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BLOOD VOLUME IN ACCIDENTAL HAEMORRHAGE

by

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The management of haemorrhage during the last trimester of pregnancy still constitutes a major obstetric problem. MacGregor and Tovey (1957), for the first time, drew attention to the importance of blood volume determinations in the management of accidental haemorrhage. Opinion is loosely held that estimation of blood volume is an important factor in the assessment of the extent of blood loss and subsequent transfusion needs of these patients but a review of literature showed that not many studies have been carried out to substantiate such thinking. The present paper reports our preliminary observations on blood volume changes in accidental haemorrhage undertaken to determine mainly the transfusion needs of these patients. In addition, it was also considered important to find out if any correlation existed between the signs and symptoms of haemorrhage and the extent of blood loss. Since acute renal failure still remains a dangerous complication of severe haemorrhage, this study was further extended to establish a critical level of blood loss that might predispose to renal failure.

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Material and Methods

Women attending the ante-natal clinic of the Lady Hardinge Hospital formed the subjects of this study. A total of 40 women were investigated,

of which 25 patients were of accidental haemorrhage. These patients presented the clinical signs and symptoms suggesting accidental haemorrhage. A complete examination of each case was carried out including a detailed history of the past and present illnesses. In the absence of clinical signs and symptoms such as, vaginal bleeding, tense and tender uterus, and other signs of shock, recognisable areas of adherent retroplacental clots constituted the single most important factor for the diagnosis of accidental haemorrhage.

Since a great majority of the patients presented with bleeding during the last weeks of pregnancy, a group of fifteen normal expectant mothers in a comparable period of gestation were included as a control group. Ten healthy non-pregnant women were also investigated to determine the baseline values.

Techniques

Before the start of any treatment adequate quantities of venous blood were collected from each patient. Certified haematologic equipment and standard techniques were employed. For the estimation of blood volume and plasma volume, the technique of MacGregor and Tovey (1957) was followed employing Evans Blue (T 1824). The total blood volume was calculated by reference to patient's packed red cell volume as estimated in Wintrobe's haematocrit.

Results

Blood volume changes in pregnancy

Blood volume determinations in 15 normal pregnant women near term are compared with those of non-pregnant subjects in Fig. 1. A significant

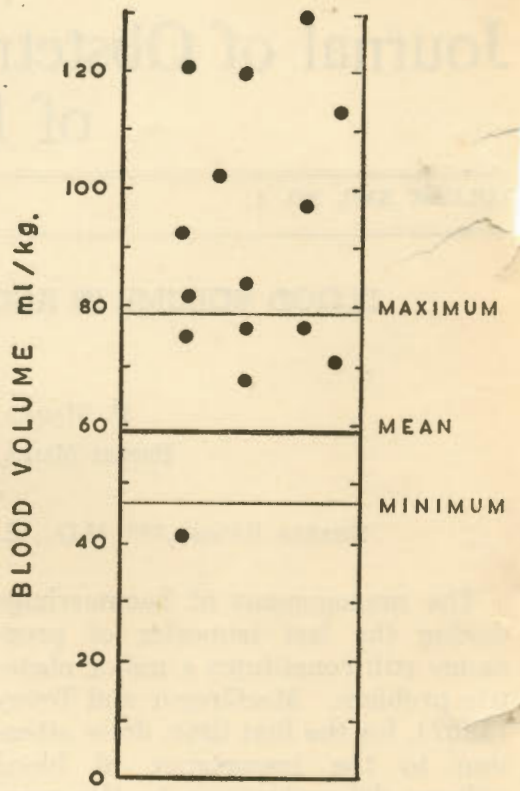

Fig. 1

Distribution of blood volume in normal expectant mothers. Each point represents a patient. The horizontal lines show the mean value and the range of variation in 10 healthy non-pregnant women.

increase in the total blood volume during pregnancy was seen in all but one case. In as many as 14 of the 15 pregnant women, the increase in blood volume exceeded the uppermost level observed in non-pregnant women. The volume of blood in normal expectant mothers varied from 67.0 to 129.6 ml/Kg. weight as compared with the normal range of

48.0 to 76.0 ml/Kg. body weight in non-pregnant women, the average value for the two groups being 89.0 and 59.5 ml/Kg. body weight respectively.

