ORIGINAL ARTICLE

# Doppler Flow Studies in Middle Cerebral and Umblical Arteries in Growth Retarded and Normal Pregnancies

Sunesh Kumar, Subodh Datta, Suneeta Mittal, K.K. Roy

**Abstract**

Randomized controlled trial, designed to assess whether any benefits are derived from the study of doppler velocimetry in two fetal vessels (umblical artery and middle cerebral artery) was undertaken in All India Institute of Medical Sciences, New Delhi, India. Twenty five pregnant women with intrauterine fetal growth retardation served as study subjects, while 25 pregnant women with normal fetal growth but matching for gestational age and without any risk factor for intrauterine growth retardation were enrolled controls. All the women in two groups underwent fetal biometry, amniotic fluid index estimation and doppler flow studies in middle cerebral and umblical arteries at weekly interval till the time of child birth. In addition women in study group underwent intensive fetal monitoring (daily kick count, nonstress test, biophysical profile). In no case decision to terminate pregnancy was based upon doppler results. In the study group and the controls age and parity were matching. Majority of women were primigrvida in both the groups. Mild pregnancy induced hypertension was the commonest underlying factor in study group. Six cases were enrolled in the study before 34 weeks, rest after 34 weeks. Results of last color doppler flow studies in middle cerebral and umblical arteries (S/D ratio RI and PI) were not significantly different in the study group and the controls. There were five caesarean sections in the study group and one in control group for fetal bradycardia during labour. Only two neonates in study group had low apgar score at one minute. Ratios of S/D values, RI and PI values in middle cerebral and umblical arteries did not differ significantly among study group subjects and the controls. In view of small size of study, no definite conclusion can be derived.

**Key words**

Doppler studies, Middle cerebral artery, Umblical artery, Intrauterine growth retardation.

## Introduction

In the last fifteen years a number of studies have appeared in literature highlighting the role of doppler flow studies for the diagnosis and management of pregnancies associated with fetal growth retardation. However, there is a lack of unanimity among medical fraternity regarding role of doppler flow studies in monitoring growth retarded pregnancies. In a summary of various published controlled trials Maulik (1) reported that benefits were highlighted in six trials and no obvious benefits were noted in two such studies.

Most centres manage cases of proven intrauterine fetal growth retardation by intensive fetal monitoring using fetal kick count, nonstress testing and biophysical profile. However, a number of centres around the world include doppler flow studies in fetal vessels as an additional parameter. Change in doppler velocimetry in these pregnancies may precede abnormalities in fetal heart rate patterns(2). However, there is a lack of consensus regarding the use of Doppler flow studies in decision making in the management of such cases. Most clinical investigators suggest usefulness of umblical artery doppler velocimetry in predicting perinatal problems in these cases (1).

**From the Department of Obstetrics and Gynaecology, All India Institute of Medical Sciences, New Delhi, India.**
**Correspondence to :** Dr. Sunesh Kumar, Additional Professor, Department of Obstetrics and Gynaecology, AIIMS, New Delhi, India.

Whereas most studies have focused on umblical artery doppler velocimetry (2-4), recently attention is being directed towards middle cerebral and other intracranial arteries in the management of high risk pregnancies (5-10). Importance of ratio of doppler velocimetry parameters in middle cerebral and umblical arteries in predicting adverse fetal outcome in high risk pregnancies have been highlighted (1,10).

Present study was carried out with the objective of testing usefulness of doppler flow velocimetry in middle cerebral and umblical arteries and their ratios in predicting abnormal outcome in cases of intrauterine growth retardation.

**Material and Methods**

Twenty five women who were regularly attending antenatal clinic at AIIMS Hospital and were found to have intrauterine growth retardation based upon clinical criteria of fundal height four weeks less then expected for duration of pregnancy and subsequently confirmed on the basis of ultrasonic fetal biometry (Abdominal circumference and Femur length: abdominal circumferences ratio) were enrolled as study subjects. An equal number of women with normal fetal growth and no high risk factor for fetal growth retardation but matching for gestational age and parity were enrolled as controls. All the subjects in the study group and control group underwent color doppler flow studies in middle cerebral and umblical arteries. Peak systolic and enddiastolic values were obtained on a pulse wave duplex ultrasound machine (Sonoline-Versa) using a 50 hz filter. Ultrasound for fetal biometry; amniotic fluid index and color doppler flow studies in middle cerebral and umblical arteries were repeated every week till the time of delivery.

Subjects with intrauterine growth retardation underwent intensive fetal monitoring in the form of fetal kick count, non stress testing twice a week and biophysical profile weekly. In no case decision to terminate pregnancy was based upon findings of color dopper flow studies.

