Colour Doppler Studies of Fetal Vessels in High Risk Pregnancies

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Summary

In a prospective study, 188 high risk pregnancies were investigated between 20-42 gestational weeks using Doppler sonography. A pulsed Doppler machine was used to record the flow velocity waveforms in the umbilical artery (UA), middle cerebral artery (MCA), decending thoracic aorta (DTA) and uterine artery. The pulsatility index (PI), resistance indices (RI) and the ratio of peak systolic (S) and end diastolic (D) frequencies of the vessels were calculated. A total of 110 pregnancies were normal with no abnormal doppler wave forms. Of the 78 (41%) pregnancies which made up the risk group, total number of abnormalities of vessels were 96, among them 45 were showing brain sparing effect in middle cerebral artery, 18 were showing absence of end diastolic flow in descending thoracic aorta 16 were having high resistance flow in uterine artery and 17 were associated with high resistance flow in umbilical artery.

Introduction

Pulsed Doppler sonography is useful for detection and evaluation of intrauterine growth-retardation (IUGR) and other high risk pregnancy complications. It does correlate well with fetal compromise, often giving earlier warning of fetal distress than other tests (Schluman, 1989; Jouppila & Kirkinen, 1984; Trudinger et al 1986). Doppler ultrasonography of the umbilical arteries is a simple, non invasive procedure. In the antenatal period, the absence of end-diastolic frequencies is correlated with fetal acidosis and hypoxia (Nicolaides et al 1988). Doppler sonography examination of fetal placental circulation can identify increased placental vascular resistance by a decrease of end diastolic blood flow velocities in the umbilical artery. This occurs during placental insufficiency and can lead to fetal jeopardy. In case of IUGR Wladimiroff et al (1986) have described compensatory reduction in vascular resistance in fetal brain during fetal hypoxemia usually reffered to as the brain sparing effect and thus offer another Doppler – based marker for IUGR.

Detection of elevated resistance to flow within fetal descending aorta reflects the increased vascular resistance associated with high risk pregnancy not only within the placental vascular bed but also within fetal abdominal viscera (Longe et al, 1986).

Fetal renal arterial flow is considerably easier to investigate by using the colour map as a guide (Carter 1990; Maeda & Takeuchi, 1990). Studies have revealed elevated resistance in fetal renal arteries in growth retardation especially when accompanied by oligohydramnios (Arduini & Rizzo 1990).

Finally, increased resistance in uterine artery as indicated by an elevated index of resistance by persistance of an early diastolic notch often precedes the onset of growth retardation (Hershey et al 1986;

Jacobson et al, 1990).

Aims and Objectives

1. The objective was to identify early, quickly and accurately, both normal and high-risk fetuses, by changes in flow velocity waveforms.
2. Fetal survillance to predict hypoxemia and acidemia.
3. To assess the physiology and pathophysiology of fetal and maternal circulation.

Materials and Methods

Patients

A total of 188 high risk pregnant patients were examined prospectively by pulsed Doppler sonography from 20 to 42 gestational weeks. Indications for referal and hospitalization were :

- Previous history of risk pregnancy and for social risks.
- Diabetes.
- Suspected SGA (small for gestational age)
- Antepartum hemmorhage.
- Pregnancy – induced hypertension.
- Others

Doppler Studies

The Doppler sonographic examinations were made with a pulsed duplex doppler machine (Medison 7700 SA & 530 D) using a 100 Hz high pass filter. We routinely recorded maximal systolics (S) and end diastolic (D) frequencies for calculating S/D ratios and resistance indices (RI) and the mean maximum frequencies for calculating the pulsatility index (PI). Uniform flow velocity waveforms were recorded for the umbilical artery, uterine artery, middle cerebral artery and descending thoracic aorta with the fetus in a study state (excluding breathing movements) and with a fetal heart rate between 120 and 160 beats/min. Doppler imaging was used at 24 wks. Gestation to examine uterine arteries in women with initial abnormal results (high resistance index (RI) or diastolic notch). The uterine artery was visualised at the cervicocorporeal junction outside the uterus. The same volume was positioned over the middle cerebral artery (MCA) near to the point where the internal carotid artery separates into the anterior cerebral artery and the MCA.

