ORIGINAL ARTICLE

The role of doppler ultrasound in high risk pregnancy: A comparative study

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ABSTRACT

Background: The objective was to determine the effectiveness of Doppler velocimetry results in the management of high-risk pregnancy. **Materials and Methods:** This cohort study was conducted from January 2005 to December 2006 in Obstetrics and Gynecology Department of Alnoor Specialist Hospital, Makkah, Saudi Arabia. A total of 200 high-risk pregnant women with gestational age >28 weeks were selected for the study and divided into group A (100) subjected to Doppler velocimetry and group B (100) without Doppler velocimetry. Standard management protocols were followed in all cases. The primary outcome measures were mode of delivery and gestational age at the time of delivery. The secondary outcome measures were prenatal and neonatal complications. Data were analyzed using SPSS version 16 (SPSS Inc., Chicago, IL, USA). **Results:** Preterm deliveries, preterm as well as full-term neonatal admissions were more frequent in group A than those in group B, i.e., (39% vs. 26%), (56% vs. 88%) (OR 0.2, 95% CI 0.04-0.7), and (30% vs. 57%) (OR 0.3, 95% CI 0.2-0.7), respectively. Similarly preterm and full-term neonatal deaths were rare in group A than those in group B, i.e., (9% vs. 78%) (OR 0.1, 95% CI 0.02-0.7), and (6% vs. 29%) (OR 0.2, 95% CI 0.03-1.8), respectively. Emergency caesarean section rate was rare in the subjects with normal Doppler than those with abnormal Doppler (48% vs. 100%) (OR 0.1, 95% CI 0.03-0.4) as well as in group B (48% vs. 82%) (OR 0.2, 95% CI 0.1-0.4). **Conclusion:** Doppler studies in high-risk pregnancies are more beneficial in the management of perinatal as well as neonatal management.

Key words: Caesarean section, color Doppler ultrasonography, pregnancy outcome, prematurity

INTRODUCTION

The significance of Doppler ultrasound in evaluating pregnancies that have the risk for preeclampsia, intrauterine growth restriction, fetal anaemia, and umbilical cord abnormalities has become indispensable. Recent findings aided in timing delivery of severely growth-restricted fetuses by promoting the use of ductus venosus Doppler. Primarily it appeared that abnormalities in ductus venosus waveform were the endpoint for pregnancies distressed with intrauterine growth restriction contrary to newer data proposing these abnormalities as plateau prior to further fetal deterioration as observed by changes in the biophysical profile.[1]

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The majority of adverse perinatal outcomes in developing countries are placental-associated diseases and it is confirmed that uterine Doppler evaluation predicts most occurrences of early-onset preeclampsia and intrauterine growth restriction, and its use in these pregnancies improves a number of perinatal outcomes. Doppler investigation of middle cerebral artery in combination with umbilical artery seems to improve prediction of adverse outcome in near-term pregnancies.[2]

It was postulated that Doppler ultrasound would be a useful addition to our catalog of tests of antenatal fetal well-being and timely intervention. On the basis of abnormal Doppler results, obstetrical decision making[3] might improve and prevent intrauterine death because hypoxic cerebral damage may begin before labor[4] and intrapartum asphyxia is probably more damaging when superimposed on underlying hypoxia. Doppler assessment may lead to intervention that reduces the risk of fetal brain damage. The hypothesis that Doppler is effective in reducing mortality and major morbidity in high-risk pregnancy could only be tested with a massive randomized trial.[5]

This study was designed to emphasize the effect of Doppler ultrasound on high-risk pregnancies in regard to obstetrical management as well as fetal, prenatal, and neonatal outcome.

MATERIALS AND METHODS

This prospective cohort study was conducted from January 2005 to December 2006. All women were recruited by a nonprobability purposive sampling technique from obstetrics unit of Alnoor Specialist Hospital, Makkah, Saudi Arabia, a 550 bedded tertiary care referral center with an average annual delivery rate of 2500. Power calculation of 80% suggested that a total sample of 100 women in each group was sufficient. The hospital serves a population from the middle and lower socioeconomic groups. Eligibility for enrolment was assessed on completion of ultrasound examination.

