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Fetal Distress and UV Flow Rate: A Correlational Study

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Abstract

Objective: The objective of the study was to investigate the distribution of umbilical venous flow rates, measured in early labor, in a cohort of normal term pregnancies and to establish the relationship between umbilical venous flow and subsequent fetal distress.

Study Design: Ninty women with uncomplicated, term, singleton pregnancies were recruited to this prospective observational study prior to active labor at SMS Medical College, Jaipur. All participants underwent an ultrasound examination, during which, umbilical venous flow velocity, and umbilical vein diameter were recorded. Umbilical venous flow rate was then calculated. Following delivery and neonatal outcomes were correlated with the ultrasound findings.

Results: Appropriately grown fetuses, with the lowest umbilical venous flow rates, were at increased risk of a diagnosis of intrapartum fetal compromise and subsequent operative delivery.

Conclusion: Fetuses with the lowest umbilical venous flow rates are at increased risk of intrapartum fetal compromise.

Keywords: Fetal Distress; UV flow rate

Introduction

The intrapartum period represents the time during pregnancy when the fetoplacental relationship is challenged to the highest degree. Uterine contractions are associated with up to 60% decline in uterine artery

flow velocities[1] and the associated reduction in placental perfusion may precipitate fetal compromise.

Impaired placental transfer of oxygen and other substrates during labor is likely to be responsible for the "fetal distress" that develops as a consequence of regular uterine contractions.

Placental function may be evaluated by ultrasound[2] and Doppler. Umbilical venous flow is a direct physiological representation of the nutrients and oxygen content reaching the fetus. The umbilical vein is the largest of the three vessels in the umbilical cord and is readily imaged by ultrasound.

Intrauterine growth and development are regulated by complex interactions between genetic factors and the in-utero environment. However, the role of an adequate blood supply that ensures availability of oxygen and nutrients to the placenta and fetus cannot be overemphasized; the umbilical vein is the lifeline of the fetus in utero. Changes in the intra-uterine environment that occur during labour can precipitate fetal compromise.

The clinical use of umbilical venous blood flow was first suggested in the early 1980s[1,] when reduced flow was demonstrated in growth-restricted fetuses. Indeed, Doppler measurement of umbilical venous blood flow has been found to be accurate when compared with several gold standards for in-vivo flow calculation.

In normal pregnancies, the flow per unit fetal weight remains essentially constant at 110-120 ml/min/kg for most of the pregnancy. In pregnancies with complications, however, abnormally low or high flow values are frequently observed. Low flow values correlate strongly with retarded fetal growth, and with increased incidences of antenatal hypoxia, neonatal morbidity and neonatal death.[3]

Furthermore, abnormalities in umbilical venous flow have been associated with an increased incidence of operative delivery for fetal compromise.

A lot of studies have been done to show the association of reduced umbilical venous flow with fetal growth restriction. To our knowledge till now only few studies have been done to show role of umbilical venous flow to predict intra partum outcome in normal, appropriately grown term pregnancies.

Aims &Objective

To establish the relationship between umbilical venous flow and subsequent Intrapartum outcome.

Methodology

Study Type - A hospital based observational study

Study Design - A hospital based prospective study

Study Place - The Department of Obstetrics and Gynecology, in collaboration with Department of Radiology at SMS Medical College and attached hospitals, Jaipur

Study Period - June 2018 to November 2019

Study Population -The study included 90 women with singleton pregnancy with early labor (cervical dilation 4 cm or less).

Sample Size: Sample size was calculated at 95% confidence level assuming SD of 48.43 ml/min in umbilical venous flow rate among patients of normal term pregnancy as found in reference study (Tomas Prior, BSc; Edward Mullins, BSc; Phillip Bennett, PhD; Sailesh Kumar, PhD. American Journal of Obstetrics & Gynecology JANUARY 2014).

At the precision (absolute allowable error) of 10 ml/min in umbilical venous flow rate 90 cases were required, as sample.

Inclusion criteria

- Singleton pregnancy
- Women with normal term pregnancies presenting in early labor, and likely to deliver within 72 hours.

Exclusion criteria

- Known fetal growth restriction (preeclampsia)
- Known fetal anomaly
- Cervical dilatation greater than 4 cm, and ruptured membranes with meconium stained liquor.

Methodology

After applying inclusion and exclusion criteria informed written consent was be taken and women with uncomplicated singleton pregnancy in early labor cervical dilation ≤ 4cm likely to deliver within 48 hours and willing to participate in the study were recruited from labor room of department of obs and gynec, SMS medical college, Jaipur.

Approval from Institutional Research, Review Board and Ethical Committee was taken. Detail history, examination and all routine investigations were done. Ultrasound assessment was done for fetal biometry (head circumference, biparietal diameter, abdominal circumference, femur length and fetal weight) and umbilical venous Doppler was assessed. All ultrasounds scans was performed by a single operator using (ALOKA PROSOUND alpha6 with convex probe)

For Doppler assessment, the umbilical vein was imaged at a free loop and pulsed wave Doppler was used to obtain umbilical vein flow velocities. The angle of insonation was maintained as close to 0 degree as possible and always less than 30 degree, to ensure accurate assessment of flow velocities. The image was magnified and internal diameter of vein was measured. An estimated fetal weight was calculated from fetal biometry.

Umbilical venous Doppler was done for the umbilical vein flow velocity and umbilical vein diameter, to calculate umbilical venous flow rate.

The following formula was used for calculation:

Umbilical venous flow rate (milliliters per minute) = velocity (centimeters per second) x 0.3 x cross-sectional area (square millimeters).

Case were managed according to local protocol and guidelines and then case were subcategorized according to mode of delivery and corrected umbilical venous flow rates.

Statistical Analysis

- Continuous variables were summarized as mean and standard deviation while nominal / categorical variables as proportion.
- Parametric test were used for continuous variable whereas $\chi 2$ (chi-square) test.
- Fisher-exact test were used for nominal / categorical variability. P-value <0.05 was taken as significant.

Result

Patient demographics are shown in Table 1 and correlation between fetal distress and UV flow rate in Table 2.The mean age in our study population was 26.4 ± 2.73 yrs. Most of the patients 62 (68.89%) belonged to urban areas and were Hindus. Maximum (93.33%) number of cases had a BMI <25 and mean BMI of the study population was 22.14 ± 1.39 kg/m^2 Maximum patient in our study were primigravidas. No difference in maternal age, residence and BMI was observed in different umbilical venous flow rate centile groups. The mean umbillical venous flow rate in the study was 211.96 ± 30.98 ml/min whereas the mean of the

corrected umbillical venous flow rate was 73.46 ± 9 ml/min/kg. Maximum (90%) of the patient had a flow rate between 150-250 ml/min. only three patients had a flow rate below 150 ml and 6 had above 250 ml/min.(Table7) Out of total 90 fetuses, 23 (25.56%) had fetal distress at the time of delivery.(Table 14) Out of 90 patients, 26 women in our study had UV flow rate less than 200ml/min .Out of these 18 (69.23%) women developed fetal distress during labor, suggesting a strong correlation of decreased UV flow rate with fetal distress. 60 cases had UV flow rate between 201 and 250 ml/min out of which only 5 (8.33%) cases had fetal distress. There was no FD case in UV flow rate of >250ml/min (Table20).11/23 (47%) cases with fetal distress had corrected UV flow rate below 70 whereas only 20/67 (29.85%) cases without fetal distress had corrected UV flow rate below 70. The difference was statistically significant with p value of less than 0.001. 3 cases had corrected UV flow rate >90 ml/min/kg and none developed fetal distress.(Table21) The mean UV flow rate in women who developed fetal distress was 181.77 as compared to 220.58 ml/min in the group who did not have fetal distress and the difference was statistically significant.(Table22) The mean score of Corrected UV flow rate in women who had fetal distress was 68.56 as compared to 74.87(ml/min/kg) in women with no fetal distress.(Table23)

Table 1: Distribution of Cases According to Age

Age Group (in yrs)	No.	%
<25	36	40.00
26 - 30	47	52.22
31 - 35	7	7.78
Total	90	100.00

Table 2: Distribution of Cases According to UV Flow Rate

UV Flow Rate (ml/min)	No.	%
<100	1	1.11
100 - 150	2	2.22
151 - 200	19	21.11
201 - 250	62	68.89
>250	6	6.67
Total	90	100.00

Table 3: Distribution of Cases According to Corrected Umbilical Venous Flow Rate

Corrected UV Flow Rate (in ml/min/kg)	No.	%
<50	2	2.22
50 - 70	26	28.89
71 - 90	59	65.56
>90	3	3.33
Total	90	100.00

Table 4: Distribution of Cases According to Mean of Umbilical Venous Flow Rate

Variable	Mean	SD	Median
Umbilical Venous Flow Rate (in ml/min)	211.96	30.98	216.40
Corrected Umbilical Venous Flow Rate (in ml/min/kg)	73.46	9.00	73.6

Table 5: Distribution of Cases According to Fetal Distress

Fetal Distress	No.	%
Present	23	25.56
Absent	67	74.44
Total	90	100.00

Table 6: Correlation Between Foetal Distress and UV Flow Rate

Foetal Distress	UV Flow Rate (ml/min)						p-value
	<200		201-250		>250		
	No.	%	No	%	No	%	
Present	18	69.23	5	8.33	0	0.00	0.001
Absent	8	30.77	55	71.67	4	100.00	
Total	26	100.00	60	100.00	4	100.00	

Table 7: Correlation between Fetal Distress and Corrected UV Flow Rate

Foetal Distress	Corrected UV Flow Rate (ml/min/kg)						p-value
	<70		70-90		>90		
	No	%	No	%	No	%	
Present	11	35.48	12	21.42	0	0.00	0.001
Absent	20	64.52	44	78.58	3	100.00	
Total	31	100.00	56	100.00	3	100.00	

Table 8: Correlation Between Fetal Distress and Mean UV Flow Rate

Fetal Distress	UV Flow Rate (ml/min)	
	Mean	SD
Present	181.77	34.62
Absent	220.58	23.84
p-value	0.001	

Table 9: Correlation Between Fetal Distress and Mean Corrected UV Flow Rate

Fetal Distress	Corrected UV Flow Rate (ml/min/kg)	
	Mean	SD
Present	68.56	9.79
Absent	74.87	8.71
p-value	0.001	

Discussion

The results from this study demonstrate that assessment of the umbilical venous flow, in appropriately grown term infants from low risk pregnancies before active labor, can predict the diagnosis of intrapartum fetal compromise and the need for operative delivery with good reliability. Currently, multi vessel Doppler assessment of fetal well-being is considered valuable only in cases of fetal growth restriction. Our data suggests that assessment of the umbilical venous flow rate can also be of value in the apparently normally grown fetus at term. Although the risk of intrapartum fetal compromise being diagnosed is highest in infants with the lowest umbilical venous flow rate, a high umbilical venous flow rate appears to suggest better fetal tolerance to the stresses of labor, with a reduced incidence of abnormal fetal heart rate patterns necessitating emergency delivery. No infants in our study with UV flow rate>250ml/min had fetal distres (NPV 100%). The mean umbillical venous flow rate in the study was 211.96 ± 30.98 ml/min whereas the mean of the corrected umbillical venous flow rate was 73.46 ± 9 ml/min/kg.Our results were similar that of Prior T et al 2014)[4] .Various studies have examined corrected UV flow rate at differing gestations,but few have examined UV flow rates in appropiately grown fetuses at term. Our study results were similar to the study done by Prior T et al 2014)[4] Similar results were also obtained in a study done by Tchirikov M et al (2009)[5] to predict fetal outcome by venous arterial index. Our results, however, suggest that fetuses with low UV flow rate have a significantly increased risk of being diagnosed with fetal compromise during labor. Similar results were obtained in study done Prior T et al 2014)[4] Tchirikov M et al (2009)[5] also observed that the reduction in UV flow rates was associated with poor fetal outcome.

Conclusion

UV flow studies could be used as a complimentary tool to the routine umbilical artery Doppler studies to increase the sensitivity to predict poor neonatal outcome like Fetal Distress.

There was a statistically significant difference in the occurrence of Fetal Distress with respect to decreased UV flow rate.Fetuses with the low umbilical venous flow rates are at increased risk of a subsequent diagnosis of intrapartum fetal compromise.

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