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Ashraf Abd El-Hamid Abd El-Moneim
General Surgery department, Faculty of Medicine, Al-Azhar University

Mohammed Sobhy Taema
General Surgery department, Faculty of Medicine, Al-Azhar University

Yousof El-Sayed Abou Shady
Gynecology & Obstetrics department, Faculty of Medicine, Al-Azhar University

Mostafa Mohammed Ibrahim Darwesh
General Surgery department, Faculty of Medicine, Al-Azhar University, mdarwesh8745@gmail.com

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ORIGINAL ARTICLE

The Effect of Bariatric Surgery on Infertility in Obese Females

Ashraf Abd El-Hamid Abd El-Moneim [a], Mohammed Sobhy Taema [a], Yousof El-Sayed Abou Shady [b], Mostafa Mohammed Ibrahim Darwesh [a,*]

[a] General Surgery Department, Faculty of Medicine, Al-Azhar University, Egypt
[b] Gynecology and Obstetrics Department, Faculty of Medicine, Al-Azhar University, Egypt

Abstract

Background: **Obesity is becoming more common among women of reproductive age all around the world. Currently, it is believed that bariatric surgery is the most efficient, long-term solution to this issue.**

Aim and objectives: **To evaluate the effectiveness and results of bariatric surgery on females with 1ry or 2ry infertility following the procedure.**

Subjects and methods: **40 participants participated in this prospective, randomised, and double-blind trial presented by morbid obesity with subsequent obstacles to fertility and pregnancy. All patients were submitted to surgical treatment for obesity from November 2018 to November 2020 in the general surgery ward of Al-Azhar University Hospital. This study compared 3 different procedures of bariatric surgery in the form of Laparoscopic Sleeve gasterectomy, single anastomosis sleeve ileal by-pass (SASI) and Laparoscopic one anastomosis gastric by-pass (OAGB) surgery.**

Result: **Following surgery, there was a large difference in BMI between pregnant and nonpregnant patients and BMI changes >5 kg/m^2 ($P < 0.001$). However, When it came to surgery methods and BMI before surgery, there was insignificant different between pregnant and nonpregnant patients.**

Conclusion: **Female obese patients' fertility gets better after they have bariatric surgery. But more research needs to be done on the direct effects of bariatric surgery on pregnancy for women.**

Keywords: Bariatric surgery, Female infertility, Obesity

1. Introduction

Obesity has become an epidemic in the United States, and it is a primary source of health-related problems. The number of women undergoing surgical weight loss operations has increased dramatically.[1]

Egypt's female obesity prevalence in 2016 was 41.1%. Egypt's female obesity prevalence climbed from 28.8% in 1997 to 41.1% in 2016, expanding at a 1.89% yearly rate. According to the World Health Organization (WHO), Egypt has the world's 18th highest obesity prevalence.[2]

Obesity, defined as a BMI of 40 kg/m^2 or more, has been linked to lower fertility in both men and women. Obesity alters reproductive characteristics and processes by interfering with normal hormone levels. Women with morbid obesity, for example, have greater amounts of leptin generated by adipocytes, which can disturb hormonal balance in women, resulting in a change in menstrual cycle and reproductive results. Obesity can also cause anovulation, aggravating polycystic ovarian syndrome symptoms (PCOS). Obesity has also been associated to low levels of reproductive hormones such as sex hormone binding globulin (SHBG), follicle-stimulating hormone (FSH), and testosterone in women, resulting in infertility.[3]

Bariatric surgery is the most effective treatment for morbid obesity and can be classified as restrictive or malabsorptive. Restrictive surgery restricts the amount of nutrients and calories that can be digested, whereas malabsorptive surgery limits the

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* Corresponding author. 34th Masjid Alnour St., Ezbet Elshal, 2nd Mansoura Sector, Dakahlia Governorate, 35511, Egypt. Fax: +201050302600.
E-mail address: mdarwesh8745@gmail.com (M.M.I. Darwesh).

