

CHANGES IN BLOOD VOLUME IN PUNJABI WOMEN BEFORE & AFTER DELIVERY

by

S. GUPTA,* M.B.,B.S., D.G.O., M.D.

and

Surgeon Commander R. K. GUPTA,** M.S., D.Ortho., F.I.C.S.
F.A.C.S., F.I.M.S.A.

Introduction

In the early part of this century, many investigators began to direct their attention towards the physiological adjustments which the maternal organism must undergo to provide for the sustenance, excretory functions, protection and ultimate expulsion of foetus. Of the pregnancy changes in the mother's physiology none are more important than those which are related to blood and circulation. During the past 35 years, information concerning the haemodynamic changes which occur during pregnancy has been obtained by many western contributors, especially the ones concerning the hydraemia of gestation and its effects on blood volume. But such studies on Indian women are few and there is hardly any authentic literature on blood volume studies in Indian women during and after delivery. The present study was undertaken to evaluate these changes in women of Punjab.

Material and Methods

Clinical subjects for the present study

*Senior Registrar.

*Senior Surgeon, Naval Hospital (Asvini),
Bombay.

Present address Consulting Surgeon, Gupta
Surgical Nursing Home, Dehradun.

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were selected from Punjabi women (women resident of the province of Punjab, India) admitted to the department of Obstet. and Gynaec., Christian Medical College Hospital, Ludhiana, Punjab. For this study cases were divided into two groups A & B.

A. *Control Group*: Twenty-five non-pregnant women from gynaecological ward as did not show any such pathology which might affect their blood volume were selected. Blood volume studies i.e. estimation of blood volume (BV), total red cell mass (TRCM) and plasma volume (PV) were made using Evan's Blue dye (T-1824) dilution technique using Klett Summerson photoelectric colorimeter.

B. *Study Group*: Twenty-five normal delivery cases were selected and blood volume studies were carried on two different occasions, first during first stage of labour, second between 40 and 48 hours after delivery.

Normal plasma volume, total red cell mass and blood volume were predicted on the basis of post-partum weight and average control value. Blood loss during delivery was measured by using a receptacle to collect blood escaping from vagina and perineum. In 4 cases where episiotomy was done, blood loss in swabs and sponges was estimated by colorimetry.

metric method and this amount was added to that which was directly measured.

Results

A. *Control Group*: The results of blood volume studies are summarized (Table I).

TABLE I
Control Values

	Maximum		Minimum		Average	
	cc	cc/kgm	cc	cc/kgm	cc	cc/kgm
Blood volume	4773	89.1	2977	67.7	3762	78.7
Total red cell mass	2154	38.2	985	24.4	1558	32.3
Plasma volume	2619	63.0	1813	37.2	2156	46.4

B. Study group:

(1) *Predicted non-pregnant values*: In these cases predicted normal non-pregnant values were established according to their post-partum weight taken after one week of delivery which is considered quite close to non-pregnant weight (Lowenstein *et al*, 1950). Their post-partum weights in Kilograms (Kgm) were multiplied with standard control values per Kgm obtained from the control group of cases, which was considered an

index of average blood volume in Punjabi women. The results are summarised (Table II).

(2) *Antepartum cases*: Blood volume was estimated during the first stage of labour. From this the actual rise of blood volume from predicted non-pregnant values was calculated. Total red cell mass

TABLE II
Predicted Non-pregnant Values

	Maximum cc	Minimum cc	Average cc
Blood-volume	5367	2998	3848
Total red cell mass	2003	1230	1568
Plasma volume	3364	1768	2280

and plasma volume and their percentage rise in pregnancy was also calculated (Table III).

TABLE III
Ante-partum Study

	Maximum Rise			Minimum Rise			Average Rise		
	cc	cc	%	cc	cc	%	cc	cc	%
Blood Volume	5951	1533	48.0	3664	138	2.9	4668	820	22.6
Total red cell mass	2526	920	63.5	1392	335	17.1	1929	361	24.1
Plasma volume	4166	1108	52.6	2205	28	1.1	2739	459	21.1

(3) *Postpartum cases:* Blood volume study was done between 40 to 48 hours of delivery. Total fall in BV, TRCM and PV and %age of their fall occurring after delivery was estimated from ante partum and post-partum blood values. Results are shown (Table IV).

habits. Climate in Punjab is relatively warmer than that of Western countries and hence it is understandable that blood volume studies in Punjabi women will show higher values. Besides this, women in Punjab are well fed and are of good physique.

