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CLINICAL RESEARCH

Pregnancy after Bariatric Surgery: 39 Pregnancies Follow-up in a Multidisciplinary Team

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Abstract
Background We investigate the outcomes of pregnancy in women who undergone restrictive–malabsorptive procedure at Centro da Obesidade Mórbida–Hospital São Lucas (COM HSL-PUCRS), Porto Alegre, Brazil.
Methods All pregnancies started after the bariatric surgery and with estimated due date until June 2008 were eligible for the study. Only the first pregnancy of each patient was included in the data analysis. Data was collected from medical records.
Results Forty seven pregnancies were identified in 41 women. Eight of them were ineligible. There were 30 complete pregnancies and nine miscarriages (23%). Cesarean delivery was performed in 69% of the complete pregnancies. Mature infants occurred in 93.1%. Twelve pregnancies (30.8%) occurred in the first year after surgery. Vitamin B12 was low in 53.4% patients; folic acid in 16.1%, iron in 6.7%, ferritin in 41.7%, calcium in 16.7%, and albumin in 10.3% of the patients. Nineteen women (79.2%) had no complication during the pregnancy and two (8.3%) presented with internal hernia. The average of newborns weight and length on delivery were 3,037 g and 48.07 cm, respectively. Children from pregnancies started in the first year of post operatory had similar outcomes of children from pregnancies started after 1 year of surgery.
Conclusions Pregnancy after bariatric surgery is safe and has fewer complications than pregnancy in morbidly obese women. However, the recommendation to delay the pregnancy for at least 12–18 months post-operatively should be kept.

Keywords Bariatric surgery · Pregnancy · Newborns · Roux-en-Y gastric bypass · Morbid obesity

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Introduction

Obesity is now recognized as a major health problem in the western world and it is increasing worldwide at an alarming rate [1, 2]. In Brazil, about 13.1% of women and 8.9% of men are affected by obesity in all its degrees [3].

Obesity is associated with anovulation and increased rates of miscarriage in obese women who become pregnant [4]. In addition to this, gestational outcomes in obese pregnant women are worse than for normal body mass index (BMI) women. Also, fetal evaluation during pregnancy is difficult [1, 5]. Obesity is an independent risk factor for adverse obstetric outcomes and is significantly associated with an increased cesarean delivery rate, gestational diabetes

mellitus (GDM), gestational hypertension, preeclampsia, and macrosomia [6].

Nowadays, bariatric surgery is the most effective treatment for weight loss in morbidly obese patients [7]. Bariatric surgery has been the only way for many women to finally achieve a healthy BMI and, as a result of decreased body mass, a better regulated hormonal milieu, greater chances of fertility, and improved pregnancy outcomes [5].

Weight loss after bariatric surgery reduces obesity-related gestational complications [5, 8], but there is the potential risk of developing micro and macronutrients deficiencies if a rigorous prenatal care in a multidisciplinary center is not done [9]. Besides this, if the woman who has had bariatric surgery does not gain weight or gains very little during pregnancy, the fetus is in risk of intrauterine growth retardation, fetal abnormality, or a small-for-gestational-age babies [10]. Because of this, many authors recommend that pregnancy should be avoided during the first 12–18 months after bariatric surgery. During this time, the woman is eating very small amounts of food and is generally losing much weight [11, 12]. Sheiner et al. [13] reported that pregnancy after bariatric surgery is not associated with adverse perinatal outcomes. Perinatal death, congenital malformations, and Apgar scores are similar in patients with or without a history of previous bariatric procedure [13].

In this study, we investigate the outcomes of pregnancy and delivery in women who had undergone restrictive–malabsorptive procedure at Centro da Obesidade Mórbida–Hospital São Lucas da PUCRS (COM HSL-PUCRS), Porto Alegre, Brazil. Obesity has become a worldwide epidemic, and bariatric surgery is a common procedure at the present time. The surveillance of this group of pregnant women is relevant to assess and interfere for better outcomes.

Materials and Methods

A retrospective study was performed through revision of medical records from female patients which underwent bariatric surgery and had their clinical follow up at COM HSL-PUCRS.

