Research Article

Structural Variances in Histomorphometry Analysis of Umbilical Cord in Normal and Intrauterine Growth Restriction

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Abstract:

Background: Intrauterine growth restriction is the clinical condition when the estimated weight of fetus is less than 10th percentile. **Objective:** To study the changes in histomorphometry of umbilical cord in normal and intrauterine growth restriction. **Materials and methods:** 100 umbilical samples were collected after applying inclusion and exclusion criteria and were divided into cases and controls. Histomorphometry measurements were recorded using Leica LAS V4.12 software. **Results:** Total area of umbilical cord, vein, artery-1 &2, Wharton's jelly were 22.65+2.66, 2.33+0.08, 2.04+0.09, 1.88+0.08 and 29.58+1.98 respectively which were less when compared to normal cords. Thickness of vein, artery-1 & 2 in IUGR were 0.33+0.02, 0.47+0.04 and 0.48+0.02 respectively. **Conclusion:** In our study all the umbilical cord parameters were reduced in IUGR than normal. Reduced blood flow to fetus may be due to structural alterations umbilical cord vessels or placental vasculature.

Keywords: Umbilical cord, histomorphometry, intrauterine growth restriction, Wharton's jell.

Introduction:

Intrauterine growth restriction is the clinical condition when the estimated weight of fetus is less than 10th percentile. Despite several risk factors identified, the underlying mechanism remains challenging. Uneven maternal-fetal exchange is due to umbilical circulation modifications caused by placental insufficiency [1]. Placenta related conditions that don't alter uteroplacental circulation are shaped and umbilical cord congenital anomalies. Spiral arteries remodeling deficiency in uterus during early pregnancy cause fetal growth restriction which is placenta related [2]. In fetal growth restriction different placental injury patterns may be correlated to various clinical outcomes which would explain specific pathophysiology [3]. Structural changes and pathology of umbilical cord may lead to adverse pregnancy outcome, fetal growth restriction including stillbirth [4,5]. Umbilical cord is fetal in origin and the connecting link between placenta and cord. Any structural changes would alter the supply of essential nutrients and oxygen which leads to intrauterine growth restriction.

Materials and methods:

This is a prospective case control study carried out in department of Anatomy, KIMS, Koppal, Karnataka on 100 umbilical cord samples. Informed consent form was taken and obstetric record was observed to collect history of patient.

Inclusion criteria: Singleton pregnancies, maternal age:18- 35 years, gestational age: 34-41weeks.

Exclusion criteria: Diabetes, unknown gestational age, HIV, any other congenital anomalies.
After delivery, umbilical cord was cut 5cm away from its attachment to placenta to maintain uniformity in cord section. The sections were fixed in formalin and paraffin blocks are prepared for tissue processing using routine histological procedures. Hematoxylin and Eosin stains are used for staining the sections. Examination of the slides was done under Leica DM 1000 LED microscope. Histomorphometry measurements were recorded using Leica LAS V4.12 software. Statistical analysis was done using SSPS 25. Institutional ethics committee approved this study.

Results:

Normal topography of human umbilical cord includes Wharton's jelly surrounding one umbilical vein and two umbilical arteries. The summary of our findings in normal and IUGR umbilical cord is given in table-1. Area of vessels along with thickness of wall, Wharton's jelly area and total cord area was measured quantitatively.

Table-1: histomorphometry parameters in normal and IUGR group

S. No	Umbilical cord parameters	Normal group Mean + SD	IUGR group Mean + SD
1	Vein area in mm^2	9.89+1.43	2.33+0.08
2	Artery-1 area in mm^2	3.37+0.25	2.04+0.09
3	Artery 2 area in mm^2	2.39+0.24	1.88+0.08
4	Wharton's jelly area in mm^2	60.26+4.55	29.58+1.98
5	Artery-1 wall thickness in µm	1.02+0.09	0.47+0.04
6	Artery-2 wall thickness in µm	0.82+0.02	0.48+0.02
7	Vein wall thickness in µm	0.58+0.05	0.33+0.02
8	Total umbilical cord area in mm^2	75.91+4.77	22.65+2.66

Total cord area in normal was 75.91+4.77 whereas in IUGR it was 22.65+2.66. Area and thickness of vein was 2.33+0.08 and 0.33+0.02 respectively in IUGR while it was more in normal group. Wharton's jelly area in normal was 60.26+4.55 while in IUGR it was 29.58+1.98. The area of artery-1 and 2 in IUGR was 2.04+0.09 and 1.88+0.08 respectively which was less when compared to normal. Thickness of artery-1 and 2 was 0.47+0.04, 0.48+0.02 in IUGR (Figure-1) while it was 1.02+0.09 and 0.82+0.02 respectively in normal group.