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amount of nutrients and calories that can be digested. Laparoscopic adjustable gastric banding, sleeve gastrectomy, and one anastomosis gastric bypass (OAGB) are the most routinely utilised treatments globally.[4]

In fact, morbidly obese women should be provided consultations regarding bariatric surgery that detail the risks and advantages of surgery vs alternative weight-loss options before attempting to conceive. Such visits are especially important if the lady is considering fertility medication, which is less successful in obese women. Individuals are therefore fully informed of the hazards of pregnant obesity and may assess their alternatives. In my experience, no severely obese patients have been able to maintain weight decrease with dieting.[5]

Whether bariatric surgery will improve overall fertility or harm it by the recommended delay in conception attempts is a critical factor in the timing of bariatric surgery in women of reproductive age, determining how they will weigh the potentially improved pregnancy outcomes and future cardiovascular benefits.[6]

This study aims to evaluate the effectiveness and result of bariatric surgery in treating females with first- or second-cycle infertility.

2. Patients and methods

This study included fourty patients presented by morbid obesity with subsequent obstacles on fertility and pregnancy. All patients were submitted to surgical treatment for obesity from November 2018 to November 2020 in the general surgery ward of Al-Azhar university hospitals.

The study was a prospective, randomized and double-blind study comparing 3 different procedures of bariatric surgery in the form of Laparoscopic Sleeve gasterectomy, single anastomosis sleeve ileal by-pass (SASI) and Laparoscopic one anastomosis gastric by-pass (OAGB) surgery. The study and the procedure were explained to all patients preoperatively and informed consent was obtained from them.

Inclusion criteria: Patients were only allowed to take part in this study if they met all of the following requirements: Patients between the ages of 18 and 40, patients with a BMI of 40 or more, patients with a BMI of 35 who have other health problems, and patients with first- or second-time infertility.

Exclusion criteria: Patients were not allowed to take part if they had any of the following: Patients who are younger than 18 or older than 40, who have finished having children, or who have Endometriosis. Patients would have been a part of the study if they agreed to be a part of it and gave their permission.

2.1. Workup plan

Each patient will be subjected to the following:

Comprehensive medical history and careful clinical examination: Patients' physical statuses (PS) are defined by how the American Society of Anesthesiology groups them (ASA). ASA PS 1: A normal patient in good health, ASA PS 2: A patient with a mild systemic disease, ASA PS 3: A person with a serious systemic illness, ASA PS 4: A patient with a serious disease that affects the whole body and is always a threat to life, ASA PS 5: A patient who is very sick and not expected to live without surgery and ASA PS 6: A patient who was said to be brain dead.

Laboratory investigations: CBC, INR, LFTs, KFTs, FBS and viral markers, thyroid profile, serum cortisol and serum prolactin, serum FSH and LH, lipid profile and semen analysis for husband: for exclusion of male factor of infertility.

Imaging: Pelvi-abdominal Ultrasound: to exclude any causes of surgery or infertility, bilateral Lower Limb venous duplex: for exclusion of DVT, echocardiography: for evolution of the heart prior to surgery, spirometry: for respiratory function assessment before surgery and hysterosalpingography: for exclusion of tubal factor of infertility.

The patients were randomly categorized into three groups as follows: Group 1: 30 patients who underwent Lap. Sleeve gasterectomy, **Group 2:** 7 patients who underwent SASI and **Group 3:** 3 patients who underwent Lap. one anastomosis gastric by-pass (OAGB).

After surgery: The night before surgery, patients were instructed to begin ambulation and given clear beverages to drink. Starting on surgical day 1, patients took enoxaparin 40 mg once day for 2 weeks to prevent blood clots. Between the second and third postoperative day, a standard gastrografin swallow radiograph scan is conducted prior to patient release to exclude the leak. Four months after surgery, a proton pump inhibitor was given to the patient. After two weeks, patients are seen as outpatients once a month. If patients experienced any worsening of their symptoms in the interim between their scheduled checkups, they were examined at the outpatient clinic. For the first month, patients are kept on a low-calorie, protein-rich liquid diet while gradually being introduced to other foods. Throughout this process, patients are monitored closely by a dietician and given routine prescriptions for multivitamins and vitamin D3. Patients are urged to get moving as soon as possible

after surgery. Patients underwent a full blood count every 3 months and a gastroscopy every 6 months. The participants were asked about any and all medications they were currently taking, including any nutritional supplements.