All pregnancies started after the bariatric surgery and with estimates due date until June 2008 were eligible for the study. All patients had undergone to Roux-en-Y gastric bypass surgery (RYGB). If more than one pregnancy occurred in the same patient during the study, only the first was included in the analysis. In the same way, all pregnancies started before the RYGB were excluded.

The variables studied included weight, blood tests (albumin, iron, ferritin, folic acid, vitamin B12, and calcium, checked during the first trimester), interval of time between the RYGB and pregnancy (months), patient age (years), gestational age at birth (weeks), weight (kg), and length (cm) of the newborn on delivery.

The weight was checked in an electronic scale (Filizola®), with 300 kg of capacity, patients were standing up in the middle of the scale, with no shoes and with light clothes. The height was checked through a stadiometer. The variables were calculated using the formulas:

Variable	Formula
BMI	BMI (Kg/m²)=weight (kg)/height (m)²
EW	EW (Kg)=weight (Kg)−ideal weight (Kg)
WL	WL=weight before surgery (Kg)−present weight (Kg)
EWL%	EWL%=WL (Kg)/weight excess (Kg)×100
Weigh after childbirth	Weigh after childbirth=WBP (kg)−WD (kg)

BMI body mass index, *Kg* kilogram, *m* meters, *ideal weight* is calculated through the BMI 25 Kg/m^2, *EW* weight excess, *WL* weight loss, *EWL* percentage of excess weight loss, *WBP* weight before pregnancy, *WD* weight at the time of delivery (through this, we could check if there was weight gain or loss during the gestation)

In order to assess the weight and length of the babies, the information on the "Cartão da Criança", provided by the Brazilian Department of Health was analyzed.

The qualitative variables analyzed were the type of delivery, clinical complications during pregnancy, BMI at the beginning and at the end of pregnancy.

The qualitative variables were described in figures of absolute and relative frequencies.

The quantitative variables were described as mean and standard deviation (symmetric distribution) or median and interquartile amplitude (asymmetric distribution).

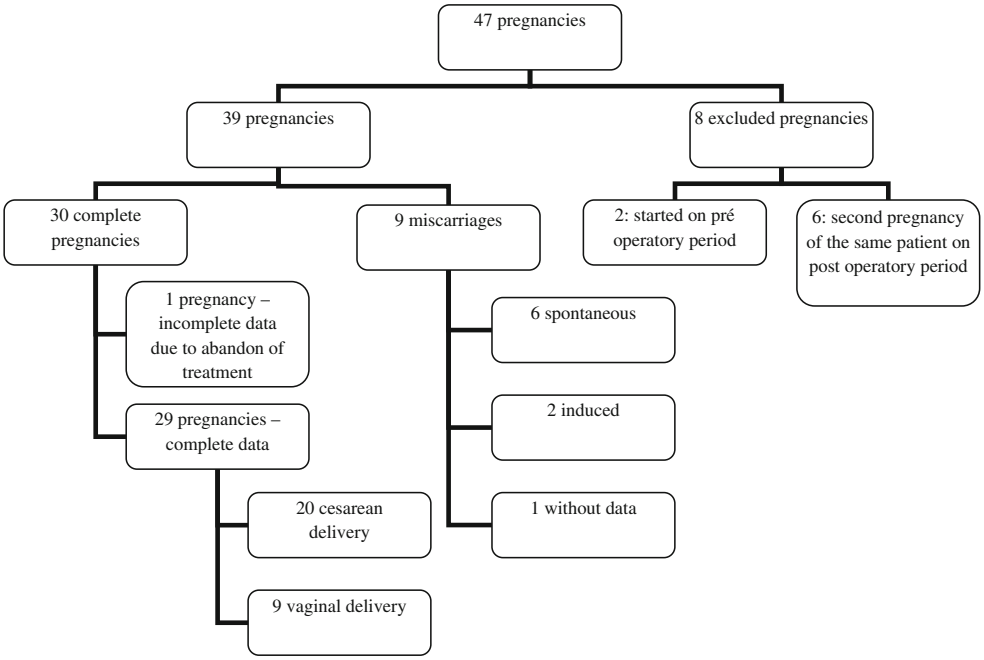
To compare means, the Student's *t* test was used. In cases of asymmetry, the Mann–Whitney test was performed otherwise.

