

## A STUDY OF VASCULAR PATTERN OF PLACENTA IN SOME ABNORMAL STATES OF PREGNANCY

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The problem of placental insufficiency has been challenging and taxing the skill and ingenuity of obstetricians and anatomists alike. The foetal blood vessels form the main stay of the adequacy of the function of the nutrients, metabolites and gases in the placenta. The study of this anatomical entity has been undertaken by various workers for over a century for better understanding of the mechanism of pregnancy and foetal development.

The vascular pattern of the placenta has been studied by various workers by using injection corrosion technique for preparing three dimensional casts of placental blood vessels—Spanner (1935), Baesich and Smout (1937), Romney and Reid (1951), Wilkin (1954), Tompsett (1959) and Crowford (1956). Shah (1964), Yousuff and Tawil (1966), Nawal Kishore (1967) and Mukerji *et al* (1971) have studied the vascular pattern of placenta by radiological examination after injecting radio-opaque material in the umbilical vessels.

### *Material and Methods*

In the present study the vascular pattern of the placenta was studied by injection corrosion technique in (a) 45 placentae from full term normal cases and (b) 107 placentae from abnormal cases admitted to the Upper India Sugar Exchange Maternity Hospital, Kanpur. Immediately after delivery the placenta was kept in fresh water with maternal surface upwards. No preservative was used. A detailed morphological study of the placenta was made, including placental dimensions, shape, weight with membranes, attachment with the cord, number of infarcts, number of veins along with their arrangement, number of arteries, loops, knots and length of the cord.

A detailed history of the patient was taken, along with the clinical examination and relevant pathological investigations.

### *Preparation of the cast*

Placenta was kept in a tray and amniotic layer was removed from the choreal surface. It was washed in running tap water for 2-3 hours followed by washing with 3.8% solution of sodium citrate for about one hour to remove all clots of blood from the lumen of finer vessels. The placenta was again washed in running tap water to remove traces of

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sodium citrate. It was then placed upside down to render it suitable for injection. Water was removed from the vessels by displacing it with acetone. Red and blue plastic materials were used for injecting the veins and arteries respectively. About 100-120 c.c. of the plastic material was required to inject each placenta. After injection the placenta was kept on a flat surface to allow the material to set in proper shape for 30 minutes. It was then placed on a glass plate and dipped in concentrated hydrochloric acid. About 20-22 hours were required for corrosion of the placenta. The specimen was then taken out from the acid and washed in indirect stream of running water to remove the corroded tissue. The cast was then dried. The colour was maintained bright by keeping in equal volumes of glycerine and formaline solution for 24 hours. Finally the cast was preserved in plastic bag.

#### Observations and Discussion

In all 152 cases were studied of which 45 were normal cases and 107 were abnormal. The distribution of cases according disease is given below.

The age of the patients varied from 14 years to 38 years. No statistically significant correlation was seen in the age groups, morphology and vascular pattern of the placenta.

#### Types of Placentae

Only 2 out of 152 were succenturiate type (Fig. 1). In one the mother was healthy and had normal full term delivery and in the other the mother was suffering from toxæmia of pregnancy, the baby was born alive but was premature. There was no postpartum haemorrhage in any of these. Robert (1967) described high incidence of antepartum and postpartum haemorrhage in cases of succenturiate placenta. No case of circumvallate placenta was seen in this series.

#### Weight of the Placenta

The weight of the placenta ranged between 200 and 800 gms. There was no correlation of the weight with any of the pathological conditions. The minimum weight of 200 gms was associated with a normal full term delivery, except that the baby was low birth weight (3 lbs). In two cases weighing 800 gms., one

TABLE I  
Distribution of Cases According to Disease

S. No.	Disease	No. of placenta	Percentage
1.	Toxaemia of pregnancy	46	30.3
2.	Anaemia complicating pregnancy	16	10.5
3.	Prematurity	10	6.6
4.	Postmaturity	6	3.9
5.	Heart disease	3	2.0
6.	Rh. incompatibility	3	2.0
7.	Still birth	5	3.3
8.	Hydramnios	5	3.3
9.	Twins	11	7.2
10.	Congenital abnormality	2	1.3
11.	Normal pregnancy	45	29.6
Total		152	100



belonged to normal group while the other belonged to Rh negative group.

#### *Length of the Umbilical Cord*

The length of the cord varied between 10 cms and 70 cms with a mean of 38.5 cms. The short cord (10 cms) was seen in a case of hydramnios who delivered a stillborn anencephalic baby. Biggest length of the cord reported by Javert and Bartan (1952) has been 181 cms. Rohatgi and Garg (1969) observed length of the cord to vary between 25.5 cms, to 108 cms with a mean of 58.1 cms.

