EFFECT OF PREGNANCY ON BLOOD VOLUME†

by

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As early as 1881, Willcocks noted hydraemia in pregnancy. Pregnancy is now recognised as one of the few conditions in which the volume of blood is substantially increased. Majority of the studies White (1950), Adams (1954) and Hytten and Paintin (1963) have shown that there is a rise in blood volume during pregnancy. The increase is mainly due to an increase in plasma volume with a lesser but a very appreciable rise in red cell volume.

During pregnancy, delivery and immediately after labour, there is a danger to the mother of excessive blood loss. However, there exists a physiological mechanism which protects the woman from such hazards, within considerable limits. This 'built in' blood bank, although a part of a very complex mechanism, is dependent largely on the increase in the volume of blood.

The present study has been undertaken with a view to ascertain changes in the blood volume, if any, during the three trimesters of pregnancy.

Material and Methods

Plasma volume, blood volume and haematocrit value were estimated in 45 normal healthy pregnant women, taking 15 cases from each of the three trimesters of pregnancy. Similar studies were conducted in 15 normal, healthy, non-pregnant female medical students who served as controls. The subjects were selected at random from all the socio-economic groups attending the antenatal clinics of the P.B.M. group of hospitals, Bikaner.

The duration of pregnancy was calculated from the first day of the last menstrual period. All estimations were done in the morning under basal conditions, after an over night fast. The subjects were made to rest in the recumbent position for at least 30 minutes before the samples of blood were drawn.

Estimation of Plasma Volume

Plasma volume was estimated by the dye dilution method. The dye used was Evans blue (T-1824) and a Klett- Summerson photocolorimeter was used to estimate its concentration. The standard method of Frank and Carr (1955) was followed.

The red cell mass was estimated from the corrected haematocrit value and the total blood volume. A correction factor was employed by multiplying the P.C.V. reading by 0.88 (Paintin, 1963) to account for the trapped plasma and also for the fact that the percentage of the R.B.Cs. in venous blood and larger vessels is higher than the overall cell percentage.

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The total blood volume was calculated from the total plasma volume and the corrected P.C.V.

All these values have been presented as ml per kg. body weight.

Results

There has been a progressive increase in plasma volume (Table 1). The increase has been 17 per cent, 33 per cent and 45 per cent in the first, second and third trimesters respectively when compared with the values in controls. The rise in plasma volume is statistically highly significant.

There has been a fall in the red cell mass (Table 2) during the first trimester. It however, rose to the control level in the second trimester and in the third trimester there was a clear rise by 18 per cent.

The blood volume (Table 3) has also shown a progressive increase in each trimester when compared with the controls. There has been a rise of 7 per cent, 20 per cent and 35 per cent in the first, second and third trimesters respectively. This rise in the second and third trimesters has been found to be highly significant statistically.

The relative changes in the red cell, plasma and total blood volume during the three trimesters of pregnancy is graphically shown in Fig. 1. The gradual but consistant rise in blood volume during pregnancy is quite obvious.

TABLE I

Showing Plasma Volume ml/kg Body Weight in 15 Non-pregnant and 45 Pregnant Women

Group	Mean	range	S. D.	S. E.	't' value
Non-pregnant	37.85	32.00—46.40	3.90	1.00	....
1st Trimester	44.49	39.60—65.60	6.80	1.75	3.20
2nd Trimester	50.47	39.20—70.60	9.66	2.50	4.44
3rd Trimester	54.99	40.00—69.50	8.26	2.13	7.10

TABLE II

Showing Red Cell Mass ml/kg Body Weight in 15 Non-pregnant and 45 Pregnant Women

Group	Mean	Range	S. D.	S. E.	't' Valve
Non-pregnant	22.65	18.90—29.30	2.89	0.75	—
1st Trimester	20.33	12.20—30.40	7.37	1.90	1.15
2nd Trimester	22.67	16.40—28.70	4.12	1.07	0.02
3rd Trimester	26.66	19.80—32.30	3.61	0.93	3.35

TABLE III

Showing Blood Volume ml/kg Body Weight in 15 Non-pregnant and 45 Pregnant Women

Group	Mean	Range	S. D.	S. E.	'ti value
Non-pregnant	60.56	52.20—65.80	6.40	1.66	—
1st Trimester	64.82	54.50—96.00	9.30	2.40	1.46
2nd Trimester	73.16	56.40—97.40	10.67	3.20	3.40
3rd Trimester	81.78	60.80—101.80	11.65	3.00	6.32

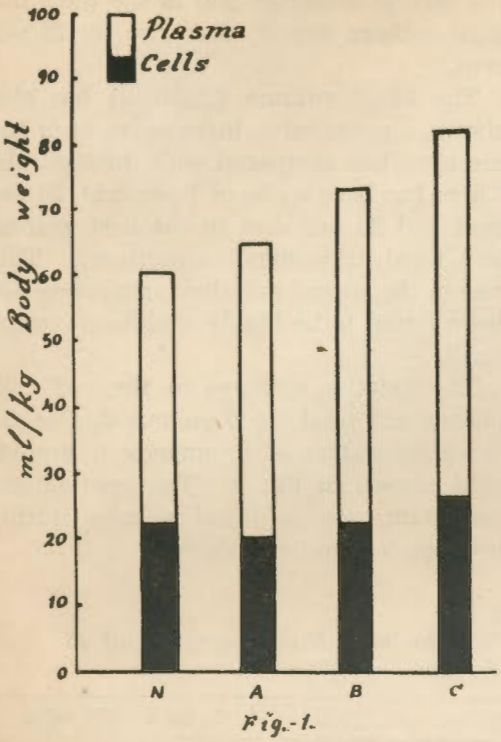

Fig. 1.

Showing changes in blood volume during pregnancy. N represents normal non-pregnant women.

A., B. C. represent the values in first, second and third trimesters of pregnancy respectively.

Discussion

Changes in blood and plasma volume in pregnant women have been studied by many investigators using a variety of techniques, although there are not many reports from our own country (Lowenstein *et al* 1950; Berlin *et al* 1953; Hytten and Paintin, 1963 and Sandhu *et al* 1965). There is a general agreement about two basic facts. During pregnancy there is a rise in total blood volume, plasma volume and red cell mass. The relative increase in plasma volume is greater than that of red cell mass, resulting in a low haematocrit value.

The most valid figures on blood and plasma volume changes in pregnancy would be derived from serial studies on the same individuals. This was accomplished in some studies, notably those of Caton and associates (1949). In other studies including the present one, statistical correlations have been derived from different patients at different stages of pregnancy and presented as blood or plasma volume per kg. body weight.

In general, there is agreement that there is a progressive increase in the plasma volume and total blood volume during the course of pregnancy and reaches the peak in the third trimester. The mechanism responsible for this hypervolaemia is not definitely known. Increased secretion of adrenal cortical hormones as well as the sex hormones during pregnancy leading to a retention of water and electrolytes may contribute largely to it. Whatever the exact mechanism involved, this hypervolaemia is an important physiological adaptation to the stress of the pregnant state. Firstly, this would help in adequately filling up the large vascular bed created by the placenta and secondly, it would protect the woman against haemorrhagic shock during and after delivery.

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