

Study of Arterial Pattern & Its Correlation with the Shape of Human Placenta by Corrosion Cast Method

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Abstract

Introduction: Placenta is an organ that connects the developing fetus to uterine wall to allow nutrient uptake, waste elimination and gaseous exchange via the mother's blood supply. Placenta is the most accurate record of prenatal experience. Our aim of study was to see different vascular patterns in normal full term human placenta by corrosion cast method.

Material and Methods: 100 normal placentae were collected within one hour of delivery. Normal full term placentas were taken for study and any abnormal placenta was excluded - eg: Bidiscoidal placenta, multidiscoidal placenta, lobed placenta, placenta succenturita, fenestrated placenta, circumvallate placenta, batterdore placenta, furcated placenta, velamentous placenta.

Results: The findings of the present study bring forth some important facts as follows: there were three type of placental shape - round, oval & irregular. Round type had more incidence than oval & irregular. Dispersed pattern & magisterial pattern was seen more in round placenta.

Conclusion: These observations on normal placenta call for further studies on the variations of its vascular pattern & shape in placenta of diseased mother eg. Hypertension, diabetes, anemia etc.

Key words: Placenta, Vascular pattern, corrosion cast

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Introduction

The placenta is a highly vascularised organ which functions in the maintenance of pregnancy and promotes normal foetal development.^{1,2} The human placenta is described as haemochorionic placenta thereby meaning that the fetal chorion is in direct relationship with the maternal blood.³

The intrauterine existence of foetus is dependent on vital organ placenta. Still one of the common methods of the investigations of the factor influencing the foetus during perinatal period is the examination of placenta. Human placenta is circular, semicircular or oval 15 to 20 cm in diameter, and 2 to 3 cm thick. The foetal surface of the human placenta is shiny and consists of large opaque blood vessels distributed on the dense opalescent surface of the thickened chorion normally, coursing to the edge of the chorionic plate.⁴

According to Schordania,⁵ the vascular pattern of the placenta is not a haphazard phenomenon, but is genetically determined by vascular characteristics of the mother. He advanced the theory that placenta belonging to the magisterial type are usually associated with a

better-developed foetus, with greater weight, length and thoracic measurement, than those of the disperse type, because of large size of arteries. The pattern of division of each umbilical artery in any placenta falls in to two types:

- a) Dispersed type.
- b) Magestrial type.

- a) **In dispersed variety/dichotomous pattern** – each umbilical artery of placenta begins at once a series of divisions, dichotomous in nature which fill each half of the placenta with arteries of gradually diminishing caliber. They are arranged like the spokes of a wheel.
- b) **In magisterial variety/monopodial pattern** – placenta has two arteries which extends almost as far as the margin of placenta before their caliber diminishes.

More recently, it was proposed that:-

- a) **Delivering vessel trees** :- repeatedly symmetrical bifurcating vascular structures with a high daughter-to-mother diameter ratio (i.e. dichotomous) can be classified as delivering vessel trees, whereas
- b) **Conveying, or distributing, vessels:** highly asymmetric structures with small daughter-to-mother diameter ratio (i.e. monopodial) can be classified as conveying, or distributing, vessels.

Various Classifications of Arterial Pattern

S. No.	Scientist	Year	Classification type	
1	Schordania ⁵	1929	Dispersed type	Magisterial type
2	Horsfield & Cumming ⁶ ,	1968	dichotomous	monopodial
	Parker et al, ⁷	1971		
	Zamir, ⁸	1988,2001		
	Aharinejad et.al, ⁹	1998		
	Kruszewski, Whitesides, ¹⁰	1998		
	Wang et al, ¹	2004		
3	Aharinejad et al. ⁹	1998.	Delivering vessel trees	Conveying, distributing, vessels

The chorionic plate (or “fetal surface”) of the human placenta is typically drawn as round, with the umbilical cord inserted roughly at the center. In clinical practice, the shape of the chorionic disk is rarely truly circular; its shape commonly varies, from round to oval, or irregular.¹¹ Placental shape is thought to be determined by where it is implanted in the uterus, regional variations in the decidua (that may determine areas of atrophy), variations in maternal vascular supply (with placental infarcts resulting in altered shape) and perhaps even the “manner of its original implantation”.