TABLE IV
Post-partum Study

	Maximum			Minimum			Average		
	cc	Fall		cc	Fall		cc	Fall	
		cc	%		cc	%		cc	%
Blood volume	4830	1382	26.9	3050	618	13.7	3704	964	20.6
Total red cell mass	2045	952	35.2	934	302	14.8	1430	499	25.8
Plasma volume	3381	785	22.4	1785	171	7.7	2274	465	16.8

(4) *Blood loss during delivery:* The blood loss occurring during 3rd stage of labour was measured. Average loss was 183 cc (range 60 cc to 390 cc). This loss was correlated with observed fall in blood volume values in the post-partum cases.

(5) *Comparison of predicted non-pregnant and post-partum blood volume:* These values in 25 cases were 3848 cc and 3704 cc respectively and were found to be comparable.

(2) *Predicted non-pregnant blood volume*

Studies of Tysoe and Lowenstein in 1950 have revealed that women after delivery regain their normal non-pregnant weight and blood volume soon after delivery i.e. earlier than one week post-partum. So in the present study, non-pregnant blood volume has been predicted on the basis of the weight recorded one week postpartum since this should be close to their non-pregnant weight. This weight in Kgms is multiplied by the average value obtained in the control group.

Discussion

(1) *Blood volume of Control group of cases*

The results of the present study closely approximate to the range for normal Indian women as reported by other investigators but are slightly higher when compared to values available for Western women (Table V). The variations may be explained on the basis of racial differences, personal factor and the different methodology adopted by different workers. Age and weight differences of subjects and climatic variations and dietary

(3) *Increase in blood volume in pregnancy*

The predicted non-pregnant blood volume of each case was compared with the antepartum blood volume observed during first stage of labour. There was an average increase of 820 cc or 22.6% of BV; 361 cc or 24.1% of TRCM and 459 cc or 21.1% of PV. Lowenstein *et al* (1950) and Berlin *et al* (1953) have also shown rise in blood volume and the present study is well within the range of those obtained by other workers (Table VI).

TABLE V
Normal Blood Volume (in CCs) in Indian and Western Women

S. No.	Name of Worker	Method	No. of cases	BV/Kgm body Wt.	PV/Kgm body Wt.	TRCM/Kgms body Wt.
1.	Dutta (1948)	Congo red	6	82.0	48.0	34.0
2.	Chaudhri et al (1951)	T-1824	50	83.1	47.7	35.4
3.	Bisht (1955)	T-1824	7	78.4	46.9	31.5
4.	Jain (1961)	T-1824	20	81.3	45.4	35.9
5.	Tysoe and Lowenstein (1950)	T-1824	14	86.4	57.0	29.7
6.	Berlin and Shirley (1951)	p ₃₂	16	64.4	27.0	27.0
7.	Lawrance and Ward-Worth (1954)	p ₃₂	8	66.48	43.1	23.4
8.	Gregerson and Ramson (1959)	T-1824 p ₃₂	8	64.7	43.0	21.7
9.	Present study (1974)	T-1824	25	78.7	46.4	32.3

TABLE VI
Showing Ante-partum blood rise

Author	No. of cases	Non-pregnant standard			Antepartum (During labour)			Rise in values					
		B. V. cc	TRCM cc	P. V. cc	B. V. cc	TRCM cc	P. V. cc	B. V. cc %	TRCM cc	%	P. V. cc %		
Lowenstein, L. Philpott, H. V (1950)	14	3876	1402	2474	4615	1826	2789	739	19.1	402	28.7	315	12.7
Berlin, et al (1953)	18	3726	1562	2140	4820	1857	2963	1094	29.2	295	18.8	823	38.4
Present study (1974)	25	3848	1568	2280	4668	1928	2739	820	22.6	361	24.1	459	

(4) Decrease of blood Volume after delivery

In all the 25 cases a comparative study of antepartum and postpartum blood volume revealed a decrease. The average decrease of BV was 964 cc or 20.6%, of TRCM was 499 cc or 25.8% and that of P.V. was 465 cc or 16.8%. Other workers have confirmed this decrease and their figures are comparable (Table VII).

et al (1950) have measured the same as 224 cc and 1041 cc respectively. Thus the total drop in circulating blood volume occurring after child birth is much greater than the apparent loss of blood in delivery. The question arises as to where the blood goes. Wilson (1950) feels that this could be due to withdrawal of blood from the circulation by stagnation. Following delivery a similar and permanent

TABLE VII
Decrease in blood volume after delivery (in ccs)

Author	No. of cases	Method	Blood volume decrease
Lowenstein and Philpott (1950)	37	T-1824	872
Berlin <i>et al</i> (1953)	18	p ³²	1100
Present study (1974)	25	T-1824	964

(5) Measured blood loss during delivery

Our figures varied from 60 cc to 390 cc, average being 183 cc. The values obtained by other workers are comparable though there are fairly wide variations as would be expected from variations in technique of 3rd stage management (Williams 343 cc; Plass 317 cc; Brandt 195 cc; Bickerstaff 150 cc; Quingley 211 cc; Lowenstein 224 cc figures as the range quoted by Holland, the range being 150 to 343 cc).