Females with viable singleton pregnancy with regular antenatal visits and gestational age 28 or more weeks were included. Moreover, females with high-risk pregnancy, e.g., with diabetes, cancer, high blood pressure, kidney disease, epilepsy, past history of three or more miscarriages, preterm delivery, preeclampsia or seizures, heart valve problems, asthma, and rheumatoid arthritis, were also included.

Pregnant women with multiple pregnancies, fetus with congenital abnormality, and smoking history of mother were not included.

Women were randomized by draw of instructions from numbered, opaque, sealed envelopes either to have Doppler ultrasound (group A) or not to have (group B). The subjects of group A were subjected to receive waveform studies at the time of first visit followed by subsequent examinations by Doppler studies.

Doppler flow velocity waveform studies were performed with a continuous wave system (Medasonics SP25A, Mountain View, CA and a D10 bidirectional Doppler). The subjects were supine with lateral tilt provided by a wedge under one hip. The ratio of peak systolic (S) to least diastolic (D) Doppler shift frequency was calculated from waveforms obtained from an umbilical artery and from a maternal utero-placental artery within the placental bed. These ratios were not adjusted to standard fetal or maternal heart rates. Results of the waveform studies were placed in the hospital records and reported both as numerical values and graphically on reference ranges prepared with data published.[6] The obstetrician in charge of each case was also informed about the result which was outside the reference range.

Gestational age was assessed using the last normal menstrual period if women sure of date and had regular cycle and also assessed by an ultrasound performed before 24 weeks gestation. If the dates differed from the ultrasound by more than 2 weeks, the ultrasound was used as the measure of gestational age. Low-dose aspirin therapy was not prescribed for any of the patients in this study. Antenatal fetal heart rate (FHR) monitoring recordings if any distress observed the subject was subjected for immediate delivery.

If the patient was randomized to group A and Doppler was normal, no intervention was done according to the protocol. The examination was repeated fortnightly according to gestational age. If the resistance index was abnormal indicating possible fetal problem, management was done accordingly by considering the standard hospital guidelines and protocols.

Group B which was Doppler not done for them must be managed according to high-risk clinical problems and our standard protocol. Sonar and fetal heart rate monitoring was available to all patients.

Data were analyzed using SPSS version 16 (SPSS Inc., Chicago, IL, USA). The data were subjected to descriptive analysis, i.e. number, percentage, means ± standard deviation. The chi-square test was applied to categorical variables. Student's *t*-test was applied to continuous data. Odds ratio (OR) with 95% confidence interval (CI) was applied to estimate the level of risk among the groups. Alpha level (α) of <0.05 was considered as significant.

The Institutional review board of Alnoor Specialist Hospital, Makkah, granted us permission to conduct this study and we declared that we have no financial or personal relationship(s) which may have inappropriately influenced us in writing this paper.

A written formal informed consent from all study participants was taken after they had been made aware of the study procedure.

RESULTS

Group B had a majority of subjects 27 (27%) with age <24 years while females of other age groups were more in group A, i.e. 43 (43%) in each. The mean age ± standard deviation (SD) of all subjects was 31.8±8.04 while no age difference was found between group A (33.2±6.8) and group B (30.5±8.9) (*P*-value 0.19). Multipara women 85 (85%) were insignificantly high in group A than in group B. Consanguinity was almost equal in both groups, i.e. group A 17 (17%) and group B 15 (15%) [Table 1].

Incidence of caesarean section, preterm deliveries, and labor induction was insignificantly high in group A than that in group B, i.e. (76% vs. 74%; *P*=0.87), (39% vs. 26%; *P*=0.12), and (15% vs. 9%; *P*=0.22), respectively. Only one placenta was found to be calcified in group A [Table 2].

The APGAR score <7 at first and fifth minutes was less frequent in group A than that in group B, i.e., (20% vs. 41%) (OR 0.4, 95% CI 0.2-0.7), and (3% vs. 13%) (OR 0.3, 95% CI 0.1-0.8), respectively. However, mortality of full-term admissions in ICU was insignificantly lower in group A than that in group B, i.e. (6% vs. 29%) (OR 0.2, 95% CI 0.03-1.8). No still birth and intrauterine fetal death was found in group A [Table 3].