To evaluate the associations among the qualitative variables, the Pearson chi-square test or Fisher's exact test was applied. The level of significance was 5% and the analysis was performed at the Statistical Package for the Social Sciences version 13.0.

Results

Forty seven pregnancies were identified in 41 women who underwent bariatric surgery on our center since March 2000. Thirty four pregnancies were completed and 13 resulted in miscarriage. Eight gestations were ineligible: two of them because the gestational period started before the surgery without the knowledge of the team of COM HSL-PUCRS, and six because was the second pregnancy of

Fig. 1 Selection of the patients



the patient in the post surgery period. In this way, our sample is constituted by 39 pregnancies.

There were 30 complete pregnancies and nine abortions (23%). There were six spontaneous abortions (75%) and two induced abortions (25%). Two patients abandoned treatment, one from the group of patients of complete pregnancies and one from the group of abortions. Cesarean delivery was performed in 69% of the complete gestations (n=20; Fig. 1). Mature infants (37th to 42th weeks of gestation) occurred in 93.1% of the cases (n=27) and premature infant (<37th weeks of gestation) in 6.9% (n=2). There was no postmature birth (>42th weeks of gestation). No malformation was described among the newborns. Sixteen newborns (55.2%) were female. Twelve pregnancies (30.8%) occurred in the first year of post-operatory period and 27 gestations (69.2%) after this time. Table 1 shows the demographics of the sample.

The nutritional status was analyzed through biochemical tests. The vitamin B12 was low level in 53.4% patients; the folic acid in 16.1%, iron in 6.7%, ferritin in 41.7%, calcium in 16.7%, and albumin in 10.3% of the patients. The reference ranges are shown in Table 2. Nevertheless, in our center, the replacement is started for levels below 400 pg/mL of vitamin B12 and below 30 ng/mL of ferritin.

Nineteen women (79.2%) had no obstetric outcomes, two (8.3%) showed hypertension related to pregnancy, one (4.2%) had severe deficiency of vitamins and nutrients deficiency requiring admission to the hospital, and two (8.3%) presented with internal hernia, with one of them having surgery to correct it during the pregnancy.

Of the 41 patients that become pregnant after the bariatric surgery, 17 had been pregnant at least once before the surgical procedure.

Out of the 29 complete gestations, 16 were female and 13 male. The weight and length average on delivery were 3,037 g and 48.07 cm, respectively. Table 3 shows the newborn characteristics. Only three children were born with weight lower than 2500 g and were considered low birth weight, but no child were macrosomic (weight over 4,000 g or over the 90th percentile for weight/age). According to the growth charts from WHO, 21.4% of the children was below the tenth percentile for weight/age, 78.6% between

Table 1 Characteristics of the pregnant women

Variables *N*	Mean ± SD 39
Age at pregnancy (years)	30.9±4.1
Pre operatory weight (Kg)	131.1±25.8
Weight in the beginning of pregnancy (Kg)	82.7±17.1
Weight in the end of pregnancy (Kg)	86.2±10.1
Pre operatory BMI (Kg/m²)	48.9±9
BMI in the beginning of pregnancy (Kg/m²)	30.7±5.3
BMI in the end of pregnancy (Kg/m²)	32.1±3.6
Weight excess lost until pregnancy (Kg)	47.8±22.2
Weight excess percentage lost until pregnancy	76.1±20.6
Time between surgery and pregnancy (months)[a]	18 (8–36)
Weight change during pregnancy (Kg)[a]	8.4 (4.7–10.8)

[a] Median (P25–75)

Table 2 Biochemical assessment in the first visit (gestational first trimester)

	Reference range	Normal *n* (%)	Deficiency *n* (%)
Vitamin B12	175–1,500 (pg/mL)	14/30 (46.7)	16/30 (53.4)
Folic acid	4–17 (ng/mL)	26/31 (83.9)	5/31 (16.1)
Iron	50–150 (μg/mL)	28/30 (93.3)	2/30 (6.7)
Ferritin	10–300 (ng/mL)	14/24 (58.3)	10/24 (41.7)
Albumin	3.5–5.0 (g/dL)	26/29 (89.7)	3/29 (10.3)
Calcium	8.5–10.5 (mg/dL)	15/18 (83.3)	3/18 (16.7)

the 10th and 85th percentile, and no child was over the 85th percentile. Table 4 describes the average of the percentiles of the newborns according to their weight/age, height/age, and BMI/age.

