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DOPPLER INDICES IN FETOPLACENTAL AND UTEROPLACENTAL CIRCULATION AT 22 WEEKS OF GESTATION

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ABSTRACT

Background: Doppler has revolutionized the field of obstetrics since its introduction in late 1950's. Useful information is obtained during second half of pregnancy and pregnancies with high resistance can be determined.

Subjects and Methods: A total number of 100 patients were studied in Combined Military Hospital, Rawalpindi from 01 June 2002 to 25 January 2003. Normal pregnant women with 20 weeks of gestation, from all socioeconomic strata and singleton pregnancy were included in the study. Doppler examination was performed and the range of normal indices determined from all the four vessels.

Results: Descriptive statistical analysis of data was carried out. For umbilical artery mean PI was 1.48 (range = 0.92-1.91) RI was 0.78 (range = 0.64-0.84) S/D ratio was 4.68 (range = 3.84-5.6) For uterine artery mean PI was 1.18 (range = 0.69-1.86) RI was 0.54 (range = 0.44-0.66) and S/D ratio was 2.18 (range = 1.92-2.36) for fetal aorta mean PI was 1.94 (range = 1.54-2.42) RI was 0.80 (range = 0.68-0.88) S/D ratio was 6.22 (range = 3.18-6.94). For MCH PI was 1.86 (range = 1.44-2.30) RI was 0.84 (range = 0.72-0.88) S/D ratio was 5.64 (range = 3.22-7.1).

Conclusion: The determined range of Doppler indices in our study varies as compared to international data. This variation equipment used difference in time of gestation and site of vessel under study.

Keywords: Doppler, flow velocity waveform, systolic/diastolic ratio, intrauterine growth retardation

INTRODUCTION

Vascular structures have long been used as anatomical landmarks during sonography. Arteries normally have forward and backward flow. Abnormal flow is represented by an increased, decreased, or absent flow components during the cardiac cycle [1].

In 1842, Christian Johann Doppler described the Doppler equation (d=2V(cost0)f/c where d is the Doppler shift frequency. V is the speed of moving blood. 0 is the angle between ultrasound beam and f is the direction of movement of blood is the transmitted ultrasound frequency, and c is the speed of ultrasound (1540 m/s). Doppler has revolutionized the field of obstetrics since its introduction in late 1950's [2]. Blood flow velocity in the fetal circulating system depends on type of vessel. The arteries always have a pulstile pattern, where as veins have either a pulsatile or continuous pattern [3]. Gosling proposed Pulstality Index (P.1) (Pl=peak systole- end diastole/mean peak

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value) [3] in 1971 and A/B ratio in 1976. Resistive Index (R.I) (RI=peak systole –end diastole / peak systole) was devised for the first time in 1973 [4]. It is independent of factors like beam/ vessel angle and only requires measurement of two precisely defined points [5]. S/D (S/D ratio = peak systole/end diastole) ratio is a variation of resistive index (R.1) [6]. The first Doppler ultrasound studies of fetus were conducted by Fitz Gerald and Drumm in 1977 [7]. The first non-invasive measurement in human fetal aorta using a manually switched duplex scanning system was made by Eik Nes in 1980 [8].

Useful information is obtained during the second half of pregnancy. The blood vessels commonly interrogated include umbilical artery, uterine artery, fetal aorta and fetal middle cerebral artery. Maternal artery studies identify pregnancies with high placental resistance, and fetal circulation studies allow us to study the response of the fetus to a deficient supply from placenta [9]. The reduction in oxygen delivery means that the fetus must redistribute its blood flow in order to maintain constant oxygen supply to the brain. These changes may be manifested as a decrease in diastolic velocity in the abdominal aorta and normal or increased diastolic velocities in the middle cerebral arteries. The identification of these waveform patterns can predict the presence of the brain sparing effect.

