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Study of Extent of Transplacental Transport by Measuring the Levels of Magnesium in Maternal and Umbilical Venous Cord Blood and Correlation of Serum Magnesium Levels with Outcome of Pregnancy

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Abstract

Magnesium deficiency during pregnancy can induce not only maternal and fetal nutritional problems, but also consequences that might last in off spring throughout life. The status of maternal serum magnesium levels in adverse pregnancy outcome is not fully clear. Hence, the present study was planned to study maternal serum magnesium levels and to explore it correlation if any with low birth weight, preterm birth, and Apgar score in 102 pregnant women. Study samples (three ml) were drawn once before 20 weeks and second sample was drawn at the time of delivery in red vacutainer tubes. Serum was analyzed for routine investigations (hemoglobin, TSH, glucose challenge test) and magnesium levels (using thiazole yellow spectrophotometrically). At <20 weeks of gestation, 74 women had serum magnesium levels between 1.5-2.2 mg/dL (1.8 + 0.1 mg/dL), while 23 had serum magnesium levels >2.2 mg/dL (2.4 + 0.1 mg/dL) and 5 (4.9%) had serum magnesium levels <1.5 mg/dL (1.3 + 0.1 mg/dL). There was significant positive correlation between serum magnesium at <20 weeks with gestational age at delivery. Also, the correlation between serum magnesium at term with gestational age at delivery was positive and statistically significant. However, the correlations were not significant between maternal serum magnesium levels with baby weight at <20 weeks; at term and APGAR score at <20 weeks; at term. It can be concluded from the present study that periconceptional nutrition status is a key determinant of pregnancy outcomes and dietary modification might reduce the risk of adverse perinatal outcomes.

Keywords: Magnesium; Serum; Cord Blood; Outcome; Apgar, Birth weight

Introduction

Nutrition is the major intrauterine environmental factor that alters expression of the fetal genome and may have lifelong consequences. Alterations in fetal nutrition and endocrine status may result in developmental adaptations that permanently change the structure, physiology, and metabolism of the offspring thereby predisposing individuals to metabolic, endocrine, and cardiovascular diseases in adult life [1,2].

Various elements play a major role in maternal and child health. The association between maternal serum levels of various elements like calcium, magnesium and fluoride and birth outcomes is complex and is influenced by many biologic factors.1 Understanding the relation between maternal serum levels of these elements and birth outcomes may provide a basis for developing nutritional interventions that will improve birth outcomes and long-term quality of life and reduce mortality, morbidity, and health-care costs [2].

Magnesium is primarily found within the cell where it acts as a counter ion for the energy-rich ATP and nuclear acids in the cell and is a cofactor in more than 300 enzymatic reactions. It critically stabilizes enzymes, including many ATP-generating reactions and contributes to the regulation of vascular tone, heart rhythm, platelet-activated thrombosis and bone formation [3].

Magnesium deficiency in pregnancy frequently occurs because of inadequate or low intake of magnesium. Magnesium deficiency during pregnancy can induce not only maternal and fetal nutritional problems, but also consequences that might last in offspring throughout life. Maternal magnesium intake is not only associated with pregnancy outcome, but, also with infant outcome [4]. Magnesium deficiency is associated with uterine hyperexcitability [5], premature labor and pre-eclampsia. Magnesium deficiency can also lead to problems with regulating body temperature in babies, and can result in Sudden Infant Death Syndrome (SIDS) [6] and intra uterine growth retardation (IUGR). Magnesium is an essential element for fetal well- being and supplementation of magnesium may be benefited to fetal outcome. Australian National Clinical Practice Guidelines have recommended antenatal magnesium sulphate for fetal neuro-protection [7].

However the status of maternal serum magnesium levels in adverse pregnancy outcome is not fully clear. Hence, the present study was planned to study maternal serum magnesium levels and to explore it correlation if any with low birth weight, preterm birth, and Apgar score.

Materials and Methods

The present study was conducted in the Department of Biochemistry in collaboration with Department of Obstetrics And Gynecology, Pt. B.D. Sharma, PGIMS, Rohtak. One hundred two pregnant women aged 17 to 36 years before 20 weeks of gestation attending the OPD were recruited for the study and they were followed till delivery. An informed and written consent was obtained from all the women and the study was approved by Ethical Board of the Institute. Women with history of hypertension, diabetes mellitus, epilepsy, thyroid disorders, severe anemia, mal-absorption syndrome, osteo-malacia and fluorosis were excluded from the study.