Maximal conservative effort: Remote follow-up for 1–2 years as regard: **Rate of weight reduction:** Percentage of excess weight lost (% EWL), diabetes resolution, and comorbidity improvement were the primary objectives. The percentage of EWL was determined by taking the difference between the patient's pre- and post-operative weights and multiplying by 100. Postoperative complications and nutritional condition were secondary outcomes.

Occurrence of conception: Several groups and publications have recommended waiting at least 12 months before trying to conceive following bariatric surgery since the majority of weight reduction happens during this time. This relies on the assumption that being pregnant at a time of poor nutrition increases the risk of complications like low birth weight and congenital defects. However, people who are older or who have infertility may be limited in their family planning options due to the suggestion to postpone conception.

Control of medical co-morbidities: Fasting plasma glucose 110 mg/dL or HbA1C 6% without hypoglycemic medication at 1 year after surgery was considered remission of diabetes; improvement was defined as a decrease of at least 25% in fasting plasma glucose and of at least 1% in hemoglobinA1c with hypoglycemic drug therapy.

If the condition can be managed without medication and with regular medical and gynaecological checkups, then the comorbidity may resolve.

2.2. Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation, median and interquartile range (IQR). Significance of the obtained results was judged at the 5% level. The used tests were: χ^2 test: For categorical variables, to compare between different groups. Student t-test: For normally distributed quantitative variables, to compare between more than two studied groups. Spearman correlation test: For abnormally distributed quantitative variables, to correlate to variable.

3. Results

This study included fourty patients presented by obesity with subsequent obstacles on fertility and pregnancy. All patients undergone surgical treatment for obesity in the general surgery ward of Al-Azhar university hospitals.

The patients were randomly categorized into three groups as follows: Group 1: 30 patients who underwent Lap sleeve gasterectomy, **Group 2:** 7 patients who underwent SASI and **Group 3:** 3 patients who underwent Lap. one anastomosis gastric by-pass (OAGB) Table 1.

A total of 40 obese patients involved in this study, their mean of age was 27.51 + 3.11 years and ranged from 24 to 37 years. Basal BMI mean was 45.91 + 3.17 kg/m^2. Considering ASA PS classification, there are 23 (57.5%) patients with ASA I, 7 (17.5%) with ASA II and 4 (10%) patients with ASA III. There were 6 (15%) patients with DM, 4 (10%) with hypertension and one patient with liver disease. Regarding type of infertility, there were 11 (27.5%) patients with 1ry infertility and 29 (72.5%) patients with 2ry infertility Table 2.

Regarding postoperative complications, bleeding occurred in 2 (5%) patients, leakage in one patient and wound infection in 2 (5%) Table 3.

Pregnancy occurred in 23 (57.5%) patients Table 4.

There was a significant difference between BMI before surgery and at the end of the follow-up ($P < 0.001$) Table 5.

When comparing pregnant and nonpregnant women, there was a statistically significant

Table 1. Demographic data of studied patients.

	Cases ($n = 40$)
Age (year)	
Mean + SD	27.51 + 3.11
Range	24–37
BMI kg/m^2 (Before surgery)	
Mean + SD	45.91 + 3.17
Range	38.2–49.7
ASA PS Number (%)	
I	23 (57.5%)
II	7 (17.5%)
III	4 (10%)
Comorbidity Number (%)	
DM	6 (15%)
Hypertension	4 (10%)
Liver diseases	1 (2.5%)
Type of infertility Number (%)	
Primary	11 (27.5%)
Secondary	29 (72.5%)
Follow-up (Month)	
Mean + SD	16.25 + 4.82
Range	12–22

ASA PS, American society of anesthesiology Physical status; BMI, Body mass index.

Table 2. Distribution of studied patients regarding complication.

	Cases (n = 40) Number (%)
Bleeding	2 (5%)
Leakage	1 (2.5%)
Wound infection	2 (5%)
Total	5 (12.5%)

difference in body mass index (BMI) following surgery and BMI changes of >5 kg/m2 (p 0.001). Surgery methods and preoperative body mass index did not vary significantly between pregnant and nonpregnant patients Table 6.

