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CLINICAL ARTICLE

Vitamin A status and its relationship with serum zinc concentrations among pregnant women who have previously undergone Roux-en-Y gastric bypass

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ABSTRACT

Objective: To evaluate vitamin A status and its relationship with serum zinc concentrations among pregnant women who had previously undergone Roux-en-Y gastric bypass (RYGB), correlating these measures with anthropometric maternal characteristics and perinatal outcomes. *Methods:* An analytical prospective longitudinal study was conducted at a clinic in Rio de Janeiro, Brazil, between March 3, 2008, and March 30, 2012, among women with singleton pregnancies who had previously undergone RYGB. Participants received daily oral supplementation with 5000 IU retinol and 15 mg zinc. Variables assessed included vitamin A status (serum retinol and β-carotene; gestational night blindness), serum zinc concentration, maternal anthropometry, complications during pregnancy, and perinatal outcomes. *Results:* Overall, 30 women participated. In all trimesters, more than 60% had inadequate serum levels of retinol or β-carotene. Night blindness was reported by 17 (57%) women in each trimester. Only 6 (20%) women had zinc inadequacy in the first and third trimesters. No significant association was observed between serum retinol or zinc and maternal anthropometry and birth weight. Vitamin A deficiency was associated with urinary tract infection (first trimester, $P = 0.020$) and dumping syndrome (third trimester, $P = 0.013$). *Conclusion:* Despite RYGB and nutritional deficiencies (especially of vitamin A and zinc) increasing risks during pregnancy, there was no apparent fetal compromise when considering the analysis of birth weight and length of pregnancy at birth.

1. Introduction

Most patients worldwide who undergo bariatric surgery are women; furthermore, approximately 50% are of childbearing age [1]. Surgically induced weight loss promotes substantial improvements in fertility owing to normalization of hormone levels and the menstrual cycle, a scenario that favors pregnancy despite the fact that the procedure can potentially induce or worsen metabolic changes [1].

Nutritional deficiencies, including vitamin A deficiency, are common after bariatric surgery. Vitamin A deficiency also correlates with a series of negative effects during pregnancy, because this vitamin has an important role in the pregnant–puerperal cycle [2].

Serum concentrations of vitamin A can be further affected by zinc deficiency [3]. Zinc is required for hepatic synthesis and secretion of retinol-binding protein, which in turn is responsible for the transport of vitamin A from the liver to body tissues. Production of retinol-binding protein is reduced under conditions of vitamin A and zinc deficiency, resulting in secondary deficiency of vitamin A characterized by low serum levels of retinol, even if liver levels are adequate [3].

The onset of pregnancy after bariatric surgery can increase the impact of vitamin A deficiency, with major repercussions for both maternal and child health. However, few studies have been published to date regarding pregnancy outcomes after bariatric surgery related to deficiencies of micronutrients, such as vitamin A and zinc. Therefore, the conduct of such studies should provide important information about this period of extreme nutrient demand.

The aims of the present study were to evaluate vitamin A status and its relationship with serum concentrations of zinc among pregnant women who had previously undergone Roux-en-Y gastric bypass (RYGB), and to identify correlates with maternal anthropometric characteristics and perinatal outcomes.

2. Materials and methods

An analytical prospective longitudinal study was conducted among pregnant women who attended a private clinic that specialized in obesity control (Clínica Cirúrgica Carlos Saboya) in the municipality of Rio de Janeiro, Brazil. Data collection was performed between March 3, 2008,

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and March 30, 2012. Inclusion criteria were age 20 years or older, singleton pregnancy, RYGB performed before pregnancy, and follow-up performed by the obesity clinic during pregnancy. Exclusion criteria were previous malabsorptive and restrictive surgeries, neoplasia, liver cirrhosis or malabsorptive syndromes, and inadequate compliance with standard nutritional supplementation (use of <80% of the number of pills prescribed). The present study was approved by the Research Ethics Committee of Hospital Universitário Clementino Fraga Filho, Rio de Janeiro, Brazil (research protocol 011/06-CEP). All participants read and signed an informed consent form, in accordance with the National Health Council (resolution 196 of 10/10/1996).

Pregnant women who had previously undergone RYGB were followed up by a nutritionist and general surgeon. Patients were counseled throughout postoperative follow-up after RYGB and told that the obesity clinic team should be informed of any pregnancy so that they could monitor the pregnancy, in addition to routine prenatal care performed elsewhere.

Participants were assessed in each trimester using biochemical indicators (serum retinol and β-carotene levels) and functional indicators (night blindness). Data were collected during consultation with the nutritionist. Supplementation with vitamins and minerals was routine practice following bariatric surgery. When pregnancy was confirmed, the supplement protocol was adapted to provide 5000 IU retinol daily and 15 mg zinc daily (chelated zinc and a vitamin–mineral supplement for use during pregnancy and lactation).

Data collected included: preoperative weight; age at the start of prenatal care; interval between surgery and the last menstrual period; height; prepregnancy weight (self-reported or measured in the first trimester); prepregnancy body mass index (BMI; calculated as weight in kilograms divided by the square of height in meters), classified according to WHO recommendations [4]; length of pregnancy at the start of prenatal care; weekly weight gain for each trimester; total weight gain during pregnancy; adequacy of the total weight gain during pregnancy in accordance with the Institute of Medicine recommendations [5]; complications during pregnancy; and the presence of dumping syndrome. Data on food consumption were not collected because this measure fell outside of the scope of the present study.

