

Short communication

J. Perinat. Med.
3 (1975) 68

Leukocyte alkaline phosphatase in newborn infants after delivery and in the puerperium

R. Horner, J. Elidan*, E. Sadovsky, Y. Z. Diamant, W. Z. Polishuk

Departments of Obstetrics and Gynecology and Pediatrics
Hadassah University Hospital and Hebrew University — Hadassah Medical
School, Jerusalem, Israel

Received October 8, 1973. Accepted December 28, 1974.

Alkaline phosphatase is normally found in many parts of the body, including the bones, kidneys, liver, and intestines. The enzyme is also found in the blood serum and leukocytes. Higher levels of serum alkaline phosphatase are encountered in various bone and liver diseases and pregnancy.

WACHSTEIN [17] in 1946, was the first to describe an increase in leukocyte alkaline phosphatase (LAP) in some types of myeloproliferative disorders. Marked increase of LAP activity has been observed in several pathologic conditions such as polycythemia vera [13], acute infectious processes [4, 6, 15], stress conditions [14], trauma and hemorrhage [16].

Higher levels of LAP activity were also found in newborn infants [8] and after adrenocortical hormone administration [14, 16].

Leukocyte alkaline phosphatase (LAP) in pregnancy increases until term [1, 2, 9, 11, 12] and decreases a few days before labor, returning to nonpregnant levels within 6 weeks post partum [9]. It was shown that LAP in pregnancy is not of placental origin but is under the influence of placental hormones and thus reflects placental function. The LAP score is probably determined by the balance of estrogen and progesterone secreted by the placenta [9].

In the immediate neonatal period the infant is still under the influence of maternal hormones, under the stress of labor, and other factors. The LAP of the newborn infant will reflect these influences.

The aim of the present study was to determine the LAP score of the newborn infant at delivery and

during the first days of the puerperium and compare it with maternal LAP scores, and to evaluate the possibility of other factors such as the weight of the infant, influencing the infant's LAP score.

1 Material and methods

LAP activity was studied in 60 women and their 61 infants (one pair of twins) at and after delivery. There were 58 deliveries at term and two in the 8th month. These included two cases of pre-eclampsia, one case of placenta previa, two cases of postmaturity, five cases of hypotonic uterine dysfunction, and two cases of post partum hemorrhage. Of the 61 infants, there were 33 females and 28 males. There was one case of Rh incompatibility and one case of congenital heart disease.

Peripheral blood smears were taken from the mothers at delivery — 60 cases, on the 1st day after delivery — 31 cases, on the 3rd day — 55 cases, and on the 5th day — 14 cases.

Blood smears from the infants were taken at delivery from the umbilical cord and by heel prick in 61 cases, and subsequently only by heel prick: On the 1st day after delivery — 46 cases, on the 3rd day — 59 cases, and on the 5th day — 14 cases.

LAP scoring was done in all cases after fixation and staining of the blood films by the KAPLOW

* This study is part of a thesis in fulfilment of the requirements for the M. D. degree of J. E.

method [5]. One hundred consecutive segmented and band form granulocytes were graded from 0 to 4 according to the intensity and quantity of the precipitated dye within the cytoplasm, through pale pink to heavy granular precipitate. The sum of the grades represents the LAP score, and the possible range is from 0 to 400.

2 Results

Fig. 1 shows the maternal values of the LAP scores and averages at delivery and on the first, third and fifth day after delivery. **The average of maternal LAP score decreases from 175 at delivery to 87 on the fifth day ($p < 0.01$).** Fig. 2 shows the newborn infants LAP scores on the same days. **The average LAP scores at delivery is 149, decreasing to 87 on the fifth day after delivery ($p < 0.01$).**

Fig. 3 compares the average LAP scores of maternal and newborn infants after delivery. It shows that **the maternal LAP scores at delivery are usually higher than that of the newborn**

