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Effect of Maternal Serum Calcium on Fetal Birth Weight

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Abstract: *Calcium is an important component of a healthy diet. It is essential for all living organisms as it signals the various cellular processes. It also helps in mineralization of bone, teeth and its maintenance throughout life. . Pregnancy causes a tremendous shift in maternal calcium metabolism as calcium becomes important for the fetal bone mineralization. This study establishes the effects of calcium on the fetal birth weight.*
Method:
This cross sectional study was conducted among 100 antenatal subjects. Ethical clearance and the necessary permission from Obstetrics department of Sri Ramachandra University were obtained. Written informed consent obtained from the subjects. Biochemical analysis of calcium was done at the SRMC central laboratory.
Result:
The statistical analysis was done with R software. Antenatal mothers with normal serum calcium levels delivered full term babies (p=<0.001) with normal birth weight (p=<0.001) than the low calcium group. Also calcium levels were significantly high in primigravida (<0.001) and in those who took regular calcium supplements in their antenatal period (0.007) than the multigravida group and women not on calcium supplements.
Conclusion:
The maximum rate of increase in calcium absorption by about 33% occurs in the final trimester. Low calcium during pregnancy may limit the fetal mineral accretion and breast milk calcium concentration. This affectsthe infant growth and bone development. Hence it is essential to educate all pregnant women about the need for adequate calcium levels during pregnancy and thereafter.
Key words: *maternal serum calcium, fetal birth weight*

I. Introduction:

Calcium (Ca^{2+}) is an important component of a healthy diet. It is essential for all living organisms as it acts as a signal for various cellular processes. It helps in the bone and teeth mineralization and its maintenance throughout life. Calcium is the most abundant mineral in our body (3).Bones contain 99% of total body $Ca^{2+}$and about 1% is freely available in the extracellular fluid. The recommended daily calcium is 1000 mg/day (>18yrs).The maternal demand for calcium during pregnancy is elevated by 300mg/day. Pregnancy causes a tremendous shift in maternal calcium metabolism as calcium becomes important for the fetal bone mineralization. Calcium is transported from the mother to the fetus throughout pregnancy through the placenta in large amounts mainly during the third trimester. This active transport of calcium occurs by a magnesium adenosine triphosphatase -dependent Ca^{2+} pump. It transfers nearly 150 mg of Ca/kg of fetal weight/day (approximately 80%) in the third trimester. Various calcium binding proteins play a role in this transport. Vitamin D helps in the synthesis of these calcium binding proteins (14).

The maternal demand for calcium is met by increase in the intestinal absorption of calcium; decrease in the calcium excretion and by increase in the resorption of calcium from the maternal skeleton. Low dietary calcium intake may be crucial to fetal bone development even in wealthy societies. Average maternal calcium supplementation about 1300 mg/day from the second trimester to term helps fetal bone mineralization in women with poor calcium levels (2).

In a country like India, nearly half of the women fail to consume the recommended calcium needed for normal living especially during pregnancy and lactation (5). Adverse effects of decreased calcium in mothers can lead to preeclampsia, low birth weight, preterm delivery, fetal low bone mineral density and caesarean section. According to the observation done in mayan Indians of Guatemala, a low socio economic region with poor protein diet, eclampsia was recorded very low as their dietary calcium was found to be high due to their staple food- lime processed tortillas (4). In India calcium intake is around 250-350mg/day and the eclampsia noted here also has elevated pre eclampsia (12).

In 2011, WHO published the recommendations for the prevention and treatment of pre-eclampsia and eclampsia. In 2012, WHO published the need for calcium supplementation in pregnant women (10).In both guidelines, WHO makes a strong recommendation for supplementation of about 1.5 grams to 2.0 grams of elemental calcium daily in areas of low dietary intake of calcium and for those at high risk of developing hypertensive disorders during pregnancy. It was also found that calcium supplementation during pregnancy lowers the blood pressure of the infants born to mothers with hypertension during the pregnancy (8).

All pregnant women are prescribed calcium supplements (1000 mg) from the second trimester onwards. But many fail to continue the supplements as well as calcium rich diet due to the lack of knowledge about the importance of calcium both during pregnancy and lactation (5). Hence it is essential to educate them about the need for calcium. Maternal calcium supplementation of about2 g/day in the mid pregnancy period can influence the mineralization of the fetal bone (9). This study establishes the effects of calcium on the fetal birth weight.

II. Materials and Methods:

Type of study: Cross Sectional Study

- Sample size: 100 antenatal mothers of age – 19 to 31 yrs
- Inclusion criteria: Normal pregnant women in their last trimester

Ethical clearance was obtained from Sri Ramachandra Medical College ethical committee and needed permission obtained from SRMC Obstetrics department. Written informed consent obtained from the subjects. Confidentiality maintained. Blood samples were collected for estimation of serum calcium. Detailed questionnaire was administered. Follow-up was done to record the details of delivery & the new born.

III. Statistical analysis:

The statistical analysis was done using the R software. 100 antenatal mothers were included in the study. Using the serum calcium levels and the fetal delivery details, Comparison was done between the fetal birth weights among the low calcium group and the normal calcium group. Also association of preterm births, calcium supplementations, gravid and socioeconomic status with calcium levels was analyzed. T-test and one way Anova was performed for comparison. The values are expressed as Mean±S.D. p value < 0.05 was considered to be significant.