Calcium and iron supplementation was given to all the pregnant women with period of gestation more than 20 weeks. They were advised to take 1000 mg calcium and 100 mg of elemental iron per daily throughout the pregnancy. Study samples (three ml) were drawn once before 20 weeks and second sample was drawn at the time of delivery in red vacutainer tubes. Serum was analyzed for routine investigations (hemoglobin, TSH, glucose challenge test) and magnesium levels (using thiazole yellow spectro photometrically) [8]. SPSS ver. 23 was used for statistical analysis and unpaired't' test and Pearson correlation test were applied.

Results

Mean age of the pregnant women under the study were 25.12 ± 2.94 years. Mean calorie intake of the pregnant women under the study was 2037.05 ± 149.54 kilocalories/day. Out of 102 women, 74 (72.5%) women had a diet >2000 kilocalories/day, 28 (27.5%) women had a diet <2000 kilocalories/day. Mean protein intake for the pregnant women under the study was 48.56 ± 4.81 gm/day (median=50 gm/day). There are correlations between total protein intake per day with baby weight (r=-0.045, p=0.652) and gestational age at delivery (r=0.069, p=0.488). Also, there was positive correlation were statistically insignificant between total calorie intake per day with baby weight (r=0.086, p=0.388) and gestational age at delivery (r=-0.074, p=0.462). Out of 102 pregnant women, 66 (64.7%) were primigravida while 36 (35.3%) were multigravida. Eleven women had pregnancy induced hypertension, 12 had preterm delivery, 3 babies were born with poor APGAR scores. Mean hemoglobin level was 9.13 ± 0.70 g/dL, mean TSH was 2.12 ± 0.58 mIU/L and mean GCT (glucose challenge test) was 93.07 ± 14.93mg/dL.

There were 31 women who had low birth weight babies, 12 had preterm delivery and 3 had babies born with poor APGAR scores. At <20 weeks of gestation, 74 (72.5%) women had serum magnesium levels between 1.5-2.2 mg/dL (1.8+0.1 mg/dL), while 23 (22.5%) had serum magnesium levels >2.2 mg/dL (2.4+0.1 mg/dL) and 5 (4.9%) had serum magnesium levels <1.5 mg/dL (1.3+0.1 mg/dL) (Table 1).

At term, 83 (81.4%) women had serum magnesium between 1.1-2.2 mg/dL (1.6+0.1 mg/dL) while 17 (16.7%) had serum magnesium >2.2 mg/dL (2.4+0.1 mg/dL) and 2 (2.0%) had serum magnesium <1.1 mg/dL (1.0+0.1 mg/dL). Mean values of cord blood magnesium levels were 1.82+0.37 mg/dL (Table 2). The correlation between serum magnesium at <20 weeks and cord blood was positive and statistically significant (r=0.532, p<0.001). The correlation between serum magnesium at term and cord blood was positive and was statistically significant (r=0.566, p<0.001).

Parameters	Values
Hb (g/dL)	9.13+0.7
TSH (mIU/L)	2.12+0.58
GCT (mg/dL)	93.07+14.93

Table 1: Routine investigations (mean+SD).

	<20 week	Term	P value
Serum magnesium (mg/dL)	2.014 ± 0.347	1.900 ± 0.424	<0.001
Cord blood magnesium (mg/dL)	-	1.82 ± 0.37	-

Table 2: Serum and cord blood magnesium levels (mean+SD).

	Serum magnesium at <20 weeks		Serum magnesium at term	
	Correlation coefficient	p value	Correlation coefficient	p value
Gestational age at delivery	0.274	0.005	0.409	<0.001
Baby weight	-0.089	0.374	-0.028	0.783
Apgar score at 1 minute	0.042	0.678	0.071	0.477
Apgar score at 5 minute	-0.055	0.581	-0.054	0.588

Table 3: Correlations between maternal serum magnesium levels and gestational age at delivery, baby weight and apgar score.

There was significant positive correlation between serum magnesium at <20 weeks with gestational age at delivery (r=0.274, p=0.005). Also, the correlation between serum magnesium at term with gestational age at delivery was positive and statistically significant (r=0.409, p<0.001). However, the correlations were not significant between maternal serum magnesium levels with baby weight (r=-0.089, p=0.374 at <20 weeks; r=-0.028, p=0.783 at term) and APGAR score (r=0.042, p=0.678 at <20 weeks; r=0.071, p=0.477 at term, Table 3).

