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Increased Incidence of Low Birth Weight babies in High Fluoride Areas

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Summary

The problem of low birth weight (LBW) is multifactorial is Fluoride ingestion during pregnancy affects the development of the fetus due to the passage of fluoride transplacentally. This study aimed to evaluate the effect of high fluoride ingestion on fetal growth. Case control study was conducted on 150 deliveries each, in areas with normal fluoride (<1.0 ppm) and high fluoride (4.5ppm) concentration in drinking water. Detailed history and clinical examination were conducted to exclude other causes of LBW. Birth weight was noted. Fortyfive (30%) newborns were LBW in area with high fluoride concentration in comparison to 13 (8.66%) in area with normal fluoride concentration. The proportion of cases for the occurrence of LBW was 77.6%, compared to that for non-occurrence of LBW, which was 43.33%. Statistical analysis on Chi square tests was highly significant (P<.05). Significant association has been observed between LBW and high fluoride intake during antenatal period indicating that high fluoride intake during pregnancy interferes with fetal development. The possible suggested mechanism was transplacental passage of fluoride, causing chronic suppression of calcium in mother and fetus leading to (a) decreased TBBM (total body bone mineral) and poor bone growth. (b) secondary hyperparathyroidism in fetus and interfering with soft tissue development by producing defective ground substance.

Introduction

The average birth weight of newborn is around 2800 to 3000 gms. Low birth weight or LBW, as it is abbreviated denotes birth weight of less than 2500gms. In India over 30% infants (Deshmukh et al 1998 and Park et al 1991) are born LBW as opposed to 5-7% in the west (Kramer, 1987). LBW is one of the important cause of neonatal and infant mortality and accounts for 75% neonatal deaths and 50% infant deaths. Even after recovering from neonatal complications, some LBW babies may remain prone to malnutrition, recurrent infections and neurological development handicaps. Therefore LBW is a key risk factor of adverse outcome of the life.

The problem of LBW is multifactorial (Park et al 1991). During an investigation to observe the transplacental passage of fluoride, LBW was a common presentation in newborn babies. Systemic fluorosis is an endemic problem in several developing countries especially in India. Fluorosis has also been reported sporadically in other parts of the world. In India at least 15 states are endemic for fluorosis. Out of these 15 states, about 5 states had indicated endemicity for fluorosis in all districts. Rajasthan is one state where all the 32 districts have been identified as fluorosis prone areas. While the WHO standards permit only 1.5mg/ℓ as a safe limit for human consumption people in several districts in Rajasthan are consuming water with fluoride concentrations of up to 44mg/ℓ. This has resulted in permanent deformities, severe joint pains and general debility.

Fluoride ingestion during pregnancy affects the development of fetus due to the passage of fluoride transplacentally. Gardner et al (1952) observed that fluoride levels in maternal blood and in the placental

tissues of pregnant women were high in areas, where drinking water contains 1.5ppm of fluoride. Feltman and Kosel (1953). Shen and Taves (1974) and Gedalia et al (1961, 1964) reported that the placenta passively permits fluoride to fetus. Armstrong et al (1970) found no significant gradient between maternal and fetal blood fluoride levels.

However Gedalia (1970) suggested that the placenta might provide a partial barrier at higher blood fluoride level. Gupta et al (1993) indicated that average fluoride concentration in the cord blood was 60% of that in the mother's blood. When concentration in mother's blood exceeded 0.4ppm, the placenta acted as a selective barrier.

Results of a recent study suggested that fluoride might indeed exert effects on fetal growth. Reviewed literature indicated that babies whose mother had received fluoride tablets in therapeutic doses during pregnancy were somewhat heavier and slightly longer at birth. Prematurity was much less frequent compared with control group in studies of WHO (1982) and Glenn et al (1982) but no study is available to indicate the effect of high fluoride ingestion on fetal growth.

Therefore it was planned to conduct a study in areas with high fluoride in drinking water on birth weight of newborn babies.

Material and Methods

Case control study was done on 150 deliveries in the two areas following over a period of 18 months in (A) area with high fluoride in drinking water (> 4.5ppm (Shivdaspura): cases (B) area with normal fluoride concentration i.e. 0.6-0.9 ppm (Jaipur) controls

Deatiled history and monthly clinical examination were conducted to exclude the other causes of LBW. The delivery was conducted by the trained staff in the case group village and by the resident doctors at Zenana hospital, Jaipur. The birth weight was noted on the weighing scale to the accuracy of nearest 50gms.

