

Serum Mg, Ca, Total Protein Levels in Maternal and Cord Blood and Its Clinical Significance

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In the clinic, the use of micro-methods for determination of Mg, Ca and other metals in newborns has been very valuable for interpretation of symptoms. These symptoms, especially of the central nervous system, are related to the fluctuations of these metals. Within the last two decades new knowledge about the metabolism of these metals set up new targets for investigation.

Reports have appeared in the literature about the normal levels of Mg in maternal and cord sera,^{1 2} but only two of them discussed the changing level of Mg with pathological conditions.^{3 4}

In the present paper, we have studied Mg, Ca and total protein levels in maternal and cord blood in order to learn more about their placental transfer of these metals. This study was done not only for normal but also for different pathological conditions of newborns. We have tried to establish basic knowledge of this metal metabolism separately in different baby groups and therefore have observed the deviation from the normal newborn infant.

In this study, pathologic baby groups consisted of babies with jaundice, asphyxia, respiratory distress syndrome, prematurity, dismaturation, postmaturation and low birth weight.

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All these infants were observed during their nursery stay for symptoms of central nervous system abnormalities which could be related to deviation of these metals from normal levels.

Materials and Methods

At the Children's Hospital of Hacettepe, 99 mothers and their babies were subject to this study. Only mothers with live births were admitted to the study so that babies with symptoms could be observed in the nursery period. One mother who received MgSO_4 therapy for her toxemia was not included in the study. 60 of the 99 deliveries resulted in normal newborns the criteria for which was that their gestation period was full term and birth weights were above 3000 gm. 39 babies had different clinical pathologic conditions namely 6 babies with hyperbilirubinemia, 5 with asphyxia, 5 with respiratory distress syndrome, 6 dismature, 7 postmature, 6 with low birth weight and 4 premature.

A venous blood sample from the mother just prior to delivery and a cord blood sample were taken for determinations of Mg, Ca, and total protein. Since none of the babies developed symptoms which could be related to the central nervous system in the nursery period, further determinations of Mg, Ca could not be done. For determination of Mg and Ca level a fluorometric method was used.^{5 6} Serum protein level was measured by O. Warburg and W. Christian's method.

Letters used to indicate the baby groups are as follows;

A: Normal infant	E: Dismature
B: Hyperbilirubinemia	F :Low birth weight
C: Premature	G: Respiratory distress
D: Asphyxia	H: Postmature

Findings

The findings obtained from this study can best be listed as follows:

1. Mg, Ca and total protein levels in maternal and cord blood in normal and 7 pathologic groups of newborns.
2. Placental transfer of Mg, Ca and total protein.
3. Deviation of Mg, Ca and total protein levels in pathologic groups of newborns from the normal infant.

1. a) Table I shows normal newborns serum Mg, Ca and total protein levels in maternal and cord blood.

TABLE I

Mg. Ca. AND TOTAL PROTEIN LEVELS IN MATERNAL AND CORD BLOOD IN A: NORMAL NEWBORN

Number of cases	Maternal blood			Cord blood		
	Mg mEq/L	Ca mg %	total prot. gm %	Mg mEq/L	Ca mg %	total prot. gm %
	60	60	60	60	60	60
Mean	1.721	9.976	7.366	1.762	11.417	5.808
St. dev. $\pm$	0.219	1.537	1.091	0.170	1.130	0.889
Min.	1.30	8.40	6.21	1.40	9.00	3.98
Max.	2.40	20.00	11.26	2.15	15.50	9.47

b) Table II through 8 shows serum Mg, Ca and total protein levels in maternal and cord blood in pathologic newborns.

TABLE II

Mg. Ca. AND TOTAL PROTEIN LEVELS IN MATERNAL AND CORD BLOOD IN BABIES WITH B: HYPERBILIRUBINEMIA

Number of cases	Maternal blood			Cord blood		
	Mg mEq/L	Ca mg %	total prot. gm %	Mg mEq/L	Ca mg %	total prot. gm %
	6	6	6	6	6	6
Mean	1.300	10.366	7.51	1.546	11.816	5.523
St. dev. $\pm$	0.174	0.895	0.775	0.224	1.484	0.633
Min.	1.288	9.10	6.64	1.30	10.50	5.23
Max.	1.75	11.60	8.25	1.90	14.4	5.78