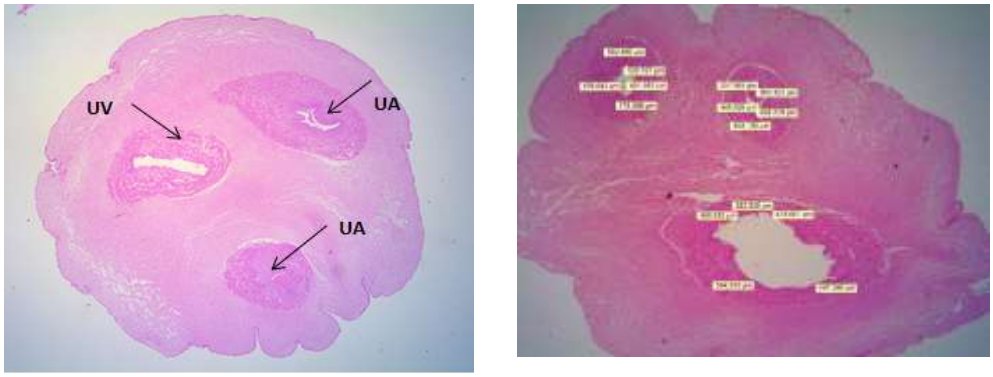

Figure-1 Normal and IUGR umbilical cord

Discussion:

Growth of the fetus depends on the vascular pattern of placenta and umbilical cord which is fetal in origin. Umbilical cord parameters were reduced in IUGR when compared to normal cord. Raio L et al observed lean umbilical cords which were prevalent and higher significantly in IUGR when compared to appropriate for gestational age (AGA) fetuses. Components of umbilical cord like cross sectional area, artery area and vein area were smaller in IUGR when compared to AGA fetuses [6]. Malik VS et al observed reduced total umbilical cord area in IUGR when compared to normal group and our findings are coinciding with the findings of these authors [17]. Raio L et al stated that umbilical artery was not associated with hemodynamic changes in umbilical artery blood flow [6]. Su E J reported that growth restricted fetuses with end-diastolic velocities reversed or absent in umbilical arteries have a significantly increased risk of long-term and perinatal outcomes compared to preserved end-diastolic velocities in growth restricted fetuses [7]. Persistent arterial malformations observed from intrauterine to adulthood on vascular ultrasound by Sehgal A et al for individuals affected by IUGR seems to be a logical link between intrauterine events and chronic circulatory diseases [8]. According to Maulik D et al IUGR, there is an increasing resistance to umbilical artery outflow, which may be absent during end-diastole results in unfavorable outcomes that include perinatal asphyxia and still birth [9]. Malik VS et al reported that no significant difference was found in wall thickness and total vessels area between normal and IUGR umbilical cord [17].

The area of the umbilical vein was found to decrease gradually and significantly corresponding to the degree of abnormality of the Doppler parameter of the umbilical artery. The caliber of the umbilical vein decreases significantly as the parameters of the umbilical artery deteriorate according to Raio L et al [6]. In severe FGR fetuses umbilical vein flow per kilogram weight when compared to normal fetuses was lower significantly as observed by Ferrazzi E et al. In their study, umbilical vein diameter / head circumference ratio was normal while umbilical vein velocity/ head circumference ratio in FGR was lower significantly than the controls [10,11]. In our study total vein area in IUGR was less when compared to normal cord which are coinciding with the findings of Kotrannavar SS et al where vein area in IUGR was significantly reduced [14].

Wharton's jelly area and umbilical artery area showed no significant difference sonographically in lean umbilical cord as observed by Ghezzi F et al in their study [12]. Bruch JF et al reported reduced areas in lumen vein, Wharton jelly and total area in IUGR with normal Doppler while reduced area of each vessel and thickness of wall in IUGR with pathological Doppler [13]. We observed reduced Wharton's jelly area in IUGR than the normal umbilical cord.

Kotrannavar SS et al studied IUGR umbilical cords which showed increased total vessel area to lumen area ratio and vessel wall area to lumen area significantly. In their study contrast to the above findings IUGR, total vessel area to lumen area and vessel wall area to lumen area in human umbilical arteries was increased but significant one was human umbilical artery-2 in IUGR [14]. Wall: lumen ratio in umbilical arteries and veins in FGR was higher significantly than control group as observed by Blanco MV et al [15]. Increased arterial wall thickness, total area and luminal area of vein, and total area of vessel was observed in pre-eclampsia (PE) while vein wall thickness and area of Wharton's jelly was increased in control group than PE group as observed by Barnwal, M et al [16]. Di Naro E et al observed umbilical veins with reduced blood flow in IUGR in their study [18].

Conclusion:

In our study all the umbilical cord parameters were reduced in IUGR than in normal. Reduced blood flow to fetus may be due to structural alterations umbilical cord vessels or placental vasculature. As umbilical vein is the key structure for transport of essential nutrients, a greater number of histomorphometry, histopathology and Doppler studies are essential to get complete picture of mechanism underlying for IUGR.

Conflict of interest: None

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