#### *True Knot*

True knot was present in only one case in our series and was associated with the birth of a macerated male baby. Wentworth (1965) described an incidence of true knot in 0.46% of his cases, while Spallacy *et al*, (1966) and Mukerji *et al*, (1971) have quoted an incidence of 1.1% and 0.8%, respectively. Wentworth (1965) opined that true knot had no effect on the baby, while Spallacy *et al*, (1966) reported an incidence of 6% perinatal mortality in the cases of true knots. Both cases described by Mukerji *et al*, (1971) had live births.

#### *Single Umbilical Artery*

We came across 4 cases of single umbilical artery (Fig. 2). Two of these belonged to normal group, one with a live baby and the other with unexplained stillbirth. In the third case the mother had eclampsia with birth of a macerated baby at 32 weeks and the fourth case was associated with hydramnios with stillborn anencephalic foetus.

The incidence of single umbilical artery has been reported by Mukerji *et al*, (1971) as 4.8%, Benirscheke and Bourne

(1960) as 0.1%, Litte (1961) as 4.7%, Wentworth (1965) as 0.8%, Bhargava (1966) as 6% and Rohatgi (1967) as 0.94%. Wentworth (1965) did not find any abnormality of foetus with single umbilical artery. However, Benirscheke and Brown (1955) reported congenital abnormalities in 45 out of 55 cases, Bansal (1970), reported 6 still births out of his 9 cases, and Mukerji *et al*, (1971) found multiple congenital abnormalities of foetus in 4 out of 12 cases. Rohatgi (1967) reported congenital abnormalities of foetus in 7 out of 14 cases of single umbilical artery. Benirscheke & Brown (1955) reported severe pre-eclamptic toxæmia in 30% of their cases of single umbilical artery, but Little (1961) and Wentworth (1965) did not find any toxæmia in their cases.

#### *Attachment of Umbilical Cord*

The mode of attachment of the cord in our series was eccentric in 67.1%, central in 21.1%, marginal in 10.5% and vellamentous in 1.3%. Robert (1967) reported eccentric attachment in nearly three fourth of his cases, while Mukerji *et al*, (1971) described eccentric attachment in 69.2%, central in 20.4% and marginal in 10.4% of their cases.

#### *Vascular Pattern*

In the present series well marked Hyrtle's, anastomosis was present in 142 out of 152 cases, was absent in 6 cases (3.9%) and 4 cases had single umbilical artery. In 102 cases the communication was transverse, it was oblique in 31, side to side in 5 and conjoint in 4 cases. This anastomosis was first described by Hyrtle in 1870. Bhargava (1966) found Hyrtle's anastomosis in all his 50 cases, while it was absent in 2.1% in Bansal's series (1970), 2.4% of Wentworth's series (1965)

in 2.1% of the series of Mukerji *et al*, (1971). All our six cases in whom Hyrtle's anastomosis was absent had normal delivery with live births. Wentworth (1965) found that the absence of Hyrtle's anastomosis had no ill effect on the foetus except in one case where it was associated with a macerated stillbirth, and in the series reported by Mukerji *et al*, (1971) one out of 5 cases was associated with still birth.

Baesich and Smout (1937) have described two types of branching of umbilical arteries:

(1) Dispersed type—the vessels divide dichotomously and rapidly diminish in calibre (Fig. 3). This type was present in 63.8% of our cases. Mukerji *et al*, (1971) described this pattern in 82.8% of their cases.

(2) Magistral type—the main arteries give off smaller branches and almost reach the placental margin before there is marked reduction in size (Fig. 4). This type was present in 36.2% of our cases. Mukerji *et al*, (1971) found this pattern in 16% in their series. Schordania (1929) thought that the magistral type was associated with a better developed foetus as the arteries were of larger size. No such correlation was observed by

Crawford (1962), Mukerji *et al*, (1971), as well as in the present series.

In 48% of our cases veins were superficial to the arteries, while Mukerji *et al*, (1971) and Arts (1961) reported that arteries crossed over the veins in 96.2% and 69% of their cases, respectively.

#### Arterio-Venous Dissociation

In our series, out of 97 cases of dispersed type branching, 68 cases (70%) showed arterio-venous dissociation, while in 55 cases of magistral, 30 cases (54.5%) showed the dissociation. Statistically these values are insignificant ( $P > 0.05$ ). Bhargava (1966) reported arterio-venous dissociation in 66.7% in normal cases.