Observations

One hundred & fifty deliveries were conducted over a period of 18 months (Oct. 97 to March 99) at Matra and Shishu Kalyan Kendra, Shivdaspura Simultaneously data of 150 deliveries were collected from control group, matched in period, gravidity, parity and socio-economic status of the subjects of study group

All the mother's (150) of the case group were continuously exposed to drinking water with high fluoride concentration i.e. 4.5ppm during antenatal period. Control group mothers were from Jaipur city which have a water fluoride content of less than 1.0 ppm well within the permissible limit. No other apparent cause of LBW was present in case or control group. The results relating to birth weight in both groups are summarized in Table I.

Out of 150 newborn, whose mother's were exposed to high fluoride during antenatal period, 45

Table I : Birth weight of babies delivered to the mothers residing in areas with high (cases and normal (controls) fluoride in drinking water

Month	LBW*		AGA		LGA	
	No.	%	No.	%	No.	%
Cases	45	30.00%	104	69.33%	1	0.66%
Controls	13	8.66%	128	85.33%	9	6.00%

* Includes preterm AGA, Term SGA and Preterm SGA

Table II
LBW

		Present	Absent	Total
History of exposure of mother to high fluoride ingestion during antenatal period	Present	45 (a)	105 (b)	150 (a+b)
	Absent	13 (c)	137 (d)	150 (c+d)
	Total	58 (a+c)	242 (b+d)	300 (a+b+c+d)

Proportion of cases for the occurrence of LBW a/(a+c) = 77.6%
Proportion of cases for the non occurrence of LBW b/(b+d) = 43.33%
Statistical significance (Chi square test) p = < 0.05

(30%) were LBW, 104 (69.33%) were AGA and only one case (0.66%) was LGA. compared to 150 newborn, whose mother's were not exposed to high fluoride during antenatal period, in whom 13 (8.66%) were LBW, 128 (85.33%) were AGA and 9 (6.00%) were LGA.

The overall occurrence of LBW in these fluoride rich areas was found to be 30%. Proportion of cases [a/(a+c)] for the occurrence of LBW was 77.6%, whereas proportion of cases [b/(b+d)] for the non-occurrence of LBW was 43.33%. The Chi square value observed is 21.87 at one degree of freedom ($P<0.05$). (Table II)

Discussion

It is quite evident from the data that the large for gestational age (LGA) babies are insignificant in number in the study group i.e. area with high fluoride concentration in comparison to these in the area with normal fluoride concentration. The data indicated high prevalence of low birth weight (LBW) in study group. This observation is in contradiction to that reported in the studies of WHO (1982) and Glenn et al (1982), where the fluoride was supplemented in therapeutic doses. No study is available in the literature indicating the effect of high fluoride ingestion on fetal growth.

Although the exact mechanism of fluorosis is not fully known but the interrelationship of parathyroid hormone and calcium in pregnancy Cunningham et al (1993), and of fluoride and PTH (Jowsey et al, 1975), indicate that fluoride may play some role in the outcome of pregnancy.

Observations of this study indicated a positive association ($p<0.05$) between LBW and high fluoride intake during antenatal period. Considering the transplacental passage of fluoride and interference in fetal development in utero, the possible mechanism may be that fluoride affects the function of parathyroid by altering serum calcium (Jowsey et al, 1975 and Teotia & Teotia 1972). Any challenge stimulation, which causes decreased level of circulating calcium, would induce parathyroid release. Even without high fluoride ingestion the parathyroid hormone concentration in plasma decreases during the first trimester of pregnancy and then increases progressively throughout the remainder of pregnancy. The increased PTH is a result of chronic suppression of calcium concentration, which is likely, to be due to increased plasma volume, increased GFR, and increased fetal transfer of calcium. Females with already compromised parathyroid functions and increased secretion of PTH during pregnancy, if exposed to high fluoride intake will accentuate the condition of hypocalcemia, further compensated by increased PTH.

In both situations viz. pregnancy and high fluoride ingestion, there is chronic suppression of calcium causing increased PTH secretion. Chronic suppression of calcium will cause a decreased supply of calcium to fetus and decreased TBBM (total body bone mineral), as also observed by Chen et al (1995). Decreased supply of calcium in utero will lead to secondary hyperparathyroidism. If maternal hypocalcemia is well compensated this situation will be avoided, but once the fetal supply of calcium is affected by continuous exposure to high fluoride ingestion during pregnancy it will lead to secondary hyperparathyroidism in fetus (Cooper, 1985). The increased PTH will maintain the serum calcium level in fetus but simultaneously affect the bone growth due to poor mineralization and soft tissue development by interfering with the production of ground substance e.g. glucosamine glycans etc. (Jowsey et al 1975, Jha et al 1983, Cramer et al 1961 and Tortora & Anagnostakes 1990).

The defective development of bone and soft tissue will interfere with the overall growth of the infant leading to a condition of low birth weight.

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