During labor, electronic fetal heart rate monitoring with external transducer on a fetal monitor (Corometric Fetal Monitor-116) was carried out. All babies were attended at birth by neonatologists. Apgar score at one, five and ten minutes was recorded in addition to birth weight. All neonates in two groups were followed up till the time of discharge from the hospital.

**Results**

Twenty five pregnant women with intrauterine growth retardation (study group) and twenty five women with normal fetal growth (control group) but matching for gestational age and parity were included in the study.

In the study group five women (20%) had mild pregnancy induced hypertension. Two had rheumatic heart disease, chronic hypertension with superimposed PIH in two cases were other associated complications. In the control group none of the women had any associated complication likely to cause fetal growth retardation.

Intrauterine growth retardation was detected before 34 weeks in 6, between 34-38 weeks in 15 and between 39-40 weeks in 4 study group subjects. Color doppler flow studies were carried out on one occasion in 9 study group subjects and 14 control group subjects, remaining women had more than one color doppler studies. Weekly doppler flow studies did not show any particular trends in the two groups, therefore, results of last color doppler study, have been co-related with the fetal outcome.

Table I-highlights the comparative differences between two group of patients. Mean birth weight was 2230gm

**Table 1. Comparison between study group and controls with respect to birth weight, caesarean section rate and perinatal outcome.**

| | Study group (n=25) | Control group (n=25) | P |
|---|---|---|---|
| 1. Birth weight(gm) | (Mean +SD) 2230±0.3739 | 2950±0.2817 | 0.0001 (t=7.7) |
| 2. Caesarean Section (n)(%) | 10(40%) | 5(20%) | |
| 3. Caesarean Section for Intrapartum fetal bradycardia n(%) | 5(20%) | 1(4%) | |
| 4. Perinatal deaths | Nil | Nil | |
| 5. Low Apgar Score(<7) | | | |
| One minute | 2 | Nil | |
| Five minute | 1 | Nil | |
| Ten minute | Nil | Nil | |

for the study group babies and 2950gm for control group babies. This difference in birth weight was highly significant. There were 5 caesarean sections for fetal bradycardia during labour among study group and one for similar indication in control group patients. Indications for caesarean section in remaining study group cases

included 3 for breech, 2 for severe uncontrolled hypertension. Among control group caesarean section was done for breech presentation in two cases, for meconium stained liquor in one and one as elective caesarean with incisional hernia repair. At birth only two babies in the study group had low apgar score (<7), remaining babies in both the groups had normal apgar score. Apgar score in these two babies was 6,8,9 and 3,6,8 at one, five and 10 minutes respectively.

**Doppler Velocimetry data in Middle Cerebral artery**

Middle cerebral artery velocimetry indices (S/D ratio, RI and PI) in relation to mean birth weight in two groups of patients is shown in Table II. No significant difference in the distribution of study subjects and controls was noted when S/D ratio, RI and PI in middle cerebral artery when compared with fetal outcome. Six patients in both the groups had S/D ratio between 2-3, twelve cases in the study group and eight in control group had S/D ratio between 3-4. Four cases in study group and seven in control group had S/D value between 4-5. Three cases in the study group and four cases in the control group had S/D value more than 5. None of these differences were significant.

**Table II. Doppler flow indices in middle cerebral artery and fetal outcome.**

| Indices | Study Group n=25 n | Mean birth wt. (Kg.) | Control Group n=25 n | Mean birth wt. (Kg.) |
|---|---|---|---|---|
| S/D Ratio | | | | |
| 2-3 | 6 •+ | 1.98 | 6 | 2.94 |
| >3-4 | 12 | 2.26 | 8 | 3.03 |
| >4-5 | 4 | 2.35 | 7 | 2.96 |
| >5 | 3 | 2.45 | 4 | 2.79 |
| Resistance Index (RI) | | | | |
| 0.5-0.7 | 10 •+ | 2.14 | 9 | 2.94 |
| >0.7-0.9 | 15 | 2.29 | 16 | 2.95 |
| Pulsality Index(PI) | | | | |
| 0.5-1.0 | 6 •+ | 1.99 | 6 | 2.94 |
| >1.0-1.5 | 19 | 2.30 | 17 | 2.98 |
| >1.5-2.0 | Nil | -- | 2 | 2.70 |

• Apgar score 6,8,9 at 1,5,10 minute
+ Apgar score 3,6,8 at 1,5,10 minute

Resistance index in middle cerebral vessel was between 0.5-0.7 in 10 study group subjects and nine control group subjects. Resistance index(RI) value was >0.7-0.9 in 15 study group and 16 control group subjects. Pulsality index(PI) values were between 0.5-1.0 in six study group and an equal number of control group subjects. PI value in the middle cerebral artery was between >1.0-1.5 in nineteen study group and seventeen control group subjects. PI value was more than 1.5 in two control group subjects only.