Power Doppler is a new ultrasound technique which is five times more sensitive as compared to color Doppler. Blood flow in individual blood vessels is, most commonly evaluated by duplex Doppler [I0]. Reversed diastolic flow in the umbilical artery or fetal aorta is an ominous finding, associated with a very high mortality rate within I to 7 days if the fetus is left in utero [11]. Absent diastolic flow suggests a poor prognosis as well, but outcome in these fetuses is not as uniformly bad as in those with reversed flow [12].

The study was undertaken to determine the range of Doppler indices in the umbilical artery, uterine artery, fetal aorta and fetal middle cerebral artery in clinically normal pregnancies managed at Combined Military Hospital Rawalpindi.

SUBJECTS AND METHODS

a. Setting

The study was carried out at Combined Military Hospital (CMH) Rawalpindi. It is the largest referral hospital for armed forces personnel and their families.

b. Equipment

CMH radiology department is equipped with color Doppler ultrasonography machine LOGIC 500 by General Electronics Medical Systems having multiple probes (including 3.5 MHz, 5 MHz and 7.5 MHz) of linear and convex shapes and is capable of performing the Power Doppler, Color Doppler and Pulse Doppler studies.

c. Study Design

It was non interventional descriptive study in nature.

d. Sampling

A total of 100 patients were selected fur study which fulfill the inclusion criteria.

e. Patient's Selection Criteria

Normal pregnant woman with 22 weeks gestational age from all socioeconomic strata and having singleton pregnancy were included in the study, while the patients having bad obstetric history, pregnancy related complications, chronic maternal diseases and multiple pregnancy were not considered for study. Smokers and patient having posterior placenta were also excluded.

f. Procedure

Before start of study, procedure was explained to patient and informed consent was taken. Just before start of study patient

Table-1: Range of doppler indices in umbilical, uterine, middle cerebral artery and fetal aorta (n=100).

Range of Indices	Umbilical A	Uterine A	Fetal Aorta	MCA
P.I	0.92 – 1.91	0.69 – 1.86	1.54 – 2.42	1.44 – 2.30
R.I	0.64 – 0.84	0.44 - .0.66	0.68 – 0.88	0.72 – 0.88
S/D Ratio	3.84 – 5.60	1.92 – 2.36	3.18 – 6.94	3.22 – 7.1

Table-2: Mean of doppler indices in umbilical, uterine, middle cerebral artery and fetal aorta (n=100).

Mean of Indices	Umbilical A	Uterine A	Fetal Aorta	MCA
P.I	1.48	1.18	1.94	1.86
R.I	0.78	0.54	0.80	0.84
S/D Ratio	4.68	2.18	6.22	5.64

was asked to pass urine to ensure empty bladder and was advised not to move during Doppler examination which was carried out in supine position. During Doppler ultrasound, initially the blood vessels were recognized. Than various indices (P.I R.1, S/D ratio) were recorded. Sampling site for umbilical artery was mid cord level from a free floating loop of the umbilical cord, for uterine artery the retro placental bed [13], for descending thoracic aorta above diaphragm in lower thorax and in Sylvain fissure for middle cerebral artery. Three different screens were obtained and averaged.

g. Data Collection and Statistical Analysis

The collected data was entered into the computer upon the completion of each case in SPSS version 10. Descriptive statistics were used to calculate frequencies and means from the recorded data.

RESULTS

Doppler indices were taken in 100 selected cases at 22 weeks of gestation, which fulfill the required inclusion criteria. The "end – diastolic velocity" was present in all of our 100 cases. 39 patients had diastolic notch. The results of the indices are given in table-1 and table-2, fig.1, fig. 2 and fig.3.

DISCUSSION

Doppler wave form analysis has definite role in obstetrics especially in the diagnosis of placental insufficiency and in establishing prognosis [14]. Doppler velocimetry has

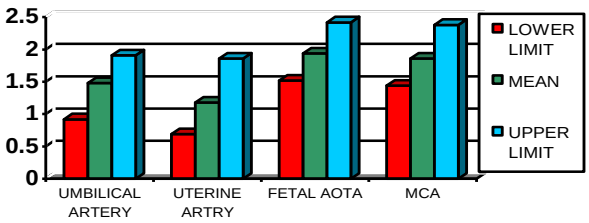

Fig.1: Range of P.I of umbilical, uterine, middle cerebral artery and fetal aorta (n=100).