The table shows According to Spearman's rank correlation coefficient analysis, pregnancy occurrence was significantly negatively correlated with BMI kg/m^2.

4. Discussion

Obesity, especially morbid obesity (defined as a body mass index (BMI) of 40 kg/m2 or more), has been shown to reduce fertility in both sexes. Obesity alters normal hormone levels, which in turn impacts reproductive traits and processes. For instance, elevated adipocyte-derived leptin levels in morbidly obese women are associated with altered menstrual cycle and reproductive results.[7]

A total of forty obese patients involved in this study, their mean of age was 27.51 + 3.11 years and ranged from 24 to 37 years. Basal BMI mean was 45.91 + 3.17 kg/m^2. Considering ASA PS classification, there are 23 (57.5%) patients with ASA I, 7 (17.5%) with ASA II and 4 (10%) patients with ASA III. There were 6 (15%) patients with DM, 4 (10%) with hypertension and one patient with liver disease. Regarding type of infertility, there were 11 (27.5%) patients with 1ry infertility and 29 (72.5%) patients with 2ry infertility.

A research by **Al-Qurashi** *et al.*[8] found that the average age of the pooled sample was 36.88 ± 6.11 years old. At baseline, the average body mass index (BMI) was 46.51 ± 6.28 kg/m^2 (46.60 ± 6.42 kg/m^2 for men and 46.42 ± 6.15 kg/m^2 for women), and at the 12-month post-op follow-up, it had dropped to 26.70 ± 4.22 kg/m^2.

Table 3. Distribution of studied patients regarding pregnancy occurrence.

	Cases (n = 40) Number (%)
Pregnancy	
Yes	23 (57.5%)
No	17 (42.5%)

According to **Moxthe** *et al.*,[9] the included patients' ages ranged from 18 to 49, and their mean body mass index (BMI) before surgery was over 40, falling in a range from 41 to 71 kg/m^2.

As regard to type of bariatric surgery, GB was done to 3 (7.5%) patients, LSG to 30 (75%) patients and SASI was done to 7 (17.5%) patients.

Regarding postoperative complications, bleeding occurred in 2 (5%) patients, leakage in one patient and wound infection in 2 (5%).

Pregnancy following bariatric surgery is associated with an increased risk of stomach herniation and gastric band slippage, as shown by **Micic** *et al.*[10]

Given the likely differences in digestion, absorption, postoperative complications, and possibly maternal and foetal health, with nutritional deficiencies being less common after restrictive compared with malabsorptive procedures, the **Moran** *et al.*[11] acknowledge that considering the effect of different types of bariatric surgery on reproductive function would be a useful addition to the literature.

Results showed that 23 patients (57.5%) became pregnant.

Similar to our results, **Musella** *et al.*[12] showed of these women who had tried unsuccessfully to become pregnant before surgery, 69 (62.7%) became pregnant afterward, and only 41 women (37.3%) did not achieve a pregnancy. The pregnancies proceeded without complications and ended with a live birth.

Micic *et al.*[10] showed that presence of obesity before pregnancy poses a significant risk of adverse maternal and perinatal outcomes. Excess body mass in the course of pregnancy may lead to development of complications in mother and child. Obesity in combination with pregnancy may result in birth defects, preeclampsia, gestational diabetes, stillbirth and cesarean deliveries. Significant weight loss and fertility improvement was observed after the application of bariatric surgery among an obese female population. A significantly higher rate of cesarean section was reported among post-bariatric surgery patients. Reproductive function after one anastomosis gastric bypass surgery is characterized by a shortened follicular phase and improved female sexual function.

Table 4. Distribution of studied patients regarding BMI before and after surgery.

	Cases (n = 40)		Test value	P value
	Before surgery	At end of follow-up		
BMI kg/m^2				
Mean + SD	45.91 + 3.17	34.73 + 2.55	17.380	<0.001**
Range	38.2–49.7	28.4–43.6		

Table 5. Comparison between pregnant and nonpregnant regarding techniques and BMI.

