

Research Articles

Histomorphological study of Hyrtl's anastomosis in pregnancy induced hypertension and small for gestational age – A clinical correlationPrabavathy G.¹, Sadeesh T.¹, Meera K.², Chandra Philip X.³, Anbalagan J.³¹Associate Professor, ³Professor, Department of Anatomy, Mahatma Gandhi Medical College & Research Institute, Sri Balaji Vidyapeeth, Pillaiyarkuppam, Puducherry, India²Associate Professor, Department of Anatomy, Malabar Medical College Hospital and Research Centre, Modakallur (PO), Ulliyeri, Calicut, Kerala, India

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Corresponding author: **Prabavathy G.** Email: prabajai1986@yahoo.com**ABSTRACT**

Introduction and Aim: Hyrtl's anastomosis is the only connection between the two umbilical arteries, which helps in equalizing the blood pressure in the umbilical arteries supplying to the different territories of the placenta. The aim was to study the morphological and structural pattern of Hyrtl's anastomosis in normal, pregnancy-induced hypertension (PIH) and small for gestational age (SGA) umbilical cords.

Materials and Methods: This study included 150 term placentas with the umbilical cord, divided into three groups. Group I (Normal), Group II (Pregnancy Induced Hypertension), and Group III (Small for Gestational Age).

Results: Hyrtl's anastomosis could be identified in 138 cases. In 69 cases, the anastomosis noted was a transverse type, oblique in 40, fenestrated in 23, and fused in 6 cases. Hyrtl's anastomosis was absent in ten cases and the single umbilical artery was observed in two cases. A significant increase in the incidence of a transverse type of Hyrtl's anastomosis was noted in PIH groups. The percentage of oblique type was more in normal and SGA groups as and when compared to PIH groups. There was a statistically significant increase in the length of Hyrtl's anastomosis in the normal groups when compared to PIH groups, both in the transverse and oblique type. A histologically significant difference in the tunica media of the umbilical arteries and Hyrtl's anastomosis was noted in PIH groups.

Conclusion: Hyrtl's anastomosis in PIH groups showed varied histomorphological anatomy when compared to normal groups

Keywords: Hyrtl's anastomosis; umbilical arteries; pregnancy-induced hypertension; small for gestational age.

INTRODUCTION

The umbilical cord forms the only connection between the placenta and the developing foetus. It is surrounded by the amnion and contains a pair of umbilical arteries and an umbilical vein supported by connective tissue, the Wharton's jelly. The umbilical vessels carry blood back and forth from the foetus and placenta, and thus critical to the survival of the foetus (1).

The Placenta is a vital organ that maintains a foeto-maternal exchange of oxygen, nutrients, and waste products during foetal development. The only connection between the two arteries in the umbilical cord is Hyrtl's anastomosis. The connection allows in equalizing the blood pressure within the umbilical arteries imparting to the various territories of the placenta. It also facilitates as a shunt (protection valve) in case of partial compression of the placenta throughout uterine contractions or occlusion of one umbilical artery. When the pressure in the intervillous space and cotyledon is increased, the anastomosis acts like a buffering system (2). It was discovered by Hebenstreit in 1737 (3) and later investigated in detail by Hyrtl in 1870 (4).

The anatomical structure of Hyrtl's anastomosis is of a large variety. Different types of Hyrtl's anastomosis have been classified using the injection corrosion technique, Doppler method, and Angiography (5). Many authors have researched the function of Hyrtl's anastomosis. The presence of an intermediate vessel in the umbilical cord seems to be a recent evolutionary development (6). Studies revealed that the absence of Hyrtl's anastomosis during pregnancy could be a part of accountable for the prevalence of discordant umbilical arteries, a condition frequently associated with placental anomalies (velamentous and marginal insertion, infarcts; 7, 8).

The networks observed early in development diminished gradually to a single connection as development progressed, though they observed rare instances of double anastomosis (9). There is an acute angle leading from the high flow artery to the weaker flow artery. There is an equal, directional flow between both the arteries in case of transverse anastomosis, as compared to oblique anastomosis (10). Prenatal ultra-sonographic detection, including Doppler assessment, has been performed, demonstrating a pulsatile blood flow in the anastomosis (11).