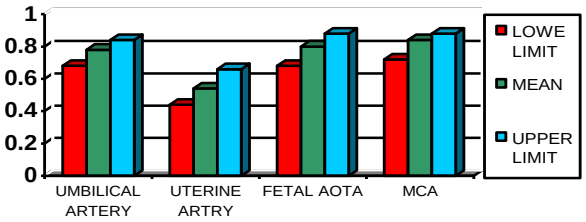

Fig.2: Range of R.I of umbilical uterine middle cerebral arterty and fetal aor ta (n=100).

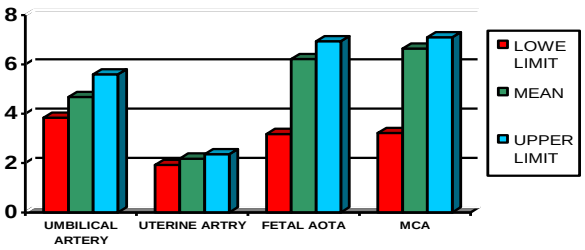

Fig.3: Range of S/D ratio of umbilical uterine middle cerebral arterty and fetal aorta (n=100).

improved our understanding of` the pathophysiological processes leading to IUGR and our possibilities of monitoring fetal health. It is an excellent method for differentiating between healthy and truly growth retarded Scan fetuses and it may help obstetricians to identify pregnancies that need special surveillance. Doppler is often giving

earlier warning of fetal distress than other tests. For this reason, all fetuses with suspected intrauterine growth restriction should undergo umbilical artery Dopplerevalution [15]. However it should be applied as a secondary diagnostic test in preselected groups of high- risk pregnancies by manual palpation and ultrasound. Persistent notehing of the uterine artery flow velocity Waveform appears to be a useful and sensitive indicator of' potential obstetrical problems as is measurement of resistive index [16]. It means that normal adaptation of Pregnancy has not occurred if the notch has not been lost by 24-26 weeks. In our study, only 39 patients had diastolic notch at 22 weeks. Rochelson et al. has shown that end diastolic velocity should be present at 20th week in umbilical artery [17]. In our study it was present in all the 100 normal patients at 22 weeks.

Wahid S et al. shows normal umbilical artery waveform pattern to establish the A/B ratio during the 2nd and 3rd trimester. It was concluded that the normal value of A/B ratio decreased From 20th week to 40th week with significant increase in diastolic flow [18]. At 22 weeks A/B ratio was 5.8 and it decreased to 4.6 at 24 weeks.

Davies et al [19] unlike our study in which patients were selected, examined both umbilical artery in 2475 pregnant women at 28 gestational weeks. PI was 1.2 + 0.5, RI was 0.67 + 0.1 and S/D ratio was 3 + 0.6.

Zimmermann P et al. assess uterine and uteroplacental circulation at 21- 24 weeks proved that Doppler was more efficient at predicting a complicated pregnancy in those patients who were at risk. Persistent notches in the main stem uterine arteries and elevated RI of > 0.68 in the uterine arteries and > 0.38 in the uteroplacental arteries were defined as abnormal waveform [20].

Erskine and Ritchie showed that A/B ratio decreases throughout pregnancy in the umbilical artery obtained at mid-cord level. Mean A/B ratio was 3.5 at 24 weeks, 2.8 at 32 weeks and 2.2 at 40 weeks [21].

Cameron et al. showed that normal systolic/diastolic ratio decreases with progress of pregnancy in second and third trimesters. At 22 weeks of gestation arcuate S/D ratio was 1.6, umbilical S/D ratio was 4 and aortic S/D ratio was 5.1 [22].

In conclusion we can say that the determined range of' Doppler indices in our study show variations as compared to international data. These might be due to different epidemiological variables, different equipment used, differences in time of the gestation, site of vessel under study and whether evaluation of' indices done by a single radiologist or not. Fetal breathing movements and heart rate also has influence upon indices.

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