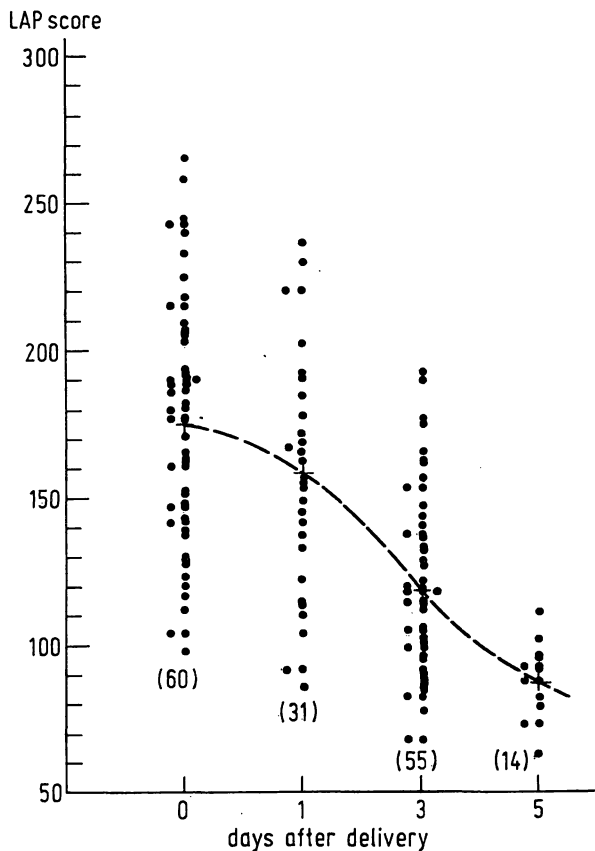


Fig. 1. Distribution and average of maternal LAP scores at delivery and on the 1st, 3rd and 5th days after delivery.

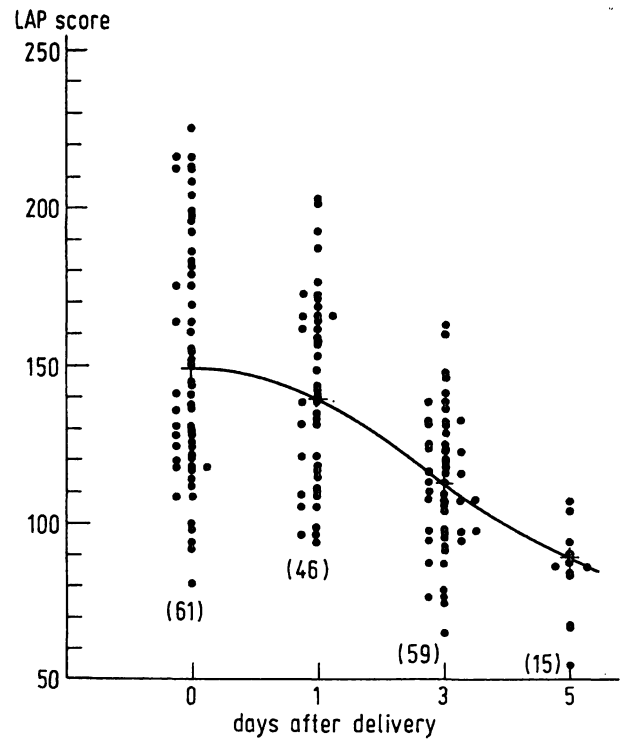


Fig. 2. Distribution and average of newborn LAP scores at delivery and on the 1st, 3rd and 5th day after delivery.

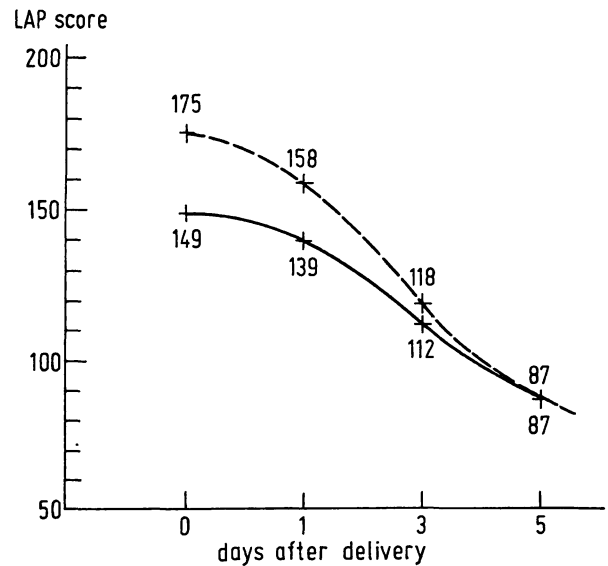


Fig. 3. Comparison of the average maternal and newborn LAP scores after delivery.

infant ($p < 0.01$), both decreasing during the following days reaching equal values on the fifth day.