IV. Results:

Table:1

Variables	Group	Sr.Calcium	p-value	Birth Weight	p-value
Ca^{2+}. supplementation	No (12)	8.475±0.61	0.007*	2.14±0.45	0.0003*
	Yes (88)	9.06±0.58		2.80±0.47	
Gravida	Primi (26)	9.15±0.58	<0.001*		0.02
	Multi (74)	8.94±0.61		2.65±0.53	
SocioEconomic Status	Lower(17)	8.94±.078	NS	2.46±0.75	0.057
	Lower middle(58)	8.9+±.62		2.74±0.48	
	upper middle(25)	9.16±0.42		2.84±0.32	
Gestational Period	Preterm(27)	8.57±0.57	<0.001*	2.08±0.47	<0.001*
	Term(73)	9.15±.055		2.95±0.27	

Table: 2

Serum Ca^{2+} (9-10.5mg/dl)	Below normal(43)	2.47±0.58	<0.001*
	Normal(57)	2.95±0.30	

From the results obtained, Table: 1 clearly shows that the serum calcium levels were normal in the group who took Ca^{2+} supplements regularly (p-value=0.007) and the primi gravid group (p-value <0.001) than the women not on calcium supplements and the multigravida group. They also delivered normal birth weight babies (p-value=0.0003). Socioeconomic status was not found to be of much significance. It was also found that mothers with below normal calcium levels delivered preterm babies (p-value<0.001) than the normal calcium group.

Table: 2 shows that mothers who had normal serum calcium levels delivered normal birth weight babies compared to the low calcium group(p-value < 0.001).

V. Discussion:

The three major sources of maternal calcium to maintain fetal bone growth are increased absorption of intestinal calcium, reduced renal calcium excretion and calcium resorption from maternal skeleton(2).

Increased intestinal calcium absorption is an important compensatory mechanism for securing additional calcium during pregnancy. It occurs along with increase in vitamin D concentrations (4–62%) in the third trimester. Thus Ca^{2+}homeostasis is maintained by the Ca^{2+}sensing receptors that sense extracellular Ca^{2+} levels and initiate parathyroid hormone and vitamin D levels (14).

The intestinal absorption of calcium increases by 60–70% during pregnancy, from approximately 33–36% in the non-pregnant state to 50–56% in the second trimester and to 54–62% in the third trimester (3).

Renal calcium excretion increases by 46% during the period of pregnancy among women with approx1200 mg/d calcium intake .This increase is due to the increased glomerular filtration rate occurring during pregnancy.

In a study conducted, 15 women who electively terminated their pregnancy (8–10 weeks) showed increase in bone resorption surfaces, cavities and reduced osteoids in their bone biopsy reports. These findings were not present in biopsies done in non pregnant controls, or in biopsies done at term for 13 women after delivery (11).

Many studies have reported that urinary markers (deoxypyridinoline, pyridinoline, and hydroxyproline) of boneresorption (24-h collection) are increased during the mid pregnancy. Serum markers of bone formation (osteocalcin, procollagen I carboxypeptides and bone-specific alkaline phosphatase) are usually decreased during mid pregnancy on comparing with the pre pregnancy values. Recent studies included dual-energy x-ray absorptiometry (DEXA) for analyzing the bone status before conception and after delivery, the maternal lumbar spine bone density showed reduced values when preconception and 4 to 6 weeks post partum readings were compared (15,16).

Daily loss of calcium in breast milk ranges from 280–400 mg. Low calcium concentrations in milk have been noticed in women with vitamin D deficiency and low calcium diet (13). Rarely, a woman suffers from fragility fracture during pregnancy or in the post partum period. Some women have excessive resorption of calcium which may contribute to fracture risk (5).These consequences may be due to preexisting low bone density or increased bone turnover.

Calcium needs increase during pregnancy, mainly for fetal skeletal calcification. The maximum rate of increase occurs in the final trimester (9). The placenta transports calcium actively to the fetus and maintains total and ionized calcium at about 1mg/dl above maternal calcium levels. From 28 to 40 weeks of gestation, fetal weight triples but calcium content quadruples due to increased bone mineral mass. Several studies have suggested that very low maternal calcium intake may be a risk for low bone mass in neonates (3). The low serum calcium levels during pregnancy limits the fetal mineral accretion and the calcium concentration in breast milk and these affect infant growth and bone mineral accretion. Calcium supplementation during pregnancy reduces the risk of preterm births (7).

Calcium is thus found to play an important role in determining the birth weight (7). Calcium is not only essential during pregnancy, but also during lactation. During lactation, the loss of calcium in breast milk is about 280-400 mg (3). These help in the bone development of the fetus. These supplements are essential at different phases of life as it protects the bone, especially during menopause when the bones become fragile (osteoporosis) and more prone for fractures (13). The role of calcium continues throughout life as its main function is bone preservation.

VI. Conclusion:

Maternal calcium is thus found to play an important role in determining the fetal birth weight. In our country, most of the pregnant women fail to consume the recommended amount of nutrition needed for the fetal growth. Maternal calcium supplementation of about 1 g/day in the mid pregnancy period becomes vital for the mineralization of the fetal bone. Hence it is essential to educate the pregnant women about the importance of calcium on fetal growth. The required supplements must be provided during their antenatal visits. Not only during pregnancy and lactation, the calcium levels need to be sustained throughout life as it is needed for the maintenance of the bone.

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