Relationship of maternal and cord blood iron stores

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علاقة مستوى مخزون الحديد في دم الام و الحبل السري للجنين

الخلاصة:
تم قياس مستوى الفريتين المصلي كقياس لمستوى مخزون الحديد في 40 ام كاملة الحمل و الحبل السري لاطفالهن وكان متوسط المستوى في الام هو ١٩-٢٠٤ µg/L بالمقارنة مع ٦٧-٢١٩ µg /L فى دم الحبل السري.
الهدف من الدراسة هو لايجاد العلاقة بين مستوى مخزون الحديد للام و الحبل السري للجنين.
كانت النتيجة عدم وجود علاقة بين المستووين.

Abstract:
Serum ferritin was measured in 40 term normal pregnant mothers and the corresponding cord blood samples. All of the mothers had received prophylactic oral iron and folate irregularly during pregnancy. The mean (±SD) maternal serum ferritin at the end of pregnancy was 58 ± 36 µg/l (range 19-204 µg/l), compared to a mean of 186 ±61 µg /l (range 67-319 µg/l) in thier newborns. No correlation was found between the serum ferritin of mothers and babies, nor between the serum ferritin and serum iron of mothers at the end of pregnancy or between these parameters in the newborn.

Introduction:
The iron content of the newborn infantis an important source of iron for haemoglobin formation in thefirst few months of life since the iron content of milk is low. The purpose of the present study was to determine the relation of serum ferritin of mothers at the time of delivery, and the corresponding cord blood.

Increasing evidence demonstrates that fetal iron supply through gestation is limited in the presence of maternal iron deficiency (1). Cord serum ferritin decreases after maternal serum ferritin has fallen below
12 g/L (2). Storage iron decreases progressively after birth (3,4) due to the need to maintain a near constant mean hemoglobin concentration of 125 g/L within a rapidly expanding blood volume, particularly between the ages of 4 and 12 months (5), when infants depend on the iron acquired from the mother before birth. Such a demand leaves the infant susceptible to iron deficiency.

The present study was undertaken to determine the effect of maternal iron deficiency on the iron supply of neonates born to a group of women in order to evaluate the need for an interventional trial on the study population.

Patients and methods:
Forty pregnant women (age range 18-39 years; each had 1-7 pregnancies) attending the Obstetric Clinic at Alzahraa Maternity Hospital in Najaf contributed in this study. All of them had a term normal pregnancy and normal delivery. Their babies were all term and of normal weights. All of the mothers had received irregular iron-folic acid supply since early pregnancy.

When the mothers were admitted for delivery, blood samples were obtained from them for determination of Hb, serum iron, total iron binding capacity (TIBC), and

serum ferritin. Similar tests were done on cord blood samples. The method used for serum iron and TIBC was that recommended by the International Committee for Standardization in Hematology[2]. Normal range for serum iron is 75-130 mg/dl (13.4-23.3, mmol/l), and for IBC 270-390 mg /dl (48.3 - 70, mmol/l). Serum ferritin was measured by ELISA method (Monobind; USA).

Results

Hb, serum ferritin, serum iron, and TIBC of the mothers and newborn babies (cord blood samples) are shown in the Table 1 and table 2. Seven of the mothers were anemic (Hb < 11.5 g/dl). 5 of these 7 had low serum iron levels and all 7 had low serum ferritin values. None of the maternal samples showed a serum ferritin in the range found in iron deficiency anemia (0-12, mg /l). The cord Hb was normal in all babies (mean cord Hb for mature neonates is 16.8 g/dl with a range of 14.7-21 g/dl). The mean serum iron of the newborn babies and their mean TIBC were both increased. The mean TIBC of the mothers was also greatly increased compared to normal adult levels in non pregnant women.

The mean (± SD) maternal serum ferritin was 57.9 ±36.5 µg/l (range 19-204, µg /l). The mean value for the newborns was 186 ± 60 µg/l (range 67- 319, µg /l). There was no correlation between maternal and cord blood serum ferritin (r= 0.2) (Fig 1). There was also no correlation between maternal serum ferritin and maternal serum iron or per cent saturation of the iron binding capacity or between cord blood serum ferritin and cord serum iron or per cent saturation of the iron binding capacity.