Serum levels of retinol and β-carotene were measured during each trimester using high-performance liquid chromatography [6]. Retinol levels were calculated as interval classes to allow classification in accordance with WHO criteria [6]: severe vitamin A deficiency (<0.35 μmol/L), moderate vitamin A deficiency (≥0.35–0.70 μmol/L), and mild vitamin A deficiency (≥0.70–1.05 μmol/L). Retinol levels greater than or equal to 1.05 μmol/L were considered adequate. The cutoff used to indicate inadequacy of β-carotene was set at less than or equal to 0.74 μmol/L (40 μg/dL) [7]. Serum levels of zinc were measured using atomic absorption spectrophotometry [8]. Zinc levels greater than 10.71 μmol/L (70 μg/dL) were considered to be within the reference range [9].

The presence of night blindness during pregnancy was determined using an interview standardized by WHO [6], and subsequently adapted and validated for use among pregnant women by Saunders et al. [10]. The interview comprised the following questions: (1) Is it difficult to see during the day?; (2) Is it difficult to see in low light or at night?; and (3) Do you have night blindness? Pregnant women were considered to have night blindness when the answer to question 1 was "No" and at least one answer to questions 2 or 3 was "Yes."

Perinatal conditions were evaluated using birth weight and length of pregnancy at birth [11]. The following factors were also assessed: correlation between weight and gestational age at birth [12], 1-minute and 5-minute APGAR scores [13], and the occurrence of breastfeeding in the early neonatal period (≤6 days).

The data were analyzed using SPSS version 17.0 (SPSS Inc, Chicago, IL, USA). The Kolmogorov–Smirnov test was used to evaluate sample normality. Arithmetic means, standard deviations, and medians were calculated for continuous variables, whereas distributions of simple frequencies and percentages were calculated for discrete variables. Other statistical measures included analysis of variance, the Kruskal–Wallis non-parametric test, the Student t test, the Pearson and Spearman correlation coefficients, and the χ^2 test. $P < 0.05$ was considered statistically significant.

3. Results

A total of 30 pregnant women were enrolled (mean age 30.22 ± 4.38 years). One spontaneous abortion occurred during the second trimester and one woman underwent two pregnancies during the present study period (but only data from her first pregnancy were included in the analysis). Consequently, the final sample comprised 30 women and 29 newborns.

Table 1 shows participants' characteristics. Before pregnancy, 16 (53%) women were classified as overweight and 7 (23%) as having class I obesity according to their BMI. During pregnancy, 11 (37%) women showed adequate weight gain, 4 (13%) were above the recommended level, and 15 (50%) were below the recommended level.

The severity of vitamin A deficiency by trimester is shown in Fig. 1. Moderate vitamin A deficiency was observed in the first trimester only (n = 2; 7%). No change was observed during pregnancy in the proportion of women with mild vitamin A deficiency ($P = 0.334$).

The mean serum concentration of β-carotene was below the recommended value in all three trimesters (Table 2). No correlation was found between serum concentrations of retinol and β-carotene in the first ($r = 0.28$; $P = 0.140$), second ($r = 0.33$; $P = 0.073$), or third ($r = -0.17$; $P = 0.377$) trimesters. However, inadequacy of β-carotene was greater than that observed for retinol in every trimester (Table 2). Night blindness was detected among 17 (57%) women in each trimester.

Zinc inadequacy was found among 6 (20%) women in the first and third trimesters and among five (17%) in the second trimester (Table 2). No correlation was observed between the serum concentrations of zinc and retinol during pregnancy ($r = 0.183$; $P = 0.342$).

No difference was observed between serum concentrations of vitamin A and maternal prepregnancy nutritional status (BMI; $P = 0.774$) and weight gain during pregnancy (total weight gain; $P = 0.759$).

The most frequent complications were urinary tract infection (UTI; n = 10; 33%) and dumping syndrome (n = 10; 33%). No complications were detected among 6 (20%) women. A significant association was observed for vitamin A deficiency in the first trimester with the presence of UTI ($P = 0.020$). Likewise, vitamin A deficiency in the third trimester correlated with the presence of dumping syndrome ($P = 0.013$).

Overall, 27 (93%) newborns were classified as having an appropriate weight for their gestational age at birth, 28 (97%) were born at term (39.28 ± 0.84 weeks) and were of appropriate weight (3128.79 ± 271.49 g), 17 (59%) had a 1-minute Apgar score of greater than 9, and all had an Apgar score of more than 9 in the fifth minute. A total of 23 (79%) newborns were breastfed in the early neonatal period. No association was observed between birth weight and vitamin A deficiency ($P = 0.530$ for serum retinol level and $P = 0.495$ for serum β-carotene level).

Table 1
Anthropometric and maternal characteristics (n = 30).

Characteristic	Mean ± SD
BMI	
Before Roux-en-Y gastric bypass	43.73 ± 5.79
Before pregnancy	27.36 ± 3.26
Prepregnancy weight, kg	72.74 ± 11.61
Age at start of pregnancy, y	30.33 ± 4.38
Interval between surgery and the last menstrual period, mo	17.70 ± 9.07
Weekly weight gain during pregnancy, kg	
1st trimester	0.16 ± 0.16
2nd trimester	0.22 ± 0.09
3rd trimester	0.21 ± 0.17
Total weight gain during pregnancy, kg	7.68 ± 3.73

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters).