in obesity related complications such as hypertension, gestational diabetes mellitus and macrosomia, without any apparent increase in adverse perinatal outcome. Because of the limitations of the data, however, we can not yet be certain of an absence of adverse effects particularly on fetal growth and development.

**Gastric bypass surgery**

The Roux-en-Y bypass and its various modifications is the most common bypass procedure performed in the US. It is an effective operation for achieving and maintaining weight loss. In this procedure, the stomach contents drain directly into the distal jejunum hence the association with deficiencies in iron, vitamin B₁₂ and fat-soluble vitamins as well as electrolytes. A management plan for these patients is outlined below. Effective contraception is required to allow appropriate
Timing of pregnancy. Vitamin supplements should be given throughout pregnancy and the puerperium, especially if breast-feeding. Iron supplements should be given: these can be introduced after assessment or given routinely. Ferrous fumarate may be better tolerated than ferrous sulphate. A dietician should ideally be involved in the management and there should be close monitoring of weight and screening for vitamin deficiency and electrolyte imbalance. Fetal growth should be monitored with serial ultrasound scans. Glucose tolerance tests should be avoided as the glucose drink may trigger or worsen the unpleasant symptoms associated with dumping syndromes. Instead patients should have a fasting glucose and 2-hour post-prandial glucose measured on several occasions for the diagnosis of or screening for gestational diabetes mellitus.

The few studies in pregnancy that have been reported have significant limitations and small patient numbers. There is a need for prospective studies or use of registries. However, current studies report a reduced risk of obesity associated complications of pregnancy. Wittgrove et al., reported no difference in terms of hypertension, preterm labour and caesarean section rates between 36 pregnancies after gastric bypass compared to the same women (17 of them) prior to surgery, but such retrospective control is a significant limitation in assessing outcome. The only significant finding
was less diabetes mellitus following surgery (2.8% of patients) compared to 41.2% before surgery. Also there were fewer macrosomic babies (5.5% of patients versus 30.4% controls). Richards et al\(^4\) compared pregnancy outcomes in 57 patients before and after surgery, and found there was less hypertension and macrosomia following gastric bypass surgery. A recent case control study of 38 women undergoing Roux-en-Y gastric bypass for obesity found that although cases had a higher mean BMI than controls there was statistically no significant difference in obstetric or neonatal outcomes.\(^4\) Patel et al\(^4\) recently reported their experience in a case control study of laparoscopic Roux-en-Y gastric bypass (LRYGB) and obesity-related perinatal complications in 26 patients who delivered after LRYGB and 254 controls. Perinatal complications were similar to non-obese controls and lower than controls that were obese. To address the duration women need to wait before embarking on pregnancy two case control studies compared outcomes in patients becoming pregnant within and after 1 year of surgery. The outcomes were similar and there were no adverse outcomes.\(^4\) However, women getting pregnant early tended to have high BMI at time of early pregnancy and had less weight gain during the pregnancy.\(^3\) Caesarean section rates were similar but there was a higher incidence of pre-eclampsia in the early group. Patel et al\(^4\) reported in their case control study that the complication rates were similar in pregnancies occurring “early” (<12 months) versus “late” (>18 months) after LRYGB.

A particular complication that obstetricians should be aware of is intestinal obstruction following Roux-en-Y procedures. There are now a significant number of such cases in the literature and these have been summarized by Wax et al.\(^5\) The obstruction is often due to internal hernia. This diagnosis must be considered in pregnant women with problems such as hyperemesis or non-specific abdominal pain. Pancreatitis can arise from the obstruction. If not identified, such obstruction can be associated with grave outcomes including maternal death due to complications such as pancreatitis or bowel necrosis. It is important to involve the intestinal surgeon in the assessment of such cases at an early stage.

**Gastric banding**

Gastric banding aims to limit caloric intake while allowing sufficient vitamin and electrolyte intake during pregnancy. LAGB has been the preferred operation in Europe because it is highly effective in achieving controlled and permanent weight loss and also because it is less invasive and can be performed laparoscopically. It has been approved by National Institute for Clinical Excellence (NICE) UK as an effective and predictable therapy for morbid obesity.

There have been several case series and case-control studies describing management of pregnancies following LAGB, pregnancy related complications of the surgery and several outcome measures. All studies indicate that the gastric band needs adjustment (loosening or tightening) at various stages of pregnancy to alleviate nausea and vomiting or regulate weight gain even though there is no clear guidance on the optimal amount of weight to be gained in pregnancy.\(^5\) This technique allows favourable
nutritional intake considered optimal for fetal development in early pregnancy. In one series of 5 pregnancies, all patients required the band to be completely deflated as a result of excessive nausea and vomiting in early pregnancy.52

Case control studies comparing patients before and after LAGB have shown a significant reduction in co-morbidities. Dixon et al,53 in their study of 79 patients who had LAGB compared to the same patients prior to surgery and to 79 other obese patients found that there was less maternal weight gain during pregnancy in LAGB patients and that those who became pregnant within 1 year of surgery gained less weight during pregnancy. Perinatal outcomes such as stillbirth rate, preterm labour, low birth weight and macrosomia were similar to the general population. Pregnancy induced hypertension (PIH) was reduced, occurring in 10% after LAGB vs. 45% pre-surgery vs. 38% in obese controls. The incidence of pre-eclampsia was also reduced occurring in 5% of patients compared to 28% and 25% pre-surgery and in obese controls respectively. Gestational diabetes mellitus was diagnosed in 6.3% of patients compared to 19% of obese controls. In their series, Skull et al54 compared pregnancies in 49 patients who had LAGB with pregnancies in 31 of these women prior to surgery. Again there was a decrease in the incidence of hypertension (8% vs. 27%) and gestational diabetes (8% vs. 22%). Ducarme et al55 reported that the incidence of pre-eclampsia, gestational diabetes, low birth weight and fetal macrosomia was reduced in patients who had LABG prior to pregnancy. The rate of caesarean section was lower in cases than controls (15.3% vs. 34.4%; \( p < 0.01 \)).55 A study of 398 patients from Israel56 showed resolution of diabetes in 71%, hypertension in 33% and sleep apnoea in 100%. Obesity and pregnancy are independent risk factors for gastro-oesophageal reflux. Reports suggest that gastric banding interferes with oesophageal motility resulting from gastric pouch formation as well as causing reflux. A study from Switzerland showed that patients with severe reflux symptoms after surgery had pre-operative excess oesophageal acid exposure as well as lower oesophageal pressures on manometry.57 The authors suggested that such patients may benefit from gastric by-pass procedures instead. However several studies agree that obesity related reflux symptoms improve when patients lose weight and that gastric banding is an effective treatment for gastro-oesophageal reflux. In an Australian study,58 of patients with reflux symptoms prior to gastric banding, only 4% experienced aggravation of symptoms while the majority resolved (76%) or improved (14%) with no change in 6%. While reflux is a problem particularly in pregnancy, most patients will benefit after surgery compared to their unoperated counterparts. The maternal benefits of surgery are therefore unequivocal.

CONCLUSION

Bariatric surgery is highly effective and increasingly widely used for weight loss in morbid obesity. Outwith pregnancy there is a resultant reduction in obesity related health complications including reduced mortality. With the high prevalence of severe obesity in the developed world affecting young women, and the increasing
trend for bariatric surgery, obstetricians will increasingly encounter these patients in pregnancy. Current reports suggest that bariatric surgery is associated with a reduction in obesity related pregnancy complications, with no apparent increased risk of other adverse maternal or perinatal outcomes. However, data are largely retrospective with associated limitations. High quality data from prospective studies would be important in establishing the evidence base for the safety issues arising from bariatric surgery and pregnancy, particularly with regard to fetal growth and development. One development that could provide good data would be an international registry of such patients, as this would allow better assessment of the risk: benefit ratio for such surgery in pregnancy. Meantime the available data that we have, must be considered reassuring to both women and obstetricians, as these data suggest that pregnancy after bariatric surgery appears safe. At present there are no data to suggest that the risks of obesity are exchanged for new risks linked to the effects of the surgery, rather there appears to be an overall risk reduction.

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