Blood volume in accidental haemorrhage

Values for the total blood volume, plasma volume and red cell volume in 25 patients of accidental haemorrhage and a group of 15 normal pregnant women are summarised in Table I. It is clear from this table that the red cell volume and the plasma volume in patients with accidental haemorrhage show a significant decrease in comparison to the normal group. The results were found to be statistically significant. It was further observed that whereas 48 per cent of the patients with accidental haemorrhage had a total blood volume of 66.1 ml/Kg. body weight, in the control group only 6.6 per cent of the cases registered a comparable decrease. In as many as 22 of the 25 patients who had accidental haemorrhage, the total blood volume ranged from 26.0 to 80.5 ml/Kg. body weight. In the remaining three patients whose blood volumes were 100.0, 106.00, 235.32 ml/Kg. body weight respectively, one was a case of hydramnios and the other two were twin pregnancies.

An attempt was made to correlate the intensity of shock as judged on clinical grounds with the estimated blood loss in each of the 25 cases. Patients who showed pallor, sweating and fall in blood pressure were considered to be in moderate shock (+), while in severe shock (++) these signs were present to a marked degree, and often accompanied by air hunger. The estimated blood loss in accidental haemorrhage was calculated by substracting the blood volume of the patient from the average blood volume of the control group. The results are presented in Table II.

It may be seen from the above table that in nearly all the patients who manifested severe degree of shock, the estimated blood loss was in

TABLE I

Total blood volume, plasma volume and red cell volume in accidental haemorrhage and in normal pregnant women

	No. of cases	Ml./kg. of body weight		
		Total blood volume	Plasma volume	Red cell volume
Pregnant	15	89.0 (67.0 - 129.6)	55.6 (44.0 - 74.8)	34.1 (13.3 - 48.0)
Accidental haemorrhage	25	66.1 (26.0 - 235.2)	31.5 (29.5 - 157.6)	24.6 (8 - 77.8)

N.B.—Figures in parenthesis represent the range of variation.

TABLE II

Correlation between shock and estimated loss of blood in 25 patients of accidental haemorrhage

Case No.	Estimated blood loss ml./Kg. body weight	Intensity of shock
1.	11.9	+
2.	39.4	++
3.	40.5	++
4.	11.0	+
5.	42.5	++
6.	46.5	++
7.	13.0	+
8.	11.0	+
9.	24.9	+
10.	32.2	++
11.	10.6	+
12.	32.2	++
13.	38.2	++
14.	24.9	+
15.	12.5	+
16.	10.0	+
17.	12.0	+
18.	10.5	+
19.	10.2	+
20.	28.0	++
21.	14.0	+
22.	30.3	++
23.	28.5	+
24.	24.9	+
25.	40.9	++

excess of 20 ml/Kg. body weight. In contrast, amongst the 15 patients in whom the intensity of shock was moderate, only in 5 was the estimated blood loss more than 20 ml/Kg. body weight. These observations would seem to indicate that in the great majority of patients with accidental haemorrhage, if not all, the degree of shock paralleled the loss of blood.

Table III summarises our observations on the estimated blood loss, the haemoglobin values and the weight of the retroplacental clot in patients with shock. It is evident from the results shown in Table III, that both, haemoglobin estimation and weight of placental clot, remain a very rough measure of the amount of blood lost.

The haemoglobin values in 10 patients of severe shock and in another group of 15 in whom the shock was mild, were 6.9 and 8.2 g. per cent respectively. Thus, although the severity of anaemia, on an average, was comparatively more marked in patients of severe shock, the range of haemoglobin variation in the two groups was not remarkably different.

TABLE III

Haemoglobin, weight of retroplacental clot and blood loss as determined by blood volume estimation in patients suffering from shock

Degree of shock	No. of patients	Average Hb. g.%	Average weight of retroplacental clot (ml.)	Average estimated loss of blood ml./kg. body weight
Mild	15	8.2 (3.5 - 10.5)	375 (120.0 - 915)	15.3 (28.0 - 40.5)
Severe	10	6.9 (2.5 - 9.0)	456 (165.0 - 720)	37.0 (28.0 - 40.5)

Figures in parenthesis show the range of variation.

TABLE IV

Features of patients who developed renal failure

Patient No.	Blood pressure mm. Hg.		Restoration time in hours*	Pulse rate per minute	Hb. g.%	Blood urea mg.%	Blood volume ml./Kg.	Urine output	Outcome
	on admission	minimal							
1.	130/90	60/40	6.0	140	5.0	27-45.5	52.8	Oliguria	Recovered
2.	100/80	not recordable	3.25	imperceptible	8.0	25-52	49.0	Oliguria	Recovered
3.	70/50	40/?	8.0	-do-	3.5	28-180	46.0	Oliguria	Recovered
4.	90/60	70/40	1.0	130	2.5	25-208	39.0	Oliguria	Died

* Indicates time required for blood pressure to be restored to a minimum of 80 mm. systolic.

? Not recordable.

Likewise, the loss of blood as determined by the weight of retroplacental clot did not show any significant difference between the two groups. On the other hand, the blood volume estimations revealed that the patients who suffered from severe shock had lost blood twice as much as those in whom the shock was mild.