Women who become pregnant before 1 year of post-operatory period lost an average of 1.7 kg, and women who become pregnant after 1 year of the procedure gain an average 9.5 kg (p=0.002). The bigger the interval between bariatric surgery and the beginning of the pregnancy, the higher the increase of the BMI during the pregnancy (p=0,002; Fig. 2). However, children from pregnancies started before 1 year of post-operatory had similar outcomes on weight, length, and BMI than children from pregnancies started after 1 year of surgery. Table 5 shows pregnancies started before and after 1 year of surgery are compared.

There was no correlation between the initial BMI (p= 0.783) and BMI from the end of pregnancy (0.667) with the type of delivery. Also, there was no statistically significant association between change of weight with weight of the children on delivery (Rs=0.025; p=0.900).

Discussion

Bariatric surgery is the most effective tool to assist in the weight loss of the morbidly obese patient [12]. In our study, pregnancies after the surgery were considered safe, according to the literature [12–14].

The abortion rate (23%) was similar to the data from Marceu [4], which reported an abortion rate of 26% in his sample of pregnancies after bariatric surgery. Also, there was no statistical difference in abortion rate in the groups before and after 1 year of surgery, as described by Dao et al. [8].

Cesarean delivery was performed in 69% of the pregnancies, and there was no relation with higher BMI of the women neither in the beginning nor in the end of the pregnancy. Sheiner [13] also described a high tendency of cesarean delivery, probably not related to the previous bariatric surgery, but to the worldwide increasing tendency of this kind of delivery. Compared with women with normal BMI, the risk of Cesarean delivery in nulliparous, singleton pregnancies is increased 2.25 times [15] and the risk of recurrent miscarriages are increased 1.4 times in obese [16].

There were no cases of GDM in our population. This data is not in accordance with the literature, in which the prevalence of GDM is higher in post-operative pregnancies than in community controls, but lower in comparison to obese cohorts [14].

Only 8.3% of the women developed gestational hypertension in our data. Studies comparing the pre and post-bariatric surgery pregnancies consistently showed a reduction in risk and rates of hypertensive disorders after obesity surgery [14].

The deficiency of vitamin B12 found in 53.4% of the gestations during the first trimester evaluation, is an expected condition due to reduction of the intrinsic factor and the acid environment for absorption of this vitamin.

The ferritin deficiency found in 41.7% of the patients demonstrates low storage levels of iron. Iron and ferritin deficiencies are common due to insufficient intake of meat and other iron-rich foods [9]. Even with the protocol of periodic assessment of micronutrients and their replacement, some patients failed in keeping the treatment.

In two patients, there was development of internal hernia, a frequent complication after Roux-en-Y gastric

Table 3 Newborn characteristics

Variables *N*	Mean ± SD 29
Female *n* (%)	16 (55.2)
Weight (Kg)	3.037±0.39
Length (cm)	48.07±1.35
BMI (Kg/m²)	13.08±1.46

Table 4 Anthropometric variables according to WHO growth charts

Variables *N*	Median (P25–75) 29
Weight/age	27.6 (12–53)
Length/age	26.9 (12.4–46.8)
BMI/age	41.2 (18.9–75.1)