Normal fetal development is largely dependent on adequate placental blood perfusion. The structural anatomy of the fetal vasculature of the human placenta has been investigated post delivery using various techniques such as latex or plastic casts, injection of gelatin dye, microscopy and angiography.^{12,13,14,15,16,17,18}

Material and Methods

The present study was conducted in the Department of Anatomy at S. N. Medical College, Agra. Total 100 Normal full term placenta were collected within one hour of delivery from the Department of Obstetrics & Gynaecology, S. N. Medical College & Hospital, and Lady Loyal Hospital, Agra. Placenta was washed with tap running water and after washing the shape of placenta were observed. Normal full term placentas were taken for study and any abnormal placenta were excluded- **eg:** Bidiscoidal placenta, multidiscoidal placenta, lobed placenta, placenta succenturita, fenesterated placenta, circumvallate placenta, batterdore placenta, furcated placenta, velametous placenta.

Injection Technique for Preparing Corrosion Cast

The technique used here is known as injection technique.¹⁹ Umbilical arteries was identified in the umbilical cord. 15 NO. needle was inserted in one

umbilical artery, tied with thread and the artery was cleaned by injecting water. 15-20ml of butyl butyrate solution was injected in the arterial tree with constant pressure. After injection the needle was taken out and artery was tied by thick thread. The artery was firmly tightened and this same procedure was repeated with the other artery.

Colour of butyl butyrate filled in right artery- red & left artery-black. The placenta was now left in 10% formalin for the fixing of tissue. The placenta was dipped in 30% KOH for 4 days. After 4 days the placenta was removed and again put in 3% KOH for further 3 days. During the clearing placenta was put in incubator at the Temp. of 37°C.

After 7 days cast was taken out from the jar. After cast formation the vascular patterns were identified

1. Dispersed or Dichotomous (Fig. 2)
2. Magisterial or Monopodial (Fig. 4)

Observations & results

Of 100 placental casts studied for vascular pattern, showed 60(60%) dispersed pattern means both artery of placenta begins at once a series of divisions, divide dichotomously & fill each half of placenta with arteries of gradually diminishing caliber. They are arranged like a spoke of wheel (FIG. 1,2). Rest 40(40%) showed magisterial pattern in which both artery supply whole placenta and both goes upto margins of placenta with same diameter (FIG. 4).

Table-1 shows arterial pattern of placenta & its correlation with the shape of human placenta. In dispersed pattern out of 60, 42 (70%) were round in shape, 12 (20%) were oval in shape, 6 (10%) were irregular in shape. In magisterial type out of 40 placenta, 18 (45%) were round, 12(30%) were oval in shape & 10(25%) were irregular in shape.

Relationship between Shape and Vascular Pattern of Placenta

S. No.	Pattern	Total	shape of placenta					
			round	%	oval	%	Irregular	%
1	Dispersed	60	42	70	12	20	6	10
2	Magisterial	40	18	45	12	30	10	25
	Total	100	60		24		16	

Irregular category include all the placenta which do not fall in round to oval category eg. triangular, ill defined shaped. In 2% of cases single umbilical artery with irregular shaped placenta was found (Fig. 5). The fetus was stillborn in both cases.