**Doppler Velocimetry data in Umblical artery**

Doppler flow indices in umblical artery in relation to fetal outcome are shown in Table-III, doppler flow velocimetry S/D ratio, Resistance index and Pulsality index did not show any significant difference in distribution of patients in various subgroups.S/D ratio was less than 2 in two study group subjects only. S/D ratio was between 2-3 in thirteen study group and eighteen control group subjects. S/D ratio was >3-4.0 in six study group and an equal number of control group subjects. S/D ratio was >4-5.0 in one control group subject only. S/D ratio was more than 5 in four study group subjects only. None of these differences were significant statistically.

Resistance Index (RI) value in umblical artery was less than 0.5 in two study group subjects, none of the control group subjects had this value less than 0.5. RI value was between 0.5-0.7 in seventeen study group and twenty one control group subjects. Six study group and four control group subjects had RI value in the >0.7-0.9 range. These difference were not statistically significant.

Pulsality Index (PI) value was between 0.5-1.0 in fifteen study group and eighteen control group subjects. PI value

**Table III. Doppler flow indices in umblical artery and fetal outcome.**

| Indices | Study Group n=25 n | Mean birth wt. (Kg.) | Control Group n=25 n | Mean birth wt. (Kg.) |
|---|---|---|---|---|
| S/D Ratio | | | | |
| <2 | 2 •+ | 1.81 | Nil | -- |
| >2-3 | 13 | 2.30 | 18 | 2.92 |
| >3-4 | 6 | 2.30 | 6 | 2.95 |
| >4.5 | Nil | -- | 1 | 2.59 |
| >5 | 4 | 2.11 | Nil | -- |
| Resistance Index (RI) | | | | |
| <0.5 | 2 •+ | 1.81 | Nil | -- |
| >0.5-0.7 | 17 | 2.30 | 21 | 2.94 |
| >0.7-0.9 | 6 | 2.15 | 4 | 3.0 |
| Pulsality Index(PI) | | | | |
| 0.5-1.0 | 15 •+ | 2.23 | 18 | 2.92 |
| >1.0-1.5 | 10 | 2.22 | 7 | 3.04 |

• Apgar score 6,8,9 at 1,5,10 minute
+ Apgar score 3,6,8 at 1,5,10 minute

was >1.0-1.5 group in ten study group and seven control group subjects. These differences were not found to be significant statistically.

**Ratio of Doppler Velocimetry Values in Middle Cerebral and Umblical Artery**

Ratio of various flow indices (S/D Ratio, RI and PI) in middle cerebral and umblical arteries were calculated. Ratio of S/D ratio in two vessels was labelled as Ratio-I, ratio of RI values in middle cerebral and umblical artery as Ratio-II and ratio of PI values in middle cerebral and umblical artery as Ratio-III. These ratios were correlated with fetal outcome in study group and controls. (Table-IV).

**Table IV. Fetal outcome in relation to ratio of doppler flow indices in middle cerebral and umblical arteries.**

| Ratio | Study Group n=25 n | Mean birth wt. (Kg.) | Control Group n=25 n | Mean birth wt. (Kg.) | P |
|---|---|---|---|---|---|
| Ratio I (S/D Middle Cerebral Artery/Umblical Artery) | | | | | |
| <1 | 7 | 2.12 •+ | 4 | 3.13 | 0.495 |
| >1-2 | 17 | 2.25 | 17 | 2.95 | |
| >2-3 | 1 | 2.57 | 3 | 2.85 | |
| >3-4 | Nil | -- | 1 | 2.80 | |
| Ratio II (RI in Middle Cerebral Artery/Umblical Artery) | | | | | |
| 0.5-1.0 | 8 | 2.12 •+ | 4 | 3.06 | 0.321 |
| >1.0-1.5 | 17 | 2.26 | 21 | 2.78 | 0.321 |
| Ratio III (PI in Middle Cerebral Artery/Umblical Artery) | | | | | |
| 0.5-1.0 | 8 | 2.20 •+ | 4 | 3.06 | 0.321 |
| >1.0-1.5 | 16 | 2.22 | 16 | 2.97 | |
| >1.5-2.0 | 1 | 2.75 | 5 | 3.17 | |

• Apgar score 6,8,9 at 1,5,10 minute
+ Apgar score 3,6,8 at 1,5,10 minute

Ratio of S/D values in middle cerebral artery and umblical artery was less than one in seven study group and four control group subjects. Ratio of S/D values was >1-2 in seventeen study group and an equal number of control group subjects. This ratio was >2-3 in one study group subject only whereas ratio was >3-4 in one control group subject only. None of the differences being significant.