Majority of subjects (87%) of group A had normal Doppler USG findings and neonatal admissions to ICU as well as mortality was higher in subjects in group A with abnormal Doppler USG findings than those with normal Doppler findings, i.e. (100% vs. 44%, *P*<0.01) and (7.7% vs. 3%, *P*<0.01).

Emergency caesarean section was uncommon in subjects with normal Doppler USG than those of with abnormal Doppler USG and also from group B (i.e. 48% vs. 100% (OR 0.1, 95% CI 0.03-0.4) and 48% vs. 82% (OR 0.2, 95% CI 0.1-0.4), respectively) [Table 4].

Table 1: Socio-demographic data

Variables	Group A, *n*=100 (%)	Group B, *n*=100 (%)	Significance *P*-value
Demography age groups in years			
<24	14	27	0.19*
24-34	43	34	
>34	43	39	
Parity			
Primipara	15	22	
Multipara	85	78	0.2**
Consanguinity			
Yes	17	15	0.69**
No	83	85	

*Mean difference between two groups by Student's *t*-test; **Chi-square test

Table 2: Maternal and fetal clinical profile and outcome

Variables	Group A, (*n*=100) %	Group B, (*n*=100) %	*P* value*
Amniotic fluid			
Normal	40	78	0.0001
Poly/oligohydromnios	60	22	
Labor induction			
Yes	15	9	0.22
Mode of delivery			
C-section	76	74	0.87
Gestational age			
Pre-term	39	26	0.12
Normal	88	94	
Placenta			
Abnormal location	11	6	0.26
Calcified	1	0	

*Chi-square test

DISCUSSION

The results of this study have confirmed that normal Doppler waveforms recorded during the third trimester are associated with good pregnancy outcome. However, certain effects on obstetric management were observed, introduction of this test into regular clinical practice reduce neonatal morbidity and mortality. Trudinger *et al.* randomized 300 high risk pregnant females into two groups, i.e. a group for antenatal Doppler umbilical artery waveform studies and a control group, and found no difference in the rates for elective delivery (induction of labor or caesarean section) in the two groups, whereas among those who went into labor (induced or spontaneous) emergency caesarean section was more frequent in the control group (23%) than those in the report group (13%). Fetal distress in labor was also more common in the control group. Babies from the control group spent longer in NICU and needed more respiratory support than did those in the report group. The findings indicated that the availability of Doppler studies leads to better obstetrical decision making.[3] As in our study Doppler ultrasound detected abnormal amniotic fluid and placental localization as well as placental calcification in group A.

Table 3: Neonatal clinical features and outcome

Variables		Group A, *N*=100 %	Group B, *N*=100 %	Significance		
				P value	ARR (%)	RRR (%)
Neonatal weight in kg (Mean±SD)		2.7±0.8	2.9±0.6	0.06*	—	—
APGAR						
At 1st minute	<7	20	41	0.36 (0.2-0.7)†	21	51
At 5th minutes	<7	3	13	0.2 (0.1-0.8)†	10	77
Preterm ICU admission		22/39 (56)	23/26 (88)	0.2 (0.04-0.7)†	32	36
Full-term ICU admission		18/61 (30)	42/74 (57)	0.3 (0.2-0.7)†	27	48
Mortality of preterm babies admitted in NICU		2/22 (9)	10/23 (78)	0.1 (0.02-0.7)†	34	79
Mortality of full-term babies admitted in NICU		1/18 (6)	9/42 (29)	0.2 (0.03-1.8)†	16	74
Duration of stay in neonatal ICU in days (mean±SD)		12.7±3.2	16±4.1	0.0001*	—	—
Still births		0	2	—	2	100
Intrauterine fetal deaths		0	1	—	1	100

*Mean difference by Student's *t*-test; †Odd ratio (95% confidence interval); ARR – Absolute risk reduction; RRR – Relative risk reduction; ICU – Intensive care unit; NICU – Neonatal intensive care unit