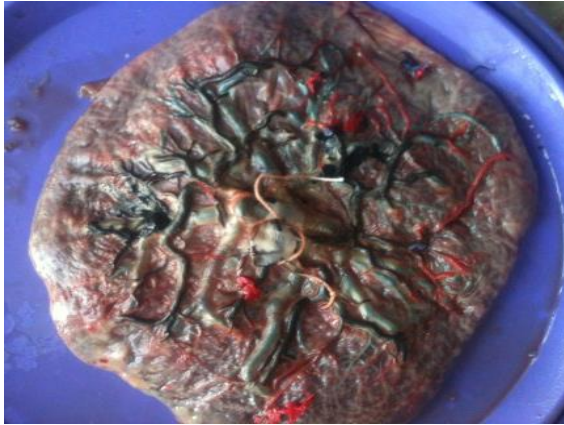


Fig. 1: Round shape placenta



Fig. 2: Cast of Round shape placenta with dispersed pattern



Fig. 3: Oval shape placenta



Fig. 4: Cast of oval placenta with magesterial pattern

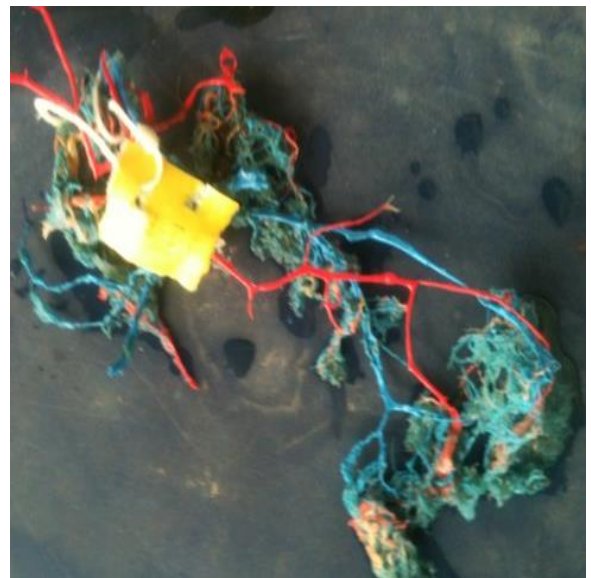


Fig. 5: Cast of irregular shape placenta with single umbilical artery

Discussion

The gross anatomy of human placenta is virtually a description of its vascular anatomy because it is totally composed of fetal blood vessels which have their main function the preservation of fetal blood to the circulating maternal blood.

A large doubt is still present in the palcental vascular pattern among different studies. So we have studied it by corrosion cast method for better understanding the vascular pattern in placenta. Horizontal arrangement noticed by Spanner²⁰ and Bacsich and Smout.¹⁹ We also noticed that umbilical arteries are lies in horizontal plane that are unlike to other human arteries which are arranged in three dimensional lattice.

In present study the arterial pattern are of two types – dispersed and magisterial that are in accordance with study by Schordania.⁵

In Schordania⁵ both varieties was about equal incidence. In our study dispersed variety had more incidence(60%) than magisterial variety(40%).(table-1)

Fraser²¹ described the arteries of human placenta as being similar of spoke of wheel, that is actually found in dispersed variety, but in our study 60% had spoke of wheel appearance(dispersed variety).

As observed by M. Yampolsky,¹¹ placenta are of three types – round, oval and irregular. We found that 60% was of round shape 24% was with oval shaped and rest are irregular. 70% placenta (42 out of 60) with round shape have dispersed arterial pattern. Irregular shaped placenta have more magisterial pattern (10 out of 16) than dispersed pattern. Oval placenta have equal pattern of dispersed and magisterial.

The umbilical cord normally contains of one umbilical vein and two umbilical arteries. Single umbilical artery (SUA), the most common anatomical abnormality of the umbilical cord, is found in 0.2-1.1% of singleton pregnancies,²² and in 6-11% of multiple pregnancies. It is believed to be caused by atrophy of previously normal artery or agenesis of one of the umbilical arteries.²³ The selection process of the missing (or existing) vessel is likely to be random, even though a right single artery is slightly more common.²⁴ Single umbilical arteries are associated more commonly with foetal anomalies than normal cords. Of infants with single umbilical artery 20% or more are reported to have associated foetal anomalies²⁵ including cardiovascular abnormalities, gastrointestinal tract defect, esophageal atresia, a variety of renal defects and multiple anomaly syndromes.²⁶ A 5-20% perinatal mortality rate has been reported in association with single umbilical artery and includes fetuses with severe congenital anomalies and chromosomal defects²³. In this study out of 100 only 2 cases have irregular shape placenta with single umbilical artery (Fig. 5) and in both outcome was stillbirth. So perhaps single umbilical artery is not compatible with life.

Conclusion

The present study was carried out to see the arterial pattern of placenta & correlate with the shape of placenta. In our study we found dispersed type of arterial pattern were dominant than magisterial type of arterial pattern. Out of 100 placenta 60% were dispersed type & 40% were magisterial type. In present study dispersed type of arterial pattern was more frequent with round shape placenta but both type of arterial pattern had equal incidence with oval shape of placenta and magisterial type of arterial pattern had more frequent with irregular shape placenta. In present study only two placenta had single umbilical artery and associated with irregular shape of placenta. Both were

still birth so perhaps single umbilical artery is not compatible with life.

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