Pregnancy Induced Hypertension is one of the complications of pregnancy, which has been mentioned in the literature. 6-20% of all pregnancies are affected by hypertensive disorders. 70% consists of preeclampsia, eclampsia, and 30% chronic hypertensive disorder in pregnancy (12). There is an increase in the number of artery pairs connected by a transverse vessel in specimens from hypertensive subjects relative to those from normotensive subjects. In pregnancy-induced hypertension specimens, the distance of anastomosis from the cord insertion and the length of anastomosis were shorter when measured, compared to normotensive subjects (13, 14). The arteries being thicker than in normal pregnancies, as observed by the differences within the tunica media and intima, have been reported by Junek (15). Hyrtl's anastomosis in small for gestational age placentas had varied anatomy, but the findings did not differ from those of appropriate for gestational age (AGA). A study on 64 placentas, observed anastomosis of umbilical arteries in 60 cases. The histological section of the anastomosis showed a thin layer of the circular smooth muscle layer without any elastic tissues (16).

A review of the literature showed less data on the comparison of histomorphological study of Hyrtl's anastomosis in complicated pregnancy conditions. The present work is aimed to study the distribution, the morphological and histological pattern of Hyrtl's anastomosis in normal, pregnancy-induced hypertension, and small for gestational age umbilical cords. This comparison may help to understand the varied anatomy factors in different groups and to update the existing knowledge for future study.

MATERIALS AND METHODS

This study was performed after getting approval from the Institutional Ethics Committee. 150 term placentas with the umbilical cord, from normal delivery & cesarean sections, were collected from the Department of Obstetrics and Gynecology, Mahatma Gandhi Medical College and Research Institute, Puducherry after obtaining written consent from their parents. The clinical history of the mother and details of the newborn was collected. Patients with diabetes mellitus, platelet disorders, and chronic hypertension were excluded. The placentas with umbilical cord collected were divided into three groups.

Group I: 50 cases – Control delivered by healthy mothers with normal blood pressure & birth weight. (Systolic: 100-135mmHg, Diastolic: 60-85mmHg)

Group II: 50 cases – women diagnosed with pregnancy-induced hypertension (PIH) (Systolic >140, Diastolic >90 mm Hg, measured on two or

more occasions at least 4 hours apart after the 20th week of gestation, with or without oedema and/or proteinuria)

Group III: 50 cases – Small for gestational age (SGA) Infants (Birth weight according to gestational age < -2SD, i.e. < -22% using the Scandinavian standard curve)

The collected placentas attached with the umbilical cord were washed in running water thoroughly; to enable identification, the specimens were tagged. The fixation of the placenta was done by immersing in 10% formalin for 5 days.

The umbilical cord was dissected longitudinally to trace the umbilical arteries and vein along the whole length up to the cord insertion after clearing the tissues. The anatomical features noted, were 1) the presence or absence of anastomosis 2) the pattern of anastomosis 3) the percentage distribution of the type of anastomosis 4) the length of Hyrtl's anastomosis measured from the one umbilical artery to another. The data obtained was tabulated.

Approximately 2-3 cm length of the umbilical artery was cut from the placental end. The Hyrtl's anastomosis in all the groups was removed. The tissues collected from the normal, PIH, and SGA cases were subjected to routine histological procedures and stained with Haematoxylin & Eosin. The sections were observed under a microscope to study the thickness of the walls of umbilical vessels, smooth muscles, and elastic fibres in the umbilical artery and Hyrtl's anastomosis.

Statistical analysis

The data obtained were subjected to analysis using statistical software SPSS 20. Comparison of the percentage distribution of various patterns of the anastomosis was analyzed using the Chi-square test and $p < 0.05$ was considered statistically significant. A comparison of the length of Hyrtl's anastomosis between different groups in the study population was analyzed using ANOVA and $p < 0.05$ was considered statistically significant.

RESULTS

Out of the 150 cases studied in three groups, Hyrtl's anastomosis could be identified in 138 cases. In 69 cases, the anastomosis noted was a transverse type, oblique type in 40 cases, fenestrated in 23 cases, and fused type in six cases. The anastomosis was absent in ten cases showing increased incidence in PIH cases. A single umbilical artery was noted in one of the normal and SGA cases. No case of more than one anastomosis was observed (Fig. 1).