Discussion

Vonnahme et al. [9] described that maternal under nutrition affects the vascularity of nutrient transferring tissue during different stages of pregnancy. During the early stages of pregnancy, when the placenta is not yet formed, there is no mechanism to protect the embryo from the nutritional deficiencies that may be inherent in the mother's circulation [9].

Colon-Ramos et al concluded from their study that poor calorie intake was associated with low birth weight [10,11]. They suggested that a pregnant woman requires additional 350 kilo-calories/day. It is important that an adequate amount of nutrients and energy is consumed. There is growing evidence that maternal nutritional status can alter the epigenetic state of the fetal genome. This phenomenon, termed "fetal programming," has led to the recent theory of "fetal origins of adult disease [12]. The association between maternal nutrition and birth outcomes is complex and is influenced by many biologic, socioeconomic, and demographic factors, which vary widely in different populations. Maternal nutrition plays a crucial role in influencing fetal growth and birth outcomes. It is a modifiable risk factor.

In the present study, mean calorie intake of the women was 2037.05 ± 149.54 kilocalories per day. Out of one hundred two women, twenty eight (27.5%) consumed less than 2000 kilocalories per day and seventy four (72.5%) consumed more than 2000 kilocalories per day. No correlation could be observed between total calorie intake and birth weight; and total calorie intake per day and gestational age at delivery in the present study. The correlation between total calorie intake and birth weight was statistically insignificant (r=0.086, p=0.388; Table 2).Correlation between total calorie intake per day and gestational age at delivery was also statistically insignificant (r= -0.074, p=0.462; Table 3). Zohdi et al. described that maternal protein restriction during pregnancy affect fetal development and increases the risk of cardiovascular disease later in life. Wood-Bradley et al concluded that maternal malnutrition due to protein restriction influences offspring kidney development. In the same light, Blumfield et al. reported that a maternal diet that is low in protein is related to higher systolic blood pressure in childhood and suggested thata pregnant woman requires 78 gm/day of protein [13]. In the present study, mean protein intake for the group was 48.56 ± 4.81 gm/day. Correlation between total protein intake per day and baby weight was not statistically significant (r=-0.045, p=0.652). Also, there was no significant correlation between total protein intake by the woman per day and gestational age at delivery (r=0.069, p=0.488).

In the present study, seventy four women at <20 week period of gestation had serum magnesium levels between 1.5-2.2 mg/dL (1.8 + 0.1 mg/dL) while twenty three had serum magnesium levels >2.2 mg/dL (2.4 + 0.1 mg/dL) and five (4.9%) had serum magnesium levels <1.5mg/dL (1.3 + 0.1 mg/dL). The correlation between serum magnesium at <20 weeks (r=0.274, p =0.005) and at term (r =0.409, p<0.001) with gestational age at delivery was statistically significant (Table 3).The findings of present study are in agreement with the previous studies. However, the correlations were not significant between maternal serum magnesium levels with baby weight (r=-0.089, p=0.374 at <20 weeks; r=-0.028, p=0.783 at term) and APGAR score (r=0.042, p=0.678 at <20 weeks; r=0.071, p=0.477 at term) (Table 3). Khoushabi et al. studied the levels of trace elements such as magnesium in maternal and umbilical cord blood and their association with pregnancy outcome.

They observed that mean serum magnesium levels during the three trimesters of pregnancy were not significantly different from that in the umbilical cord blood. They attributed these findings to trans-placental transport of magnesium [14]. In contrast, in the present study, correlation between serum magnesium at <20 weeks and cord blood was positive and statistically significant (r=0.532, p<0.001). The correlation between serum magnesium at term and cord blood was positive and was statistically significant (r=0.566, p<0.001). Elizabeth et al in their study reported that low maternal serum magnesium levels are associated with low birth weight and poor APGAR scores. This discrepancy in results could be attributed to larger sample size in their study [15]. In contrast, there was no significant correlation between maternal serum magnesium levels and birth weight (r=0.028, p=0.783) in present study. Also, the correlation of serum magnesium levels with APGAR score was statistically insignificant (r=-0.054, p=0.588; Table 3).

It can be inferred from the present study that an adequate periconceptional nutrition status is a key determinant of pregnancy outcomes. Dietary modification and graphically relevant nutrition–environment interactions-based intervention might reduce the risk of adverse perinatal outcomes. Findings of the present study may serve as baseline data for planning preconception and nutrition-based interventions during pregnancy to improve pregnancy outcomes.

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