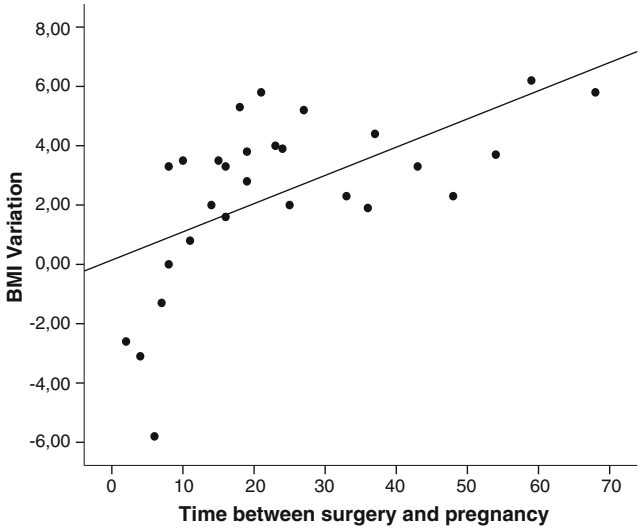


Fig. 2 BMI variation according to time between surgery and pregnancy

bypass, but there are few case reports on this type of hernia induced by pregnancy [17–19]. In one of them, the pregnancy occurred only 2 months after bariatric surgery and resulted in miscarriage. The other case happened in a pregnancy started 43 months after surgery and corrective surgery was performed during the pregnancy with no damage for the fetus. According to Baker [18], because intra-abdominal fat decreases with weight loss, gaps between sutures may widen and defects may partially reopen. The enlarged gravidic uterus is associated with increased intra-abdominal pressure and intestinal displacement, forces that likely combine to play a significant role in the pathogenesis of internal herniation.

A number of series have reported high rates of low birth weight (LBW) and small-for-gestational-age babies born from women with history of bariatric surgery, although not many systematic studies have addressed this issue [14]. In our data, three (10.3%) out of 29 children had LBW. Marceu [4] showed that LBW occurred in 27.4% of the pregnancies after biliopancreatic diversion. This data is related to the disabsorptive procedure and may not be applied to our data, which is related to the RYGB procedure. Various studies comparing post-operative pregnancies with pregnancies in the obese have shown a decrease in the rates of macrosomia and large-for-gestational-age babies among post-bariatric surgery deliveries [14]. Our data shows neither case of fetal macrosomia nor large-for-gestational-age. It is shown that 21.4% of the babies were found below the tenth percentile for weight/age, which implies increased risk for malnutrition. Meanwhile, no child was above the 85th percentile which could indicate increased risk for obesity.

Finally, despite weight loss among the women who become pregnant before 1 year of surgery, this condition caused no damage for the weight, length, and BMI of these children.

The present study showed some limitations, including loss of data for nutritional status evaluation, making difficult our evaluation.

Conclusion

Pregnancy after bariatric surgery is safe and has fewer complications (obesity related and injuries for the baby development) than pregnancy in morbidly obese women. However, the recommendation to delay the pregnancy for at least 12–18 months of pos-operation should be kept, in order to avoid that the rapid weight loss increases the risk of maternal and fetal malnutrition.

Table 5 Data comparison of the pregnancies and newborns before and after 1 year of post operatory of bariatric surgery

Variables	<1 year	>1 year	*p* value
Miscarriage *n* (%)	3/12 (25.0)	6/27 (22.2)	1.000
BMI in the beginning of pregnancy (mean ± SD)	33.03±5.54	29.78±5.08	0.082
Weight gain during pregnancy [median (P25 to P75)]	−1.7 (−7.8 a 7.1)	9.5 (6 a 12.5)	0.002
BMI in the end of pregnancy (mean ± SD)	30.53±3.81	32.84±3.43	0.132
Pre term births *n* (%)	2/9 (22.2)	0/20 (0)	0.089
At term births *n* (%)	7/9 (77.8)	20/20 (100)	0.089
Complication during pregnancy[a]	1/6 (16.7)	4/18 (22.2)	0.640
Type of delivery			
Cesarean *n* (%)	4/9 (44.4)	5/20 (25.0)	0.396
Vaginal *n* (%)	5/9 (55.6)	15/20 (75.0)	0.396
Weight at birth (mean ± SD)	2.983±0.335	3.061±0.430	0.635
Length at birth (mean ± SD)	48.13±1.64	48.05±1.27	0.898
BMI at birth (mean ± SD)	12.72±1.37	13.21±1.51	0.461

[a] Complications: GDM, gestational hypertension, nutritional deficiencies, and internal hernia

Conflict of interest disclosure Drs. Bebber, Rodrigues, Padoin, and Repetto and Nut Casagrande have no conflict of interest which would include funding for the research. Dr. Rizzolli has contracted research from Takeda Pharmaceutical Co. and Dr. Mottim is the principal investigator of Brazilian Health Ministry and Brazilian Science and Technology Ministry and principal and co-investigator of Johnson & Johnson.

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