(6) Co-relation between observed blood volume changes ante-partum & post-partum and apparent blood loss at delivery

In our series the average measured blood loss at delivery was 183 cc, whereas the fall in blood volume after delivery was on an average 964 cc. Lowenstein

withdrawal of RBCs from active circulation and passing into the body of the uterus seems to occur. But Philpott (1955) from his study of excised uterus in 3 cases of Porro caesarean section has doubted this contention of uterus being a reservoir. The demand for foetus, the increased oxidation of tissues, the increased cardiac output and circulation time and other circulatory changes which suggest an analogy with an arterio-venous aneurysm, are adequate reasons for the increase of blood volume during pregnancy. After delivery physiological changes require a return of the blood volume to normal non-pregnant values. This would seem to be accomplished with a minimum blood loss from the body and with conservation and reutilization of the major portion of blood loss from the acute circulation, a part of the normal body economy.

(7) *Comparison of Post-partum blood volume with predicted non-pregnant blood volume*

If it is true as stated by workers like Tysoe (1950 and Caton *et al* (1951) that the normal non-pregnant blood volume is regained by one week post-partum or even earlier, we would expect post-partum blood volume and predicted non-pregnant blood volume to have a close relationship. In the present study, it is apparent that the average blood volume after delivery (3704 cc) reaches approximately its non-pregnant predicted value (3848 cc) 40 to 48 hours after delivery.

Summary

1. Blood volume studies of 25 control cases, all Punjabi women were conducted and the figures obtained are compared with other workers, both Indian and Foreign.

2. Twentyfive pregnant women who had normal pregnancies were selected for serial blood volume studies by dye dilution method using Evan's blue Dye (T-1824). These studies were conducted on two different occasions; (a) During the first stage of labour (b) In early puerperium (between 40-48 hours after delivery) The results are analysed and discussed.

3. The normal non-pregnant blood volume in the present study was predicted by weight taken one week postpartum. This was compared with antipartum blood volume. The blood volume, red cell mass and plasma volume were found to increase in pregnancy.

4. Postpartum fall in blood volume

was observed when postpartum and antepartum blood volume estimations were compared.

5. Blood loss during delivery (3rd stage of labour) was measured and found to be markedly lower than the total observed fall in blood volume following delivery.

6. It was found that predicted non-pregnant blood volume values and blood volume recorded 40-48 hours after delivery were closely comparable.

References

1. Berlin, N. I., Robert, J. and Shirley, J. H.: *Am. J. Med.* 9: 747, 1951.
2. Berlin, N. I., Goetsch, C. and Hyde, G. H.: *Surg. Gynec. Obstet.* 97: 173, 1953.
3. Bist, D. B.: Thesis for M.D. Examination, Lucknow University, 1955.
4. Caton, W. L., Roby, C. C. and Gibson, T. G.: *Am. J. Obstet. Gynec.* 61: 1207, 1951.
5. Chaudhri, R. N., Chakravarti, H. and Datt, B. N.: *Ind. J. M. Res.* 39: 237, 1951.
6. Dutta, N. C.: Report of Scientific Advisory Board, New Delhi. I.R.F.A., 1948.
7. Gregerson, M. I. and Rawson, R. A.: *Physiolo. Rev.* 39: 307, 1959.
8. Holland, W. S.: *Surg. Gynec. Obstet.* 101: 479, 1955.
9. Jain, B. L. and Rao, B. N. B.: *J. Ind. Med. Associ.* 37: 6, 1961.
10. Lanzkowsky, P.: *J. Obstet. Gynec. Brit. Emp.* 67: 932, 1960.
11. Lawrence, J. H. and Ward-Worth, J. C.: *Am. J. Thoracic Surg.* 27: 402, 1954.
12. Lowenstein, L., Pick, C. A. and Philpott, N. W.: *Am. J. Obstet. Gynec.* 60: 1206, 1950.
13. Philpott, N. W. and Jackson, D. D.: *J. Clin. Invest.* 34: 942, 1955.
14. Tysoe, F. W. and Lowenstein, L.: *Am. J. Obst et Gynec.* 60: 1187, 1950.
15. Wilson, C. J.: *Surgery* 28: 182, 1950.