

MATERNAL AND FETAL PLASMA CORTISOL LEVELS IN NORMAL AND ABNORMAL LABOUR

by

SHANTI M. SHAHANI,* M.D.

P. C. MERCHANT,** M.Sc.

and

V. R. AMBIYE,*** M.D.

Introduction

The mechanisms for initiation of labour in the human female are not conclusively known. In some animals, like the sheep, the fetal adrenal seems clearly implicated (Basset and Thornburn, 1969). Prolongation of human pregnancy in cases of anencephaly without hydramnios is suggestive of the fetal role in parturition. But there is no direct evidence supporting a relationship between fetal adrenal function and onset of labour in the human female. The degree of fetal adrenal response to external stress is also not very clear.

Many investigators have evaluated fetal corticoids as related to mode of delivery (Murphy, 1973; Talbert *et al*, 1973) but there does not seem to be a consensus on the extent of fetal adrenal response to environmental or maternal stress.

This presentation is a preliminary study to evaluate the fetal adrenal response to maternal and environmental stress.

*Professor of Endocrinology.

**Senior Scientific Officer.

***Registrar Obst. & Gynaec.

Department of Endocrinology, T.N. Medical College and B.Y.L. Nair Hospital, Bombay-400 008.

Material and Methods

Patients admitted to the maternity ward of Nair Hospital undergoing spontaneous labour, elective caesarean section and abnormal labour were selected. Heparinized maternal venous blood was collected during the first stage of labour and second stage at the time of delivery. Simultaneously mixed cord blood was collected in heparinized tubes. All caesarean sections were done under general anaesthesia. The blood samples were centrifuged and plasmas frozen until the time of analysis.

Total cortisol levels were determined by a fluorometric method (Mattingly, 1962). Student T test was used for statistical analysis of the data.

Observations

A total of 178 samples were collected in 82 subjects. The clinical groups included; (1) Normal spontaneous labour, 18. (2) Difficult labour which included breech and forceps delivery, 16. (3) Elective caesarean sections, 25. (4) Premature labour 14. (5) Emergency L.S.C.S. after patient had gone into labour, 9.

Table I shows the rise in maternal cortisol levels at the time of delivery in relation to first stage of labour.

TABLE I
Maternal Plasma Cortisol Levels During First Stage and at the Time of Delivery

	Plasma Cortisol in $\mu\text{g}/100\text{ ml}$ Mean \pm S.D.
1st stage	33.34 \pm 8.76
At time of delivery	55.2 \pm 11.4

Table II gives comparative data in maternal and fetal plasma cortisol levels in different clinical conditions. It shows that the cortisol values were higher in the maternal than in the fetal blood but the ratio of maternal to cord blood was not constant for all clinical conditions. The maternal levels in the different clinical

TABLE II
Plasma Cortisol Levels in Different Clinical Conditions ($\mu\text{g}\%$)

	Maternal Levels Mean \pm S.D.	Cord Blood Levels Mean \pm S.D.
Normal labour	55.2 \pm 11.4	17.6 \pm 5.95
Difficult labour	89.18 \pm 9.8 (P < .001)	27.63 \pm 8.58 (P < .001)
Caesarean section (Elective)	23.61 \pm 4.84 (P < .001)	12.2 \pm 2.6 (P < .001)
Premature labour	61.4 \pm 7.4 (N.S.)	25.3 \pm 8.7 (P < .01)
Emergency L.S.C.S. (After trial labour)	68.8 \pm 13.2 (P < .02)	35.0 \pm 5.9 (P < .001)

conditions showed significantly higher cortisol values in difficult labour and emergency L.S.C.S. and lowest values in elective caesarean sections when compared to normal spontaneous labour. No significant changes were noted in premature labour.

As for the fetal cortisol was concerned, lowest values were obtained in elective caesarean section versus any other mode of delivery vaginal, instrumental or even emergency caesarean. Interestingly, fairly high levels were obtained in premature labour.

Table III shows the fetal cortisol values in relation to fetal maturity and weight. Cortisol values in cord blood in premature babies (< 2 kg.) were significantly higher than full term babies born spontaneously per vaginam.

TABLE III
Plasma Cortisol Levels in Relation to Fetal Maturity and Weight

	Weight (Kg)	Mean Cortisol Levels ($\mu\text{g}\%$)
Full term labour	>2.5 kg.	17.6
Premature labour	<2.0 kg.	25.3
		<.001

Comments

Normal spontaneous vaginal delivery though considered a physiological phenomenon may not be completely devoid of stress.

The changes in maternal cortisol values from 33.34 $\mu\text{g}\%$ in the first stage of labour to 55.2 $\mu\text{g}\%$ in the second stage at the time of delivery of the fetus clearly indicate an increased adrenal cortical activity as a result of stress during the 2nd stage of labour. Goldkrand *et al* (1976) have shown a small difference between pre-induction maternal cortisol levels and the

delivery values but they did not seem to attach much significance to the difference.