Tab. I shows the LAP scores of the newborn at delivery as compared to those of the mothers. Most maternal and infants LAP scores, 50 of the 60 cases — (83%) — at delivery were between

Tab. I. Comparison of newborn and maternal LAP score at delivery*.

No. of cases	Maternal LAP score	Comparison of newborn to maternal LAP score		
		equal to maternal	more than maternal	less than maternal
1	<100	1	—	—
5	100—120	1	2	2
14	121—160	2	2	10
23	161—200	3	1	19
13	201—240	—	—	13
4	>240	—	—	4
60	Total	7	5	48

* Differences in LAP scores of less than 10 were considered equal.

Tab. II. Comparison between peripheral blood and umbilical cord blood LAP scores of the newborn at delivery*.

No. of cases	peripheral blood LAP score	Comparison between umbilical blood cord and peripheral blood LAP scores of the newborn at delivery*		
		equal	higher than peripheral	less than peripheral
2	<100	2	—	—
5	100—120	5	—	—
7	121—160	4	—	3
7	161—200	6	—	1
4	201—240	3	1	—
25	Total	20	1	4

* Differences in LAP scores less than 10 were considered equal.

121 and 240. In 48 out of 60 cases, the LAP scores of the newborn infants were lower than those of the mothers. In only five cases was the infant's LAP score higher than that of the mother. Tab. II shows no significant difference in LAP scores of the newborn at delivery, between heel prick peripheral blood and umbilical blood ($p < 0.01$).

Tab. III shows the LAP score of the newborn at delivery in three groups according to the birth weight. It was found that the higher the birth weight, the lower the LAP score. The average LAP score in Group B is lower than in Group A

Tab. III. The relationship between birth weight and the LAP score at delivery.

group	weight [kg]	No. of newborns	average LAP score
A	<2.5	2	156
	2.6—2.8	9	165
	2.8—3.1	11	167
B	3.1—3.4	11	142
	3.4—3.7	17	144
	3.7—4.0	6	150
C	4.0—4.3	4	131
	>4.3	1	120

($p < 0.025$). The average LAP score in Group C is lower than in Group B. However, the small number of cases in Group C does not permit statistical evaluation. The difference between Groups C and A is significant ($p < 0.025$).

3 Discussion

We have confirmed the fact shown by others [7, 8, 18] that the **maternal and newborn LAP scores are elevated at delivery, with the maternal values higher than those of the infants and both decrease after delivery** [8, 9].

It is most probable that the LAP activity of the mother and of the fetus in utero is under the control of steroids produced by the placenta [10]. It is also possible that the stress of labor resulting in increased corticoid blood levels is an additional factor contributing to the elevation of the infants LAP score [16].

HALBRECHT and SHABTAY [3] suggested that the high LAP activity in the newborn is related to the infant's metabolism and not to the placental hormones. The decrease of the maternal and infant LAP activity is explained by the delivery of the infant and the expulsion of the placenta.

The lower LAP activity in the newborn, as compared with that of the mother, could be explained by the lower hormonal levels in the fetus or possibly by a lower response of fetal granulocytes compared with the maternal granulocytes. Against this latter suggestion is the fact that on the 5th day after delivery the maternal and newborn LAP values are equal.

We have no explanation for our findings that LAP activity is inversely related to the weight of the newborn at delivery. OKELL [7], however, found that the LAP activity was directly related to the weight. HALBRECHT [3] did not find any

correlation between LAP score and infants weight.

No correlation was found between the LAP score in the newborn and the sex, race, blood type or complication of labor [7, 8].

Summary

Leukocyte alkaline phosphatase (LAP) activity increases progressively during pregnancy, returning to non-pregnant levels 6 weeks post-partum. This enzymatic activity is under the influence of placental steroid hormones, thus reflecting placental function. LAP activity is thus a reflection of the dynamic relations between estrogenic, progesterational and corticoid activity during pregnancy. LAP activity was studied in 60 women and in their 61 newborn infants at delivery and during the first five days of the puerperium. The KAPLOW cytochemical technique was employed.

The average maternal LAP score as well as the average newborn infant LAP score was considerably higher than the LAP score of the normal adult. The level of the enzyme in the maternal granulocytes was significantly higher than that of the newborn (Tab. I).

