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The Relationship Between Doppler Parameters and Perinatal Outcomes in Postterm Pregnancies

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Abstract
Aim: The aim of the study is to identify the relationship between doppler parameters and perinatal outcomes in post-term pregnancies.
Material and Method: 101 pregnant women (37-41 weeks, control group; n:51 and ≥41 weeks, study group, n:50) were included in the study. We performed umblical artery and middle cerebral artery blood flow velocity waveform (pulsatility index, resistivity index, and systole/diastole ratio) analyses for our patients.
Results: The mean value of the umbilical artery resistivity index was significantly higher in the study group than the control group while the mean value of the umbilical artery pulsatility index was significantly lower in the study group. The middle cerebral artery resistivity index was significantly lower in the study group, which was consistent with preferantial perfusion of the brain. We also found decreased ratios of middle cerebral artery resistivity index in umblical artery resistivity index in the study group (1.11) compared with the control group (1.25). These findings can be interpreted in favor of worse perinatal outcomes in the study group while the increased adverse perinatal outcome rates (%64) in the study group supports this view. The ratio of middle cerebral artery resistivity index to umblical artery resistivity index <1.155 can be used as a sign of adverse perinatal outcomes in prolonged pregnancies with a senstivity of %76.6 and a specificity rate of %85.2.
Conclusion: Doppler ultrasonography can be used for reducing perinatal mortality and morbidity of prolonged pregnancies.
Key Words: Doppler; Postterm Pregnancy; Perinatal Mortality; Perinatal Morbidity.

Uzamış Gebeliklerde Doppler Ultrasonografi Bulguları ile Perinatal Sonuçlar Arasındaki İlişki

Özet
Amaç: Uzamış gebeliklerde doppler ultrasonografi bulguları ile perinatal sonuçlar arasındaki ilişkiyi incelemek amaçlandı.
Gereç ve Yöntem: Bu çalışmaya 37-41 gebelik haftası arasındaki 51 (kontrol grubu), ≥41 gebelik haftasındaki 50 hasta (çalışma grubu) dahil edildi. Renkli doppler ultrasonografide umblikal arter ve orta serebral artere ait akım paternleri değerlendirilerek doppler indeksleri ölçüldü. Bu damarlarda akımı değerlendirmek için, pulsatilite indeksi, rezistivite indeksi ve sistol/diastol oranı ölçüldü.