TABLE III

Mg. Ca. AND TOTAL PROTEIN LEVELS IN MATERNAL AND CORD BLOOD IN C: PREMATURE

Number of cases	Maternal blood			Cord blood		
	Mg mEq/L	Ca mg %	total prot. gm %	Mg mEq/L	Ca mg %	total prot. gm %
	4	4	4	4	4	4
Mean	1.575	9.825	7.065	1.672	10.800	4.420
St dev. $\pm$	0.161	1.517	1.154	0.100	1.154	1.119
Min.	1.45	9.40	6.80	1.58	10.60	2.90
Max.	1.70	10.80	7.62	1.80	10.90	5.28

TABLE IV

Mg. Ca. AND TOTAL PROTEIN LEVELS IN MATERNAL AND CORD BLOOD IN BABIES WITH D: ASPHYXIA

Number of cases	Maternal blood			Cord blood		
	Mg mEq/L 5	Ca mg % 5	total prot. gm % 5	Mg mEq/L 5	Ca mg % 5	total prot. gm % 5
Mean	1.578	10.360	7.424	1.686	11.300	5.340
St. dev. $\pm$	0.324	0.500	1.119	0.617	0.708	1.740
Min.	1.30	9.70	6.48	1.50	10.50	2.90
Max.	1.88	10.80	8.25	1.90	12.20	7.34

TABLE V

Mg. Ca. AND TOTAL PROTEIN LEVELS IN MATERNAL AND CORD BLOOD IN INFANTS. E: DISMATURE

Number of cases	Maternal blood			Cord blood		
	Mg mEq/L 6	Ca mg % 6	total prot. gm % 6	Mg mEq/L 6	Ca mg % 6	total prot. gm % 6
Mean	1.650	10.400	7.581	1.627	11.700	6.103
St. dev. $\pm$	0.708	0.548	1.420	0.155	1.740	0.548
Min.	1.45	9.70	6.60	1.43	9.70	4.88
Max.	2.05	11.50	8.48	1.78	14.20	6.92

TABLE VI

Mg. Ca. AND TOTAL PROTEIN LEVELS IN MATERNAL AND CORD BLOOD IN INFANTS. F: LOW BIRTH WEIGHT

Number of cases	Maternal blood			Cord blood		
	Mg mEq/L 6	Ca mg % 6	total prot. gm % 6	Mg mEq/L 6	Ca mg % 6	total prot. gm % 6
Mean	1.746	10.166	7.687	1.880	10.983	5.468
St. dev. $\pm$	0.205	0.708	1.184	0.233	1.096	0.548
Min.	1.48	9.10	6.48	1.50	9.70	4.50
Max.	2.08	10.90	9.10	2.10	12.20	6.72

TABLE VII

Mg. Ca. AND TOTAL PROTEIN LEVELS IN MATERNAL AND CORD BLOOD IN BABIES WITH G: RESPIRATORY DISTRESS SYNDROME

	Maternal blood			Cord blood		
	Mg mEq/L	Ca mg %	total prot. gm %	Mg mEq/L	Ca mg %	total prot. gm %
Number of cases	5	5	5	5	5	4
Mean	1.556	10.140	7.226	1.662	11.200	4.934
St. dev. $\pm$	0.174	0.500	0.867	0.142	0.867	1.660
Min.	1.30	9.40	6.48	1.50	10.60	2.90
Max.	1.70	10.80	8.19	1.80	12.20	7.34

TABLE VIII

Mg. Ca. AND TOTAL PROTEIN LEVELS IN MATERNAL AND CORD BLOOD IN H: POSTMATURE INFANTS.

	Maternal blood			Cord blood		
	Mg mEq/L	Ca mg %	total prot. gm %	Mg mEq/L	Ca mg %	total prot. gm %
Number of cases	7	7	7	7	7	7
Mean	1.674	10.100	7.161	1.695	11.057	5.714
St. dev. $\pm$	0.265	0.813	0.813	0.142	1.740	0.708
Min.	1.38	8.90	6.45	1.48	7.70	4.71
Max.	2.18	11.60	8.25	1.88	13.30	6.88