Arterio-venous anastomosis was not observed in any of our cases. Similar findings have been reported by Boe (1954), Arts (1961), Crawford (1962) and Smart (1962). Mukerji *et al*, (1971) observed arterio-venous communication only in one out of 160 cases. Wentworth (1968) reported that arterio-venous anastomosis had no ill effect on the foetus.

It was observed that the umbilical arteries gave 2 to 7 primary branches which subsequently gave branches of 2nd and 3rd order before entering the cotyledons, as given in the Table II.

TABLE II  
Showing Number of Primary Division of the Umbilical Arteries

No. of Primary division of the umbilical arteries	Pattern of branching of the Umbilical Artery			
	Dispersed		Magistral	
	No. of cases	Percentage	No. of cases	Percentage
1	0	-	0	-
2	10	10.31	7	12.73
3	38	39.18	22	40.00
4	26	26.80	11	20.00
5	12	12.37	8	14.55
6	8	8.25	5	9.09
7	3	3.09	2	3.64
Total	97		55	



These findings are in conformity with those of Bhargava (1966) and Bansal (1970). We have further studied the course of these vessels in the formation of cotyledons, and our findings are similar to those of Crawford (1956) who explained the origin of the vessels in the cotyledons in three ways:-

(i) by deep direct branching from the main trunk.

(ii) by superficial branches which perforate the chorion.

(iii) by branches derived directly from the vessels which supply cotyledons.

The primary division of the veins were also studied by us and biggest number of cases both in dispersed and magisteral type, were 35 and 29, respectively with contained 4 tributaries of the first order. Our findings are given in Table III.

Bhargava (1966) has not given any significance to these findings in his work. Bhargava (1966) has, however, claimed significant relationship between levels of tortuosity of arteries and conditions like abnormal development, prematurity and hydramnios. The presence of tortuosity in the veins has also been studied in the present work. In the dispersed and magisteral types of branching it was present in 90.7% and 76.3% cases, respectively. In all our cases the vessels in the umbilical cord showed spiral arrangement. Loops were present in 30 cases, which varied from circular to U shaped. The presence of loops had no bearing on the condition of foetus at birth.

#### *Area Supplied by Each Umbilical Artery*

In the present series it was found that

TABLE III  
*Showing Number of Primary Division of Vein*

No. of Primary division of vein	Pattern of Branching of the Vein			
	Dispersed		Magisteral	
	No. of cases	Percentage	No. of cases	Percentage
1	2	2.00	1	1.82
2	4	4.12	3	5.45
3	20	20.62	11	20.00
4	35	36.08	29	52.73
5	29	29.90	5	9.09
6	5	5.15	4	7.27
7	2	2.06	2	3.64
Total	97		55	

#### *Tortuosity of Vessels*

The tortuosity of arteries was found to be present in 82.5% of dispersed type of branching and in 90.9% of magisteral type (Fig. 5). In both these types the biggest groups showed tortuosity at PST levels. It has been observed by us that marked tortuosity of arteries is usually associated with cases of toxæmia of pregnancy and postmaturity.

61 dispersed type of cases and 28 magisteral type of cases showed equal areas of distribution of the two umbilical arteries. In the rest the distribution was unequal. These values were found to be statistically insignificant.

#### *Twins*

Out of 152 placentae, 11 cases were of twins. Out of these 11 cases, 3 cases

were associated with toxæmia, 2 cases had anaemia and 6 were normal. Two out of 11 twins were monochorial and nine were dichorial. Hyrtle's anastomosis was present in all the cases, and there was no abnormality in the shape and size of the placentae.

#### Summary

1. 152 placental casts were studied by injection corrosion technique. Forty-five from normal cases and 107 were associated with abnormal pregnancy.

2. There was no correlation between the age and parity of the patient with the vascular pattern of the placenta, and the shape of the placenta had no relation with the fate of the foetus.

3. No correlation was found between the distribution of blood vessels and the foetal weight.

4. There was no correlation between the vascular pattern or distribution of blood vessels with any clinical condition, except that marked tortuosity of blood vessels was associated with toxæmia and postmaturity.

5. Four cases of single umbilical arteries were seen, in one case the baby was normal, the second case was associated with stillbirth, the third one belonged to a case of eclampsia with a macerated foetus and the fourth was associated with hydramnios with stillborn anencephalic foetus.

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See Figs. on Art Paper VI-VII