	Cases ($n = 40$)		Test value	P value
	Pregnant ($n = 23$) Number (%)	Nonpregnant ($n = 17$) Number (%)		
Techniques				
GB	1 (4.3%)	2 (11.8%)	2.510	0.137
LSG	19 (82.6%)	11 (64.7%)		
SASI	3 (13.1%)	4 (23.5%)		
BMI kg/m^2 (Before surgery) Mean + SD	42.47 + 3.11	44.16 + 3.42	1.629	0.116
BMI kg/m^2 (after surgery) Mean + SD	31.18 + 2.37	40.25 + 3.02	10.648	<0.001[a]
BMI changes >5 kg/m^2	21 (91.3%)	6 (35.3%)	13.624	<0.001[a]

[a] P value $\leq$ 0.001 highly significant.

Although pregnancy rates are reported to be increased after bariatric surgery, the literature does not commonly report the number of women trying to conceive or their fertility history, indicating difficulty in deriving conclusions related to fertility itself. The study of **Legro *et al.***[13] does not discuss the presence of PCOS or other factors as contributing to infertility, so the mechanisms associated with infertility and fertility improvements after bariatric surgery are unclear. This is particularly relevant because the existing literature on fertility improvements after bariatric surgery generally does not distinguish between ovulatory and anovulatory obese women.

Musella *et al.*[12] found that similar to our findings, of the women who had tried and failed to conceive before to surgery, 69 (62.7%) got pregnant subsequently, while only 41 (37.3%) did not. Both pregnancies were uneventful and resulted in healthy newborns.

Evidence presented by **Micic *et al.***[10] indicates that pre-existing obesity significantly increases the probability of poor maternal and neonatal outcomes. As the pregnancy progresses, both the mother and the baby's health might be jeopardised by the effects of the mother's excessive weight. Preeclampsia, gestational diabetes, stillbirth, and caesarean sections are some of the complications that might arise when obesity is present during pregnancy. Females who had bariatric surgery lost a significant amount of weight and saw an increase in fertility. Patients who had bariatric surgery also had a considerably greater risk of caesarean delivery. Shortening of the follicular phase and enhanced female sexual function are hallmarks of reproductive function after one anastomosis gastric bypass surgery.

Table 6. Correlation between pregnancies with other studied Parameters.

	Pregnancy	
Studied Parameters	Spearman's Correlation	P value
Age	−0.244	0.524
Techniques		
GB	0.211	0.682
LSG	0.137	0.487
SASI	0.315	0.158
BMI kg/m^2	−0.742	0.001**

P value > 0.05 insignificant, **P value $\leq$ 0.001 highly significant.

Although the research indicates a rise in conception rates following bariatric surgery, it is difficult to draw conclusions about fertility because of the lack of information about the number of women attempting to conceive or their reproductive history. **Legro *et al.***[13] does not address the prevalence of PCOS or other variables as contributing to infertility, hence the processes connected with infertility and reproductive improvements following bariatric surgery are unknown. This is important since the current evidence on reproductive benefits following bariatric surgery often does not differentiate between ovulatory and anovulatory obese women.

When compared to this, **Goldman *et al.***[14] and **Laurino *et al.***[3] found no statistically significant increase in live birth rates.

The mean body mass index (BMI) before surgery was significantly lower than the mean BMI at the end of the follow-up period ($P < 0.001$). When comparing pregnant and nonpregnant women, there was a statistically significant difference in body mass index (BMI) following surgery and BMI changes of >5 kg/m^2 ($P < 0.001$). Surgery methods and preoperative body mass index did not vary significantly between pregnant and nonpregnant patients.

Musella *et al.*[12] showed that the BMI was 33.9 ± 2.9 kg/m2 after intragastric balloon, 34.3 ± 2.3 kg/m^2 after adjustable gastric banding, 34.9 ± 2.1 kg/m^2 after sleeve gastrectomy, and 35.4 ± 0.5 kg/m^2 after one anastomosis gastric bypass.

Ochner *et al.*[15] showed that individuals with higher versus lower preoperative BMI had lower % IWL, overall F3, 1989 ¼ 20.2, P o 0.0005. No between-

group difference was seen in %IWL at 1 month after surgery. Beyond 1 month postsurgery, however, a significant dosage effect was seen at all-time points, with each BMI category showing lower %IWL than the next lower BMI category.