Blood volume in patients with renal failure

Four of the 25 patients, in whom the blood volume was determined, developed oliguria. Relevant features in respect of these patients are presented in Table IV.

It is significant that all the 4 patients showed profound decrease in their circulatory blood volume, averaging nearly 50 per cent of that observed in normal pregnancy. It may be further observed that all the patients were in a state of profound hypotension lasting for a period upto eight hours. They all manifested severe anaemia, the haemoglobin ranging from 2.5 g. per cent to a maximum of 8.0 g. per cent.

Discussion

The results of this study, that there occurs an increase in the blood volume in pregnancy, are in agreement with similar findings observed by other workers (Roscoe and Donaldson, 1946; Tysoe and Loewenstein, 1950; Gemzell *et al.*, 1954; Lund and Sisson, 1958). However, the average blood volume found in this study is less than that reported in the western literature (Dieckmann and Wegner, 1934; Thomson *et al.*, 1938; Mclennon and Thouin, 1948; Caton *et al.*, 1949). No satisfactory explanation is available to account for this difference. Physical build, racial peculiarities and minor alterations in technique may be responsible for the lower values obtained by us. Further, the variations in results could also be due to the inclusion of women of different parity by various workers. Multigravidae are reported to have greater blood volume than the primigravidae (Hytten and Paintin, 1963). It is significant that as many as 14 of the 15 women studied here were primigravidae.

These observations have confirmed that the estimation of blood volume is a valuable guide in the assessment of blood loss in accidental haemorrhage. Thus, the total blood volume determinations in 25 patients of accidental haemorrhage showed a decrease of 26 per cent, on an average, from the values obtained for normal pregnant women. We found it to be a far more accurate assessment of haemorrhage than either the measurement of retroplacental clot or the haemoglobin estimation. It is generally known that the haemoglobin values in the immediate post-haemorrhagic period are very fallacious because of the peripheral vasoconstriction and subsequent continued dilution of blood (Ebert, 1941; Pareira *et al.*, 1960).

We have observed the normal range of blood volume to be 67.0 to 129.6 ml/Kg. body weight in normal pregnancy. A loss of 20 ml/Kg. body weight should be considered serious and predisposing to severe shock. In our experience, a reduction of blood volume to half the normal is indicative of a grave danger of renal failure. It must, however, be stated that opinion is divided as to what should

be considered a critical level of blood volume after which signs and symptoms of shock would appear. Grant and Reeve (1951) demonstrated that in several instances a patient could have a circulatory blood volume of 70 per cent of the normal with no clinical evidence of shock. Likewise, Gibberd (1948) observed that in patients of accidental haemorrhage, the pulse was initially slow in spite of considerable blood loss. In the opinion of some workers, the rate of blood loss is more important than the volume of blood lost (Wintrobe, 1961).

In the four patients in whom acute renal failure supervened, the blood volume estimation revealed a profound decrease. There is general agreement that it is the severity of haemorrhage which predisposes to renal failure (O'Driscoll and Meagher, 1962; Tovey and Lennon, 1962). In this respect, the delay or inadequacy of transfusion would make an appreciable difference in the ultimate outcome. It may not be out of place to mention that 3 of the 4 patients of renal failure, with blood volumes ranging between 46 to 53 ml/Kg. body weight, could be saved by energetic blood transfusion. The one who succumbed, had a blood volume of 39 ml/Kg. body weight.

Summary

Blood volume determinations, including estimation of plasma volume and red cell mass, were carried out in 25 patients of accidental haemorrhage complicating pregnancy with a view (a) to assess the transfusion needs (b) to observe if any correlation existed between the clinical signs and symptoms of shock and the loss of blood and (c) to find out a critical level of blood loss that predisposed to renal failure. A group of 15 pregnant and 10 non-pregnant normal women were also studied.

Pregnancy was observed to cause nearly a 48 per cent increase in blood volume in the last trimester, the average blood volume of the pregnant and the non-pregnant women being 89.0 ml. and 59.5 ml/Kg. body weight. The volume of blood in accidental haemorrhage was nearly 25 per cent less than that observed in the normal pregnant women. A blood loss amounting to 20 ml/Kg. or more resulted in severe shock, while a reduction in blood volume of 50 per cent or above predisposed to renal failure. Transfusion of blood on the basis of estimated blood loss was found to be adequate and life-saving, particularly in patients of renal failure. Assessment of haemorrhage by haemoglobin determination or by weighing the retroplacental blood clots were unsatisfactory. By and large, the estimated loss of blood correlated well with the severity of shock as judged clinically.

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