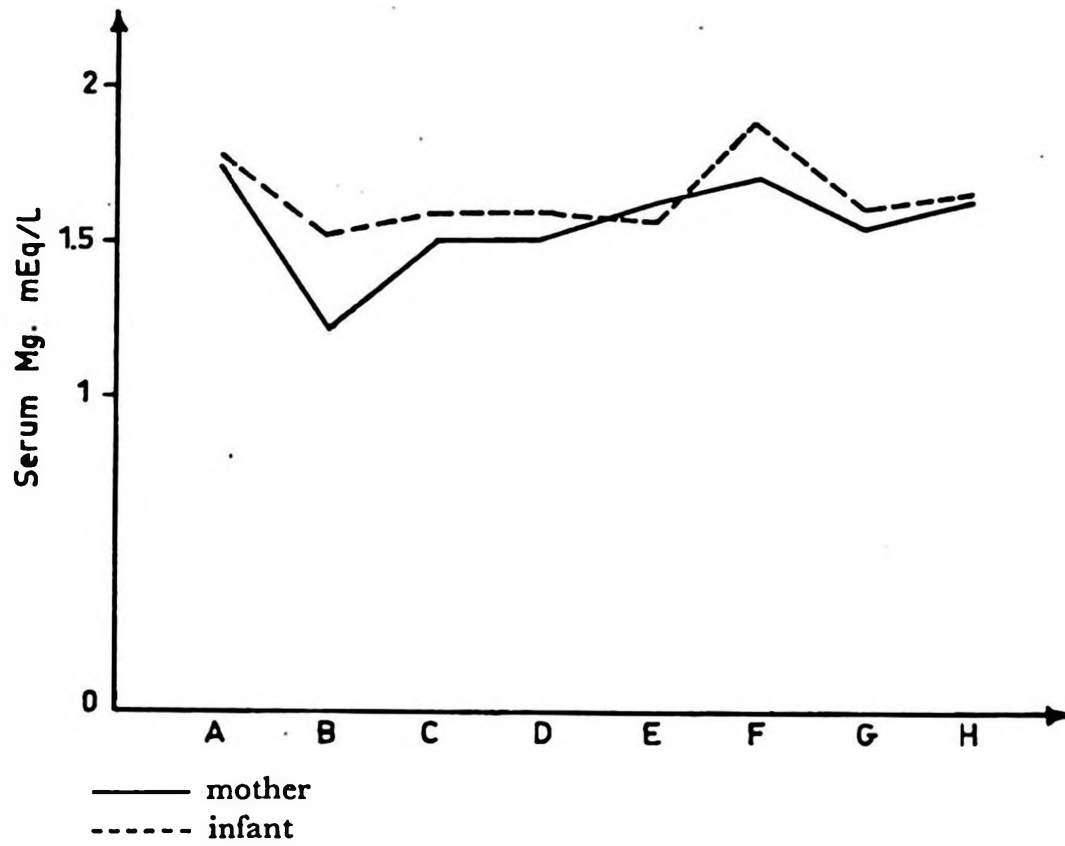
2. a) Figure 1 shows Mg levels in maternal and cord blood in all groups of newborns

b) Figure 2 shows Ca levels in maternal and cord blood in all groups of newborns

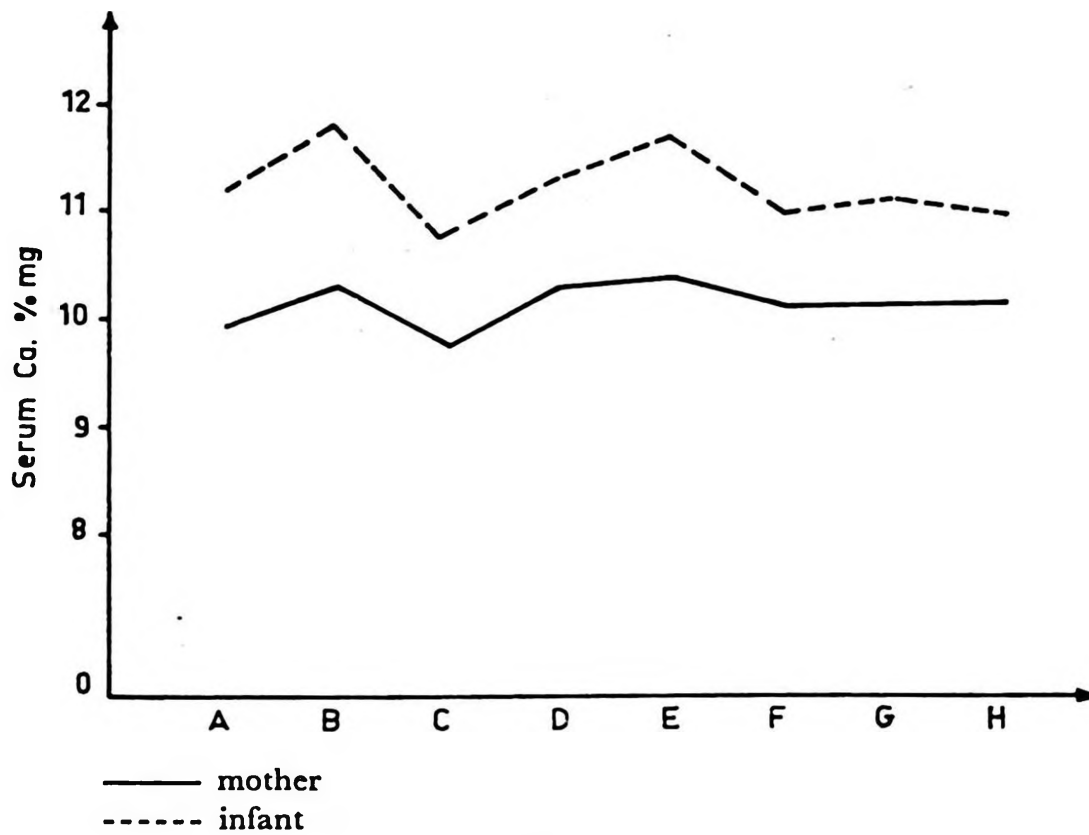
As can be seen from Figures 1 and 2, Mg and Ca levels were higher in the babies than in their mothers in all groups of newborns.