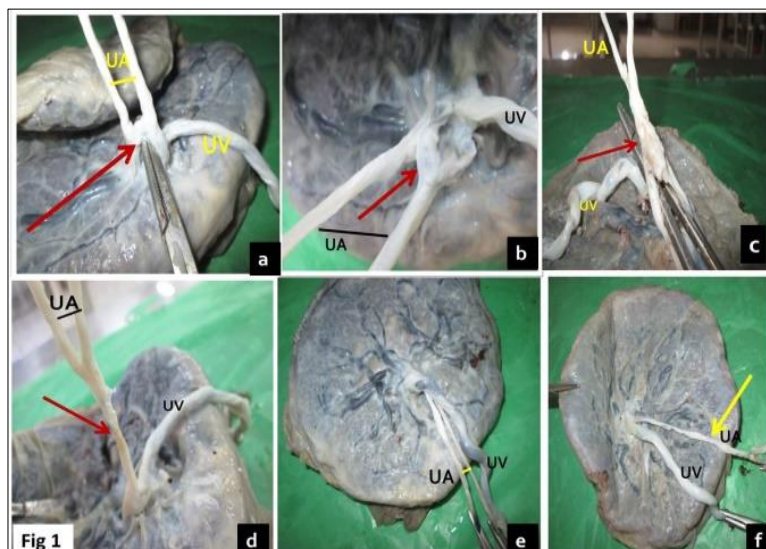


Fig. 1: Different patterns of Hyrtl's anastomosis (a-transverse, b-oblique, c-fenestrated, d-fused, e- no anastomosis, f-single umbilical artery) UA- Umbilical artery, UV- Umbilical vein.

The percentage distribution of the different patterns of Hyrtl's anastomosis in Normal, PIH, and SGA cases was compared (Table-1). An inter-comparison on the transverse type of anastomosis, the p-value was statistically <0.001(p<0.05), indicating the increased incidence in PIH groups. The percentage distribution of the transverse type was the same in normal and SGA groups. In oblique type, the p-value

was found to be 0.037 (p<0.05), which was statistically significant, showing increased distribution in normal and SGA groups compared to PIH groups. In the fenestrated type, the p-value was 0.003, showing statistically increased distribution in SGA and normal groups compared to PIH groups. In other types, the p-value was not statistically significant.

Table 1: Incidence and percentage distribution of the different pattern of Hyrtl's anastomosis in Normal, PIH and SGA groups.

The pattern of Hyrtl's anastomosis	Normal (n=50)	PIH (n=50)	SGA (n=50)	Statistical significance p-value
Transverse	16 (32%)	36(72%)	17 (34%)	<0.001*
Oblique	18 (36%)	7 (14%)	15 (30%)	0.037*
Fenestrated	9 (18%)	1 (2%)	13(26%)	0.003*
Fused	3 (6%)	1 (2%)	2 (4%)	0.594(NS)
No anastomosis	3 (6%)	5 (10%)	2 (4%)	0.472(NS)
Single umbilical artery	1 (2%)	0	1 (2%)	0.602(NS)

*p<0.05 is considered statistically significant

NS: Not significant

The anastomosis was noted at two levels: a) Localized within the umbilical cord (Normal -12, PIH- 14 and SGA- 16) b) At the cord insertion (Normal -32, PIH- 34 and SGA- 30). The distribution of the anastomosis was noted more towards the cord insertion in all three groups.

The length of Hyrtl's anastomosis was measured in the transverse and oblique type of all three groups. The mean length of Hyrtl's anastomosis ranged from 3 mm to 12 mm. There was a statistically significant difference in the length of Hyrtl's anastomosis between the groups as determined by ANOVA [F

(2,147) =12.80, p<0.001] in transverse type and oblique type [F (2,147) =20.28, p<0.001] (Table 2). A Tukey post hoc test revealed that there was a statistically significant (p value <0.001) increase in the length of Hyrtl's anastomosis in normal groups when compared to PIH groups, both in the transverse (11.10±2.18, p<0.001) and oblique type (9.50±2.86, p<0.001). However, there was no significant difference in length between normal and SGA cases in transverse type (p=0.788) and oblique type (p= 0.986)

Table 2: Length (mm) of Hyrtl's anastomosis in Normal, PIH and SGA groups

Pattern of Anastomosis	Normal (n=50)	PIH (n=50)	SGA (n=30)	F-value	p-value
	Mean±SD	Mean±SD	Mean±SD		
Transverse	11.10±2.18	8.40±3.73	10.72±2.51	12.80	< .001
Oblique	9.50±2.86	6.10±3.84	9.60±2.52	20.28	< .001

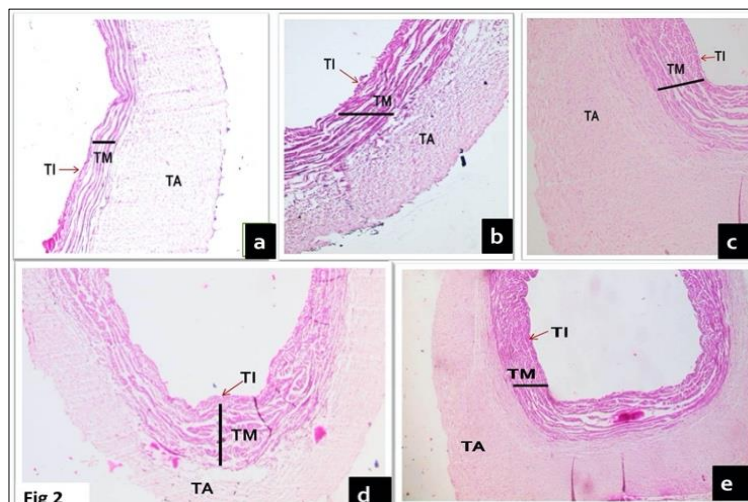


Fig. 2: Histological section (H&E stain 10x: **a-** Normal umbilical artery, **b-** PIH umbilical artery, **c-** Normal Hyrtl's anastomosis, **d-** PIH Hyrtl's anastomosis, **e-** SGA Hyrtl's anastomosis) TI- Tunica intima, TM- Tunica media, TA- Tunica adventitia