During the first five days after labor, there was progressive decrease in the LAP score in the maternal and the newborn blood; on the fifth day the LAP scores of both were only slightly above the normal adult score (Figs. 1, 2).

An inverse relation between the LAP score and the birth weight of the infant was found (Tab. III).

These results confirm the view that LAP activity in the fetus in utero, are dependent on placental steroid function. The lower LAP values in the newborn, as compared to those of the mother are probably dependent on the lower newborn hormone levels.

The significance of the relation between LAP scores and the infants birth weight is not clear.

Keywords: Newborn, leukocyte alkaline phosphatase, puerperium.

Zusammenfassung

Die alkalische Leukozytenphosphatase bei Neugeborenen nach der Geburt und in der Neonatalzeit.

Die Aktivität der alkalischen Leukozytenphosphatase (LAP) steigt während der Schwangerschaft allmählich an und erreicht 6 Wochen nach der Geburt wieder ihren Normalwert. Diese Enzymaktivität steht unter dem Einfluß der placentaren Steroidhormone und spiegelt demnach eine placentare Funktion wider. Die LAP-Aktivität ist somit ein Indikator der dynamischen Beziehungen zwischen der Östrogen-, Progesteron- und Kortikoidaktivität während der Schwangerschaft.

Es wurde die LAP-Aktivität bei 60 Frauen und ihren 61 Neugeborenen bei der Entbindung und während der ersten 5 Tage des Wochenbettes bestimmt. Dabei wurde die cytochemische Methode von KAPLOW angewandt.

Sowohl der mütterliche Durchschnittswert der LAP als auch der der Neugeborenen lag beträchtlich höher als der

normale LAP-Durchschnittswert von Erwachsenen. Der Enzymspiegel in den mütterlichen Granulozyten war signifikant höher als der der Neugeborenen (Tab. I).

Während der ersten 5 Lebenstage fiel der LAP-Wert im mütterlichen und kindlichen Blut allmählich ab. Am 5. Tag lagen die LAP-Werte von beiden nur etwas über dem Normalwert bei Erwachsenen (Figs. 1, 2).

Es wurde eine umgekehrt proportionale Beziehung zwischen dem LAP-Wert und dem Geburtsgewicht des Kindes gefunden (Tab. III).

Die Ergebnisse bestätigen die Annahme, daß die LAP-Aktivität beim Fet in utero von der placentaren Steroidfunktion abhängt. Sind die LAP-Werte beim Neugeborenen verglichen mit denen bei der Mutter niedriger, hängen sie wahrscheinlich vom niedrigeren Hormonspiegel des Neugeborenen ab.

Die Signifikanz der Beziehung zwischen den LAP-Werten und dem Geburtsgewicht der Kinder ist nicht klar.

Schlüsselwörter: Alkalische Leukozytenphosphatase, Neugeborenes, Wochenbett.

Résumé

Phosphatase alcaline de leucocytes chez les nouveaux-nés après la naissance et dans la période puerpérale.

L'activité de la phosphatase alcaline de leucocytes (LAP) augmente progressivement durant la grossesse et atteint à nouveau son degré normal six semaines après la naissance. Cette activité enzymatique est soumise à l'influence des hormones stéroïdes placentaires, reflétant ainsi la fonction placentaire. L'activité LAP reflète donc les relations

dynamiques entre l'activité des oestrogènes, des progestérones et des corticoïdes durant la grossesse.

L'activité LAP a été observée chez 60 femmes et chez leurs 61 nouveaux-nés durant l'accouchement et les cinq premiers jours de la période puerpérale, avec recours à la technique cytochimique de KAPLOW.

Le score LAP moyen des mères ainsi que des nouveaux-nés s'est révélé beaucoup plus élevé que chez l'adulte normal.

Le niveau de l'enzyme était nettement supérieur dans les granulocytes maternels que chez le nouveau-né (Tab. I). Durant les 5 premiers jours suivant l'accouchement, on a pu observer une baisse progressive du score LAP dans le sang maternel et du nouveau-né; le 5ème jour, il ne dépassait plus que légèrement dans les deux cas celui des adultes normaux (Figs. 1, 2).

Un rapport inverse a été enregistré entre le score LAP et le poids du nouveau-né à la naissance (Tab. III).

Mots-clés: Nouveau-né, période puerpérale, phosphatases alcalines de leucocytes.