Table 1: Different parameters of newborns (cord blood) at the time of delivery

Parameter	Mean ± SD Cord blood	Range
Hemoglobin (g/dl)	16.8 ±14.9	14.7 - 21.0
Serum iron (µg/dl)	190 ± 82	90 - 449
TIBC (µg /dl)	352 ± 121	130 - 537
Serum ferritin (µg/l)	186 ± 60	67-319

Table 2: Different parameters of mothers at the time of delivery

Parameters	Mean ± SD Maternal blood	Range
Hemoglobin (g/dl)	12.7 ± 1.3	10.4 -15.6
Serum iron (µg/dl)	131.7 ± 36.3	48 -178
TIBC (µg /dl)	560 ± 146	369 -890
Serum ferritin (µg/l)	57.9 ± 36.5	19 -204

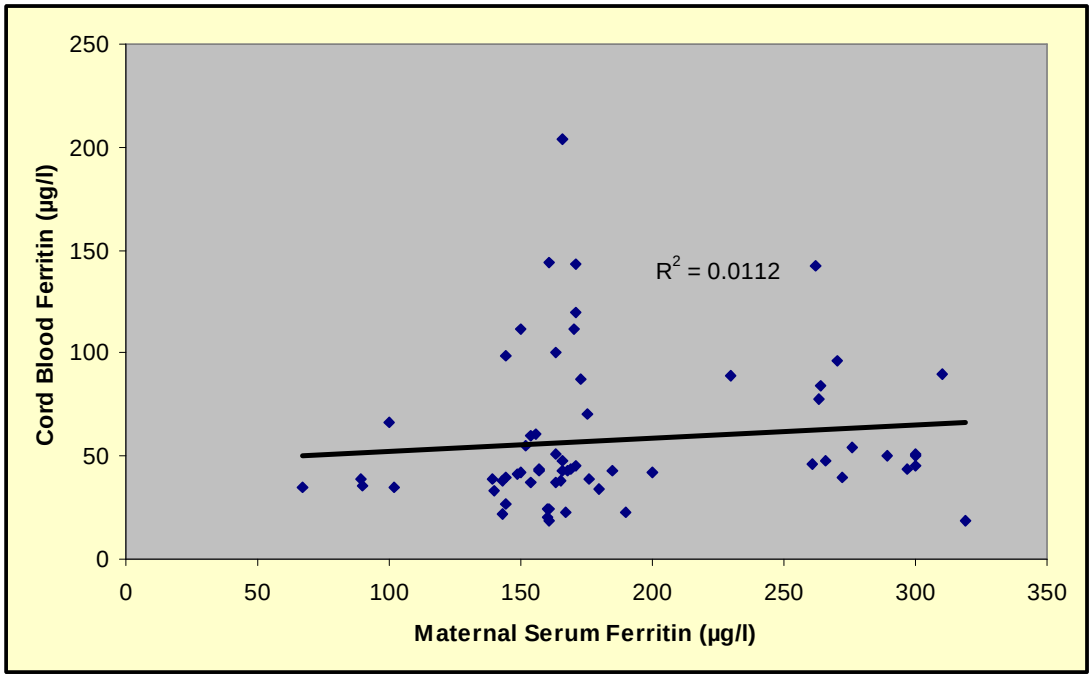

Figure 1: Relation of maternal to fetal (cord blood) serum ferritin

Discussion:-

During embryonic life until birth a normal fetus acquires about 250-300 mg iron [3]. The only source of fetal iron showed to be maternal plasma iron and so pregnant women are likely to become iron deficient if this fetal requirement is not allowed for. Earlier studies on iron status during pregnancy suggested that children born to severely iron-deficient mothers develop iron deficiency anemia themselves later on in infancy, and this might be due to depleted iron stores at birth [4] . However, several studies on humans and experimental animals disproved this idea and showed that in iron-deficient pregnant mothers total fetal iron was not reduced, though more of the fetal iron came from maternal iron absorption than from maternal iron stores [5 - 9]. Most of these studies comparing iron status of pregnant mothers and their newborn babies were based on the standard tests of serum iron, TIBC, and percentage saturation.

Serum ferritin is a good measure of the iron storage of the body, particularly of iron in the reticuloendothelial system. A study on 20 normal and 6 iron-deficient mothers showed no relationship between the predelivery serum ferritin in the two populations of mothers and the serum ferritin of their newborns' cord blood [10]. The current study group of mothers although had received irregular oral iron since early pregnancy and showed higher levels than those of Jaime-Peres *et al*. for both maternal and cord serum ferritin, however the present study, consistent with that of Jaime-Peres *et al*, did not show any correlation between maternal and cord serum ferritin. In contrast, other investigators [11] found lower serum ferritin concentrations in cord blood samples of iron-deficient mothers than of iron replete mothers. The explanation for the difference between their findings and those of the present study is uncertain but may be that serum ferritin and therefore iron stores are only reduced in neonates if maternal iron stores are completely exhausted, and that was not the case in any of current study subjects.

Previous experimental work has shown that transfer of iron across the placenta occurs against a concentration gradient for plasma iron and transferring saturation [12]. Most of these studies have shown that the fetus does not show excessive tissue accumulation of iron even after very high doses of parenteral iron have been given to pregnant mothers. It will be of interest, therefore, to study cord blood ferritin from pregnant patients with iron overload as well as from those with iron deficiency in the subsequent studies.

References:

1. Sweet DG, Savage G, Tubman TR, Lappin TR, Halliday HL. Study of maternal influences on fetal iron status at term using cord blood transferrin receptors. Arch Dis Child Fetal Neonatal Ed 2001;84: F40-F43.
2. Oski FA, Brugnara C, Nathan DG. A diagnostic approach to the anemic patient. In: Nathan DG, Orkin SH, Ginsburg D, Look TA, eds. Hematology of Infancy and Childhood, 6th ed. Philadelphia: W.B. Saunders, 2003. pp. 409-418.
3. Jaime-Perez JC, Gomez-Almaguer D. Iron stores in low-income pregnant Mexican women at term. Arch Med Res 2002; 33:81–84. 602 *Jaime - Perez et al./ Archives of Medical Research 36 (2005) 598–602*
4. Georgieff MK, Wewerka SW, Nelson CA, Deregnier RA. Iron status at 9 months of infants with low iron stores at birth. J Pediatr 2002;141:405–409.
5. Rao R,Georgieff MK. Perinatal aspects of iron metabolism. Acta Paediatr Suppl 2002;91:124-129.
6. Erdem A, Erdem M, Arslan M, Yazici G, Eskandari R, Himmetoglu O. The effect of maternal anemia and iron deficiency on fetal erythropoiesis: comparison between serum erythropoietin, hemoglobin and ferritin levels in mothers and newborns. JMatern Fetal Neonatal Med 2002;11: 329-332.
7. Gupta R, Ramji S. Effect of delayed cord clamping on iron stores in infants born to anemic mothers: a randomized controlled trial. Indian Pediatr 2002;39:130-135.
8. Andrews NC. Disorders of iron metabolism and sideroblastic anemia. In: Nathan DG, Orkin SH,GinsburgD, Look TA, eds. Hematology of Infancy and Childhood, 6th ed. Philadelphia: W.B. Saunders, 2003. pp. 456-497.
9. Sweet DG, Savage GA, Tumban R, Lappin TRJ, Halliday HL. Cord blood transferrin receptors to assess fetal iron status. Arch Dis Child Fetal Neonatal Ed 2001;85:F46-F48.
10. Malope BI, MacPhail AP, Alberts M, Hiss DC. The ratio of serum transferrin receptor and serum ferritin in the diagnosis of iron status. Br J Haematol 2001;115:84-89.
11. Ramakrishnan U, Frith-Terhune A, Cogswell M, Kettel Khan L. Dietary intake does not account for differences in low iron stores among Mexican American and non-Hispanic white women: Third National Health and Nutrition Examination Survey, 1988–1994. J Nutr 2002;132: 996-1001.
12. Mora JO, Nestel PS. Improving prenatal nutrition in developing countries: strategies, prospects, and challenges. Am J Clin Nutr 2000; 71(Suppl):1353S–1363S.
13. Lynch SR, Stoltzfus RJ. Iron and ascorbic acid: proposed fortification levels and recommended iron compounds. J Nutr 2003;133:2978S-2984S.
14. Collins, D.R., 2008. Differential Diagnosis in Primary Care. 4re Edn. Lippincott Williams and Wilkins., pp: 43.
15. Emamghorashi, F. and T. Heidari, 2004. Iron Status of babies born to iron-deficient anaemic mothers in Iranian hospital. Eastern. Med. J., 6: 808-814.
16. Emery, D. and D. Barry, 2006. Comparison of Maori and non-Maori maternal and fetal iron parameters. J. NZ.MA., 117 (1195).
17. Lee, H.S., M.S. Kim, K.H. Kim, Y.J. Kim and W.Y. Kim, 2006. Iron status and its association with pregnancy outcome in Korean pregnant women. Eur. Clin. Nutr., 60: 1130-1135.
18. Sichieri, R., V.M. Fonseca, D. Hoffman, N.M.F. Trugo and A.S. Moura, 2006. Lack of association between iron status at birth and growth of preterm infants. Rev. Saúde. Pública., 40.
19. Veghari, G.R., A.R. Mansourian and A.J. Marjani, 2007. The comparison of the anaemia in pregnant women and non pregnant women in the villages of South-East of Caspian Sea- Gorgan- Iran. J. Med. Sci., 7: 303-306.