In our study the results indicate that the mode of delivery makes a significant difference not only in the maternal cortisol activity but also in the cord blood.

In elective caesarean section, the mean maternal cortisol values were 23.61 $\mu\text{g}\%$ in comparison to 55.2 $\mu\text{g}\%$ in normal deliveries and 89.18 $\mu\text{g}\%$ in difficult vaginal labour. This clearly shows that vaginal deliveries impose a higher stress on the mother than an elective operative procedure. Caesarean section following a trial labour or difficult labour definitely imposes a severe stress on the maternal cortical function. In premature labour the mean maternal cortisol values were not significantly different from those obtained in normal delivery.

Talbert *et al* (1977) have shown that unbound cortisol concentration in maternal serum after vaginal delivery is twice as high as that after caesarean section. However, total cortisol levels were not different in maternal blood but cord blood levels were significantly higher in vaginal delivery. In our studies, mean fetal (cord) cortisol values after spontaneous vaginal labour was (17.6 $\mu\text{g}\%$) and after difficult labour or an emergency caesarean following labour, was 27.63 and 35.0 $\mu\text{g}\%$ respectively. This indicated an increase response of the fetal adrenal to higher maternal stress. Most investigators (Talbert *et al*, 1973) have felt that acute fetal distress during labour is too short an insult to cause adequate response from the fetal adrenal.

Significant difference was also noted between mean cortisol values in cord blood during caesarean section (12.2 $\mu\text{g}\%$) when compared to normal vaginal labour (17.6 $\mu\text{g}\%$) at term, though the

difference was not as marked as noted by others. Comparative studies on fetal blood in premature deliveries versus normal term deliveries indicated higher cord blood cortisol values in premature delivery (25.3 $\mu\text{g}\%$ versus 17.6 $\mu\text{g}\%$). This was an expected finding. These results are suggestive of a fetal role in the onset of labour. It is known that glucocorticoids play a role in the onset of labour in some experimental animals but the human female was considered different. Pokoly (1973) has mentioned that idiopathic prematurity could be attributed to an abnormally high cortisol output by the fetus although he considered it improbable since babies born after premature labour had lower cortisol concentration than at term.

Comparison of maternal and fetal levels of corticosteroids is difficult. This is so because the ratio of cortisol to cortisone is not the same in fetal plasma. Cortisol is the predominant corticoid in maternal plasma and cortisone predominated in fetal plasma (Schweitzer *et al*, 1969).

In our study, the plasma cortisol was about two to three times higher in maternal than in fetal plasma. The ratio was somewhat lower in caesarean section than with vaginal deliveries (Giroud, 1971).

Our data are suggestive of a physiologic role of fetal adrenal in the initiation of labour. This may not be conclusive, until more precise studies with unbound cortisol are done in premature cases.

However, it is clear that the fetus responds to maternal stress of labour and that there may be causal relationship between fetal cortisol and parturition.

Summary

The role of fetal adrenal in parturition and to maternal stress is not definitely known in the human female.

In this study maternal and cord blood cortisol levels were evaluated at the time of parturition in different clinical conditions.

The results indicate that the fetal cortisol varies with the degree of maternal stress during labour in most conditions except in cases of prematurity. Fetal cord blood cortisol in these cases was higher than normal delivery suggesting some role of fetal adrenal in the onset of parturition. Further studies on free cortisol by more precise assays are indicated.

Acknowledgements

The authors express their grateful thanks to Department of Obstetrics and Gynaecology of Nair Hospital for allowing collection of blood samples on their patients.

Thanks are also due to Dean Dr. M. S.

Kekre for allowing the publication of this data.

References

1. Basset, J. M. and Thornburn, G. D.: *J. Endocrinol.* 44: 285, 1969.
2. Giround, C. J. P.: *Cl. Obstet. & Gynec.* 14: 745, 1971.
3. Goldkrand, J. W., Raymond, L. and Robber, H.: *Obstet. & Gynec.* 47: 1, 1976.
4. Mattingly, D.: *J. Clin. Path.* 15: 374, 1962.
5. Murphy, B.E.P., Clark, S. J. and Donald, I.R. et al.: *Am. J. Obstet. & Gynec.* 115: 521, 1973.
6. Pokoly, T. B.: *Am. J. Obstet. & Gynec.* 117: 549, 1973.
7. Schweitzer, M., Branchoud, C. and Giround, C.J.P.: *Steroids.* 14: 519, 1969.
8. Talbert, L. M., Esterling, W. E. Jr. and Potter, H. D.: *Am. J. Obstet. & Gynec.* 117: 554, 1973.
9. Talbert, L. M., Pearlman, W. H. and Potter, H. D.: *Am. J. Obstet. & Gynec.* 129: 781, 1977.