Ratio of resistance index(RI) in middle cerebral artery and umblical artery was between 0.5-1.0 in eight study group and four control group subjects. This ratio was >1.0-1.5 in seventeen study group and twenty one control group subjects. These differences in number of cases were not significant.Ratio of pulsality index(PI) in middle cerebral artery and umblical artery was between 0.5-1.0 in eight study group subjects and four control group subjects. This ratio was >1.0-1.5 in sixteen study group and an equal number of control group subjects. Ratio was >1.5-2.0 in one study group subject and five control group subjects. These differences were not found to significant statistically.

**Discussion**

A number of randomized clinical trials have appeared in the literature in last one decade highlighting role of doppler flow studies in predicting perinatal outcome. Till 1995 eight such trials were reported, all evaluating umblical artery velocimetry, few used uterine velocimetry in addition (1).

Trudinger et al 1987(3) were first to report results of a randomized clinical trial on umblical artery doppler velocimetry. In a study of 127 study subjects and 162 controls authors noted a reduction in intrapartum distress and emergency caesarean section rate in the study group. Reanalysis of same data by oxford perinatal data group, however, showed no improvement in using odd ratio approach. In a study of 500 pregnant woman (250 study group; 250 controls) where a randomisation of routine versus highly selected use of doppler ultrasound and biophysical profile was done, authors found a statistically significant decrease in low 5 minute Apgar score and serious neonatal disease in the study group (11).

In a summary of eight peer reviewed controlled trials comprising of 9002 subjects it was found that six of these studies involving a population of 6022 showed a significant benefit from the use of doppler as a fetal monitoring tool (1). In remaining two studies with a population of 2,980 no significant improvement in fetal outcome was noted.

In a metanalysis of 12 studies, published in the electronic publication of Cochrane Database of Systematic Reviews, a significant reduction in the perinatal deaths of normally formed fetuses consequent to the use of umblical arterial doppler surveillance was reported (12).

Fewer reports have appeared in literature highlighting role of cerebral umblical doppler ratio as a predictor of adverse perinatal outcome. In one of the study, 45 normal growth and 45 growth retarded fetuses between 30-41 weeks, it was observed that cerebro-umblical ratio of 1.08

was used as a single cut off value. They found diagnostic accuracy of 90% for cerebro-umblical ratio of 1.08 was used as a single cut off value (10). They found diagnostic accuracy of 90% for cerebro-umblical ratio as compared with 78.8% for middle cerebral artery, and 83.3% for umblical artery doppler velocimetry in predicting adverse perinatal outcome.

Pulsality index in fetal internal carotid and umblical arteries in 156 normal and 42 growth retarded pregnancies was also observed in one study (13). All pregnancies were in the third trimester. In normal pregnancies there was a gestational age related fall in pulsality index for umblical artery as well as umblical artery/internal carotid artery ratio, however, there was no such fall for internal carotid artery. In growth retarded pregnancies raised PI values in umblical artery were associated with reduced PI values in internal carotid arteries, they labelled this finding as 'Brain sparing effect'. However, growth retarded fetuses with structural or chromosomal defects had normal PI values in the internal carotid artery.

Pulsality index in umblical artery, descending aorta and internal carotid artery in 75 high risk pregnancies between 26-28 weeks gestation have been studied (14). Those fetuses which later developed growth retardation (n=23) had higher PI in umblical artery and descending aorta and lower PI in internal carotid artery than normally grown fetuses. The ratio between PI of umblical and carotid arteries was reported to be a good predictor of growth retardation by the authors. It has been suggested that cerebroplacental ratio of 1.0 in which cerebral RI is numerator and umblical arterial RI is denominator as a cut off value (1). A ratio of less than 1 is considered indicative of disease or abnormality.

In present study of 25 growth retarded and 25 normally grown fetuses using various ratios, ratio of S/D values, ratios of RI and ratio of PI in middle cerebral and umblical arteries, no significant difference was found in the distribution of growth retarded and normally grown fetuses in various groups based upon ratios.

In view of small size of present study no definite conclusions can be derived, however, middle cerebral artery, umblical artery doppler velocimetry data and cerebral: umblical doppler ratios were not significantly different in growth retarded and normal pregnancies.

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