Histological features

On histological examination, there was a significant increase in the thickness of the muscle layer of tunica media in the umbilical artery of the PIH group, when compared with the normal umbilical artery (Fig. 2a, b). The elastic fibres were not differentiated well. There was also a significant increase in the muscular layer of Hyrtl's anastomosis in PIH cases. The bundle of muscle fibres observed was arranged circularly and longitudinally, compared to normal Hyrtl's anastomosis (Fig. 2c, d). A Histological section of Hyrtl's anastomosis of SGA showed thinner and only a circular smooth muscle layer without any elastic tissue. Loose intimal and adventitial connective tissue was seen (Fig. 2e).

DISCUSSION

Stieve and Strube (17) and Patten (18) reported that the placental circulation is established during the third and fourth week of the embryonic period. They observed networks with multiple anastomosis in the umbilical arteries. A study in 904 normal cases, 99.7% possessed Hyrtl's anastomosis with frequency according to type as 50.8% oblique, 48% transverse, 1.8% anastomosis by branch, 1.6% fusion and 0.1% lacking anastomosis (19). Bhutia *et al.*, (14) done a morphological study in Hyrtl's anastomosis of umbilical arteries in pregnancy-induced hypertension and described all these different patterns of the anastomosis. In the present study of 150 placentas in three different categories, 92% cases showed anastomosis - 46% transverse, 27% oblique, 15% fenestrated, 4% fused, and 1% incidence of the single umbilical artery. There was no branch pattern of anastomosis observed in the present study.

Ullberg *et al.*, (16) studied the Hyrtl's anastomosis of full-term infants of AGA and SGA. They noted all different types of anastomosis and found no significant difference between the two groups. In the present study, we found statistically significant increased distribution in SGA groups compared to the

normal groups in the fenestrated type. We also noted the distribution of anastomosis is more towards the cord insertion (64%) in all three groups as same as their study.

Bhutia *et al.*, stated that the transverse and oblique types were equally common in normotensive cases. In hypertensive cases, transverse anastomosis was found 1.8 fold more times (14). In the present study, we also observed a significant increase in the transverse type of anastomosis in PIH groups (72%) than normal groups (32%).

The length of the anastomosis varied between 0 and 20 mm (mean 7 mm). In the Ullberg *et al.*, (16) study, the mean length of Hyrtl's anastomosis varied from 6 mm to 12 mm, which showed increased length in normal groups as compared to PIH cases in both transverse and oblique type of anastomosis. The length in SGA was more or less the same as normal groups.

Barnwal *et al.*, (20) and Bhutia *et al.*, (14), observed an increase in the thickness of the muscular layer of umbilical arteries of pregnancy-induced hypertension as well as in Hyrtl's anastomosis when compared to the control. In the present study, there was also a significant increase in the thickness of the muscle layer of tunica media in the umbilical artery of PIH group when compared with the normotensive umbilical artery. There was also a significant increase in the muscular layer of Hyrtl's anastomosis in PIH cases. The reason for the increase in thickness is probably due to the intrinsic contractile response of the smooth muscle to stretch and further increase in pressure of the blood vessel stimulates the increase in the smooth muscle fibres.

The present study agreed with the findings of Ullberg *et al.*, who studied and compared the histological section of Hyrtl's anastomosis of normal and SGA and reported vessel like anastomosis showing thinner tunica media with circular muscle and absence of elastic tissue.

CONCLUSION

Our study reveals that the characteristics of Hyrtl's anastomosis differ between PIH groups from that of normotensive groups. Observation of an increased percentage of the transverse type of anastomosis in PIH groups, suggests an important functional role in regulating the blood flow, by equalizing the pressure gradients in the PIH umbilical arteries. A significant increase in the thickness of the wall of umbilical arteries and Hyrtl's anastomosis in PIH groups analyzed in the present study may be useful in detecting the hemodynamic status of the foetus. There is no significant histological change in Hyrtl's anastomosis of SGA groups, which indicates its non-contributing part for intrauterine growth retardation.

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