Alfadda *et al.*[16] noticed that the maximum mean percentage weight loss occurred at 3 years postsurgery by −43.48% at 4 years postsurgery for females. The rate of weight regain was seen to increase gradually from 3 years postsurgery onwards until the end of the study period. Significant weight regain (defined as ≥25% weight gain from nadir weight) was seen in 53.3% of the patients after 6 years. The mean %EWL values were significantly increased at 3 and 4 years postsurgery when compared to the mean values at 6 years postsurgery, where the coefficients at 3 and 4 years indicate that %EWL increased by 19.04 and 21.02 units when compared to the mean value of %EWL at 6 years postsurgery.

According to Spearman's rank correlation coefficient analysis, pregnancy occurrence was significantly negatively correlated with BMI kg/m^2.

Musella *et al.*[3] revealed that age, the existence of co-morbidities (hypertension and DM), and BMI before surgery were not predictive of pregnancy.

Hartz *et al.*[17] discovered, in a massive research, that being overweight at age 23 was linked to a higher infertility risk than being of a normal weight.

When comparing 1880 infertile women to 4023 controls **Grodstein** *et al.*[18] found that those with a body mass index (BMI) of 26.9 kg/m2 had a higher prevalence of anovulatory infertility.

Of the 110 women who had attempted unsuccessfully to conceive before to weight reduction, 69 conceived subsequently, as shown by **Musella** *et al.*[12] Both pregnancies were uneventful and resulted in healthy newborns. Pregnancy was predicted only by the amount of weight lost (odds ratio 20.2, $P = 0.001$) and the attained body mass index ($P = 0.001$).

Evidence shows that after weight reduction surgery, a woman's risk of developing maternal problems such gestational diabetes and preeclampsia may be similar to that of the general population. Similarly, pregnancies that follow bariatric surgery may have a decreased risk of newborn problems such early delivery and low birth weight. Confirmation of these results requires data from large cohorts of consecutive pregnant individuals. Because reported rates before and after surgery vary greatly across research, it is unknown what influence bariatric surgery has on the requirement for caesarean birth. Pregnancy-related nutritional issues after laparoscopic adjustable gastric banding (LAGB) or one anastomosis gastric bypass surgery are surprisingly rare. Consecutive patient studies that meticulously track patients' dietary habits and health are required. Very little research has been done on how bariatric surgery affects fertility.[6]

More than 150 000 women of reproductive age underwent bariatric procedures in the most recent 3 years for which inpatient data are available. This figure is likely an underestimate because many patients undergo outpatient bariatric surgical procedures (e.g., LAGB surgery) that would not have been reported in the Nationwide Inpatient Sample. A growing number of women of child-bearing age have undergone these procedures and need information and guidance about fertility, pregnancy, and contraception.

The available evidence suggests that risks for maternal complications, such as gestational diabetes and preeclampsia, may be lower following surgically induced weight loss than the risks in obese women and may approach community rates. Similarly, neonatal complications, such as premature delivery and low birth weight, may be lower in pregnancies following bariatric surgery. Results from large cohorts of consecutive patients with pregnancies are needed to confirm these findings. The effects of bariatric surgery on need for cesarean delivery are unclear as reported rates before and after surgery vary widely between studies. Nutritional problems during pregnancy following LAGB or one anastomosis gastric bypass surgeries appear uncommon and many are attributed to supplement nonadherence. Studies of consecutive patients that systematically monitor adherence and nutritional status are needed. The relationship of bariatric surgery to fertility has not been well studied.[6]

4.1. Conclusion

According to the findings of this research, female obese individuals' fertility increases after bariatric surgery. Women who have had bariatric surgery should be studied more thoroughly on their ability to conceive and carry a child to term. Obese individuals' infertility and the success they have with subsequent pregnancies should be evaluated quantitatively. When it comes to obesity, more information is required on the effectiveness of different types of bariatric surgery in achieving weight loss and improving fertility. In spite of obesity and previous failure, these strategies will guarantee future pregnancy outcomes and boost fertility.

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Conflicts of interest

The authors declared that there were NO conflicts of Interest.

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