Table 4: Risk of emergency caesarean section with relation to Doppler findings

Variables	Emergency C-section (%)	OR (95% CI)	ARR	RRR
Risk of emergency C-section in Group A (normal Doppler vs. abnormal Doppler)				
Normal Doppler (group A) (total C-section rate = 63)	30 (48)	0.1 (0.03-0.4)	52	52
Abnormal Doppler (group A) (total C-section rate = 13)	13 (100)			
Risk of emergency C-section (normal Doppler in group A vs. group B without Doppler)				
Normal Doppler (group A) (total C-section rate = 63)	30 (48)	0.2 (0.1-0.4)	35	42
Group B with C-section (total C-section rate = 74)	61 (82)			
Risk of emergency C-section (abnormal Doppler in group A vs. group B without Doppler)				
Abnormal Doppler with C-section (total C-section rate = 13)	13 (100)	3.9 (0.8-20)	18*	18*
Group B with C-section (total C-section Rate = 74)	61 (82)			

*Absolute risk increase; ARR – Absolute risk reduction; RRR – Relative risk reduction

Caesarean section were less frequent in group B, suggesting that Doppler results had identified those fetuses which would not tolerate labor; however, a corresponding increase in caesarean sections were observed in those who had shown abnormal Doppler studies in group A. Moreover, this study revealed a high rate of preterm deliveries in group A than that in group B, suggesting that Doppler velocimetry can often distinguish between the small fetus that can safely be managed conservatively from the fetus at high risk of developing fetal distress or perinatal death who is likely to get benefit from earlier delivery.

A significant reduction was seen in admission rates to neonatal intensive care for both pre-and full-term babies in group A although all babies with abnormal Doppler waveform admitted to neonatal intensive care. The neonatal deaths of pre- and full-term babies admitted to NICU were significantly higher in group B than those in group A, but the percentage of neonatal deaths in babies with abnormal Doppler waveform was more than normal Doppler observed.

Our study found an increased number of preterm births, obstetric interventions, and improved outcome morbidity and mortality from the use of Doppler waveform analysis in late pregnancy. Evidence suggested that many pregnancy disorders originate at conception or in early gestation and the perinatal events contribute less to long-term morbidity. Thus, major improvements in outcome might not essentially result from further improvement in fetal assessment during late pregnancy. With the identification of fetuses at risk of placental disease and growth retardation especially in earlier pregnancy, directing the therapeutic applications for improving fetal growth and development, Doppler technology might be more likely to make a worthy and longstanding contribution.[6,7]

McParland and Pearce described in a review article the results of a study of 509 pregnancies in which patients were stratified into "concealed" or "revealed" groups according to whether the waveforms were normal or abnormal. Fewer neonatal deaths were observed in the "revealed" group although further details were not provided.[8] In a randomized comparison of routine versus highly selective Doppler waveform and biophysical profile usage, Tyrell *et al.* observed fewer depressed at fifth minute APGAR scores and less neonatal morbidity in the routinely monitored group.[9]

According to systemic review by Imdad *et al.*, the effectiveness of Doppler velocimetry of umbilical and fetal arteries in "high-risk" pregnancies, together with the appropriate intervention, reduced perinatal mortality by 29 % (RR 0.71, 95 % CI 0.52-0.98). On the other hand impact on stillbirth showed a reduction of 35 % (RR 0.65, 95 % CI 0.41–1.04): that results did not reach the limits of statistical significance. This intervention could be potentially recommended for high-income settings or middle-income countries with improving rates and standards of facility-based care.[10]

Qahtani mentioned in her review article that Doppler ultrasonography of the umbilical artery in high-risk pregnancies reduced significantly the number of antenatal admissions (44%, 95% CI 28-57%), induction of labor (20%, 95% CI 10-28%), and Caesarean section for fetal distress (52%, 95% CI 24-69%) 37. Additionally, the clinical action guided by Doppler ultrasonography reduced the probability of perinatal deaths by 38% (95% CI 15-55%). *Post hoc* analyses revealed a statistically significant reduction in elective delivery, intrapartum fetal distress, and hypoxic encephalopathy in the Doppler group.[11]

CONCLUSION

Doppler studies in high-risk pregnancies are more beneficial in the management of perinatal as well as neonatal management but for each institution the role of Doppler studies in late pregnancy is being influenced by the usage of other tests of fetal welfare which are already well established in clinical practice.

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