c) Figure 3 shows total protein levels in maternal and cord blood in all groups of newborns.

It is seen that total protein levels were higher in maternal blood than in the cord blood in all groups of newborns.

**Figure 1**

Serum Mg levels in maternal and cord blood in all groups of infants.

**Figure 2**

Serum Ca levels in maternal and cord blood in all groups of infants.

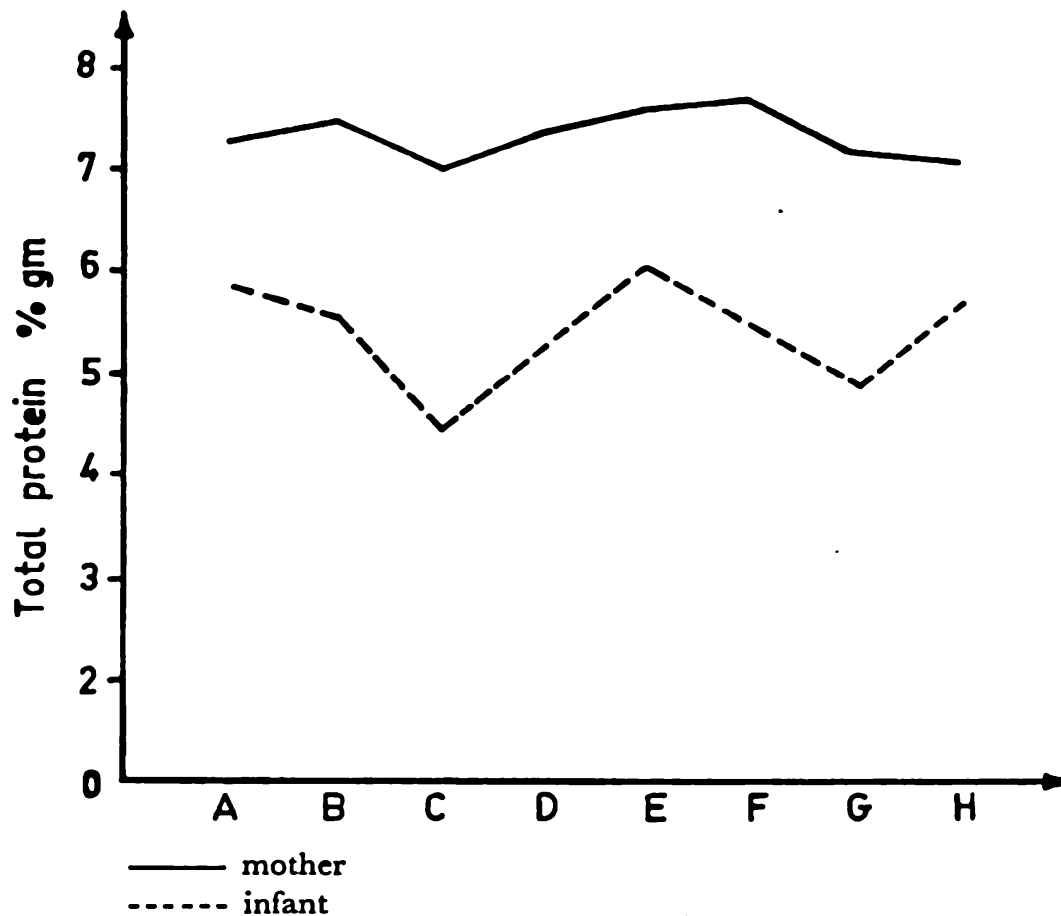


Figure 3

Serum total protein levels in maternal and cord blood in all groups of infants.