Observations & Results

The analysis of the findings is shown in Table I. Fig. 1 shows incidence of isolated and combined fetal vessel abnormalities while Photographs (1 to 4) show fetal vessel abnormalities in different cases.

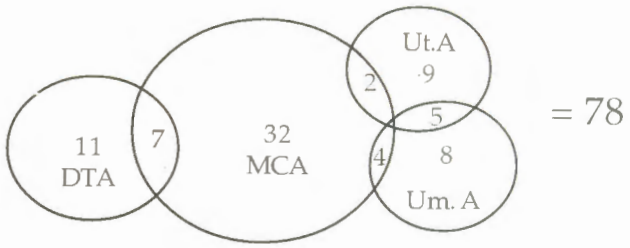
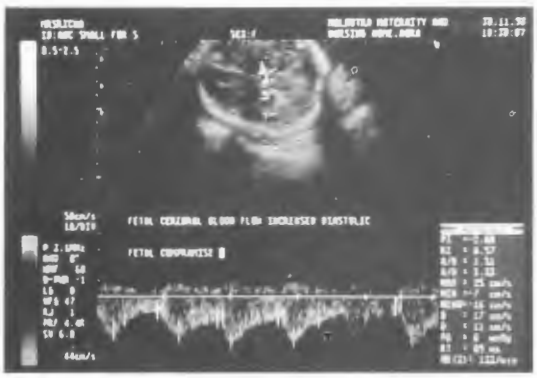


Fig-1: Diagram showing isolated and combined fetal vessel abnormality.

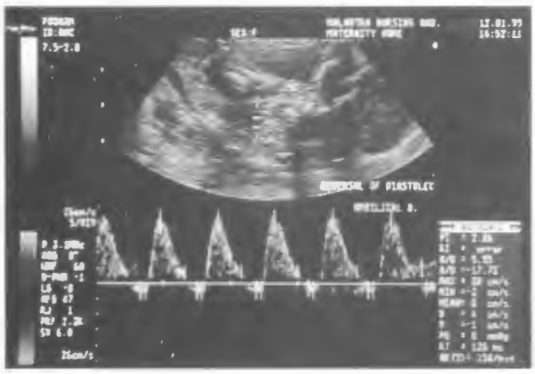
Photograph I.: Color Doppler of a patient under study showing AEDF in fetal aorta at 30 wks.

Table I: Findings

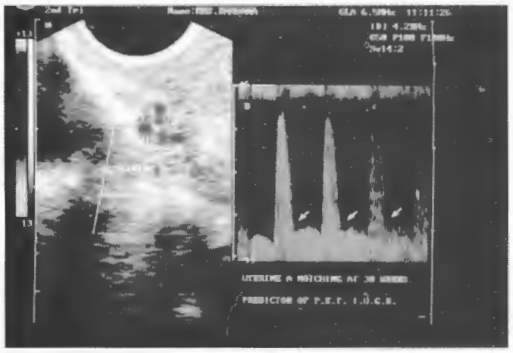
Fetal Vessel Pathology	Total Cases Studied	Abnormalities Detected		
		Isolated	Combined	Total
1. Brain Sparing effect in MCA.	188	32 (17%)	13 (6.9%)	45 (23.9%)
2. Absence of End diastolic flow (AEDF) in DTA	188	11 (5.8%)	7 (3.7%)	18 (9.5%)
3. High resistance in uterine artery	188	9 (4.8%)	7 (3.7%)	16 (8.5%)
4. High resistance flow in umbilical artery.	188	8 (4.3%)	9 (4.8%)	17 (9%)



Photograph 2.: Color Doppler of a patient under study showing Brain sparing effect in MCA



Photograph 3.: Color Doppler of a patient under study showing high resistance flow in umbilical artery.