Ces résultats confirment l'hypothèse selon laquelle l'activité LAP du fœtus dans l'utérus dépend de la fonction stéroïde placentaire. Si les valeurs LAP sont moins élevées chez les nouveaux-nés que chez la mère, c'est probablement du au degré inférieur des taux d'hormones chez le nouveau-né.

Quant aux rapports entre les scores LAP et le poids des nouveaux-nés à la naissance, on n'en connaît pas encore la signification.

Bibliography

- [1] EFRATI, P., B. PRESENTEY, M. MARGALITH, L. ROSENSZAIN: Leukocytes of normal pregnant women. *Obstet. Gynec.* 23 (1964) 429
- [2] HAERING, M. Z.: Das Verhalten des alkalischen Leukozyten-Phosphatase (ALP) in der Schwangerschaft, unter der Geburt und im Wochenbett. *Z. Geburtsh. Gynäk.* 162 (1964) 132
- [3] HALBRECHT, I., F. SHABTAY: LAP activity in preterm infants. *Israel J. Med. Sci.* 8 (1972) 1956
- [4] HOFFMAN, G. C., V. J. LUCICH: The clinical application of a modified azo dye technique for the determination of alkaline phosphatase activity in neutrophils. *Cleveland Clin. Quart.* 27 (1960) 146
- [5] KAPLOW, L. S.: Cytochemistry of leukocyte alkaline phosphatase: use of complex naphol AS phosphatases in azo dye-coupling techniques. *Amer. J. Clin. Path.* 39 (1963) 439
- [6] KENNY, J. J., W. C. MOLONEY: Leukocyte alkaline phosphatase behavior during prolonged incubation and infection in normal and leukemic leukocytes. *Blood* 12 (1957) 295
- [7] O'KELL, R. T.: LAP in the infant. *Ann. N. Y. Acad. Sci.* 155 (1968) 980
- [8] O'KELL, R. T., L. L. AXON: LAP in the newborn infant. *Amer. J. Obstet. Gynec.* 93 (1965) 1181
- [9] POLISHUK, W. Z., Y. Z. DIAMANT, E. SADOVSKY, H. ZUCKERMAN: Leukocyte alkaline phosphatase in pregnancy and the puerperium. *Amer. J. Obstet. Gynec.* 107 (1970) 604
- [10] POLISHUK, W. Z., E. SADOVSKY, Y. Z. DIAMANT, H. ZUCKERMAN: Leukocyte Alkaline Phosphatase as an alarm signal in severe fetal distress. *Harefuah* 79 (1970) 359
- [11] PRITCHARD, J. A.: Leukocyte phosphatase activity in pregnancy. *J. Lab. Clin. Med.* 50 (1957) 432
- [12] QUIGLEY, H. J., E. A. DAWSON, B. H. HYUN, R. P. CUSTER: The activity of alkaline phosphatase in granular leukocytes during pregnancy and the puerperium. *Amer. J. Clin. Path.* 33 (1960) 100
- [13] TANAKA, K. R., W. N. VALENTINE, R. E. FRIEDRICKS: Disease or clinical conditions associated with low LAP. *New Eng. J. Med.* 262 (1960) 912
- [14] VACCARI, F., B. SABOTTO, E. MANZINI: Alkaline phosphatase activity of leukocytes in shock. *Blood* 10 (1955) 730
- [15] VALENTINE, W. N., W. S. BECK: Biochemical studies on leukocytes. Phosphatase activity in health, leukocytosis and myelocytic leukemia. *J. Lab. Clin. Med.* 38 (1957) 39
- [16] VALENTINE, W. N., J. H. FOLLETTE, E. B. HARDIN, W. S. BECK, J. S. LAWRENCE: Studies on leukocyte alkaline phosphatase activity; relation to "stress" and pituitary-adrenal activity. *J. Lab. Clin. Med.* 44 (1954) 219
- [17] WACHSTEIN, M., N. Y. MIDDLETOWN: Alkaline phosphatase activity in normal and abnormal human blood and bone marrow. *J. Lab. Clin. Med.* 31 (1946) 1
- [18] WHITT, J.: Evaluation of an histochemical method for determining leukocyte alkaline phosphatase activity and a discussion of normal values in adults and newborns. *Amer. J. Med. Tech.* 29 (1963) 169

Dr. R. Horner
Dept. of Obstetrics and Gynecology
Hadassah University Hospital
Jerusalem/Israel