3. a) Table IX and X shows difference of Mg, Ca and total protein levels in maternal and cord blood between normal and pathologic baby groups.

TABLE IX

DIFFERENCE OF Mg. Ca. AND TOTAL PROTEIN LEVELS BETWEEN NORMAL AND BABIES WITH HYPERBILIRUBINEMIA

		Dif	S.t Dev.±	P
Maternal blood	Mg mEq/L (A-B)	0.443	0.083	P<0.05
	Ca mg % (A-B)	0.390	0.447	P>0.05
	Total prot. gm % (A-B)	0.145	0.390	P>0.05
Cord blood	Mg mEq/L (A-B)	0.216	0.099	P<0.05
	Ca mg % (A-B)	0.399	0.682	P>0.05
	Total prot. gm % (A-B)	0.285	0.300	P>0.05

TABLE X

DIFFERENCE OF Mg, Ca AND TOTAL PROTEIN LEVELS BETWEEN
NORMAL AND PREMATURE INFANTS

		Dif	St. Dev. $\pm$	P
Maternal blood	Mg mEq/L (A-C)	0.146	0.093	$P > 0.05$
	Ca mg % (A-C)	0.151	0.862	$P > 0.05$
	Total prot. gm % (A-C)	0.301	0.642	$P > 0.05$
Cord blood	Mg mEq/L (A-C)	0.090	0.058	$P > 0.05$
	Ca mg % (A-C)	0.617	0.640	$P > 0.05$
	Total prot. gm % (A-C)	1.388	0.640	$P < 0.05$

As can be seen in Table 9, Mg levels in maternal and cord blood in babies, which developed hyperbilirubinemia were lower than the normal newborn level. This was found to be statistically significant ($P < 0.05$).

b) Table 10 shows total protein difference between normal and premature babies which was found to be statistically significant ($P < 0.05$). The mean total protein levels in premature babies were lower than mean total protein levels of normal newborns.

c) No other statistically significant results were found in the differences of Mg, Ca and total protein levels in maternal and cord blood between normal and pathologic newborns.

Discussion

The first report in the literature about Mg and Ca levels of the cord blood was reported by Bogertan and Plass in 1923. Later, in 1936, Andersch and Oberst⁷ published higher Ca levels in cord blood than in the maternal blood. In 1961, Mays and Keele⁸ and in 1964 Anast² found the Mg level of cord blood to be 1.684 mg./100 ml. and 1.89 mg/100 ml respectively.

All these authors tried to establish a normal value for Mg level in the cord blood. In the present study we have not only tried to establish the normal value of Mg, Ca and total protein levels but also we have investigated the deviation from the normal of these metals in pathologic newborns. We found the mean value of Mg be 1.721 mEq/L in the maternal blood and 1.762 mEq/L in the cord blood in normal newborns.

Our findings of active placental transfer of Mg and Ca, corresponded to other authors' findings.^{9 10 11} We also found a higher total protein level in maternal blood than in the cord blood in all groups of newborns.

Engel et al⁴ postulated that since Mg is predominantly an intracellular cation, acute tissue injury from birth asphyxia will result in hypermagnesemia. Their results with 95 placental plasma samples in birth asphyxia were correlated with hypermagnesemia. Although our number cases of asphyxia is very small, we did not observe hypermagnesemia in these cases (Table IV).

Our finding, significant low Mg levels in maternal and cord blood in babies which develop hyperbilirubinemia is a new and interesting one. The reason for Mg levels being lower than in normal newborns is not known. This point has to be investigated in the future. One possible explanation is that Mg may enter the cell and cause increasing hemolysis in subsequent days. In order to answer this question, Mg levels within the cell have to be quantitatively measured in cases with hyperbilirubinemia. Perhaps in this way we can begin to learn the role of Mg in the bilirubin metabolism.

Summary

The maternal and cord blood serum Mg, Ca and total protein levels were determined in 60 normal and 39 pathologic newborns. Placental transfer of these metals, and significant relationships of Ca, total protein levels of infants with pathologic conditions and normal newborns were discussed.

It was seen that there was an active placental transfer of Mg and Ca. In all babies, cord blood total protein levels were lower than in the maternal blood. This was especially true in premature infants. Finally it was observed that low Mg levels in maternal and cord blood resulted in babies with hyperbilirubinemia. This last point needs further investigation.

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