Photograph 4.: Color Doppler of a patient showing diastolic notch of uterine artery at 30 weeks.

The results were as follows :-

1. Among 188 high risk pregnancies colour doppler abnormalities were present in 78 (41%) cases.
2. Most common early abnormality of this study was brain sparing effect in MCA. Total 45 (23.9%) cases were having brain sparing effect in MCA, out of this 13 were associated with other fetal vesseles abnormality.
3. AEDF in DTA was present in 18(9.5%) cases, 11 (5.8%) were having isolated abnormality, 7 were having other fetal vesseles abnormality.
4. Uterine artery showed high resistance in 16(8.5%) cases, out of which 2 were associated with brain sparing effect in MCA and 5 were in association with high resistance in umbilical artery.
5. Umbilical artery showed high resistance blood flow in 17(9%) cases. Out of which 4 were associated with brain sparing effect in MCA and 5 were associated with high resistance in uterine artery.
6. Total number of isolated & combined abnormalities were 96 among 78 cases, 18 cases showing abnormality in two vessels.

Discussion

Hemodynamic etiologic factors can be studied in vivo and non invasively by colour and pulsed doppler ultrasonography. Its potential seems very promising and gives possibility of in vivo physiologic study to predict the onset of fetal acidosis and this can lead to significant decrease of intrauterine mortality in IUGR fetuses. Infact we identify the small fetuses who are not compromised (specificity : 46% fetal biometry, 83% fetal biometry and Doppler).

The linear relationship between the PI value for the umbilical artery and the quadratic relationship between the PI value for the MCA and gestational age are consistent with the results obtained for normal group by other authors (Wladimiroff et al 1988, Vanden et al 1989 & Vyas et al 1990). But in high risk pregnancies like PIH, placental insufficiency and IUGR, MCA is particularly sensitive to fetal hypoxia, and flow of blood to the fetal brain increases as its oxygen content falls in order to ensure the sufficiency of the oxygen supply to vital system (Peeters, 1979). In such cases, Doppler velocimetry findings comprise the increase of mean blood velocity and the decrease of the pulsatility index (PI) in the MCA, while an increase of PI and a decrease of mean blood velocity occur in umbilical artery; C/U index, the ratio between PI of MCA and PI of umbilical artery is decreased (<1) in presence of severe hypoxia. In these cases growth retardation is primarily of placental origin menifesting itself in high value from the umbilical artery. In conclusion, we suppose that MCA responses to initial hypoxia and is initially showing cortical sparing effect which precedes the so called brain sparing effect.

Each part of the maternal circulation can be located by colour Doppler and measured by pulse Doppler ultrasonography. The resistance to uterine blood flow increased as gestation continued. Both measured parameters RI & PI progressively increased in uterine artery during pregnancy in high risk cases. We also observed the same vessels in molar pregnancy, threatened abortion and pregnancy associated with

myoma. Long et al (1990) noticed that PI were significantly lower in the patients with trophoblastic diseases when compared with the non-pregnant and pregnant groups.

Jaffe and Warsof (1992) studied uteroplacental blood flow in abnormal early pregnancy. Circulation abnormalities probably play a significant role in early pregnancy failures and they believe that color Doppler ultrasonography will help define the different etiologic mechanisms causing these early complications.

Conclusion

1. Intrauterine risk appropriate for gestational age fetuses can best be identified by the PI of the middle cerebral artery. The value of the PI in umbilical artery is generally not helpful.
2. In small for gestational age fetuses. PI value in the umbilical artery can discriminate between a case of chronic placental insufficiency and normal placental function.
3. The PI ratio of MCA: UA is valuable for monitoring growth retarded and small for gestational age fetuses particularly those whose umbilical artery PI is high providing early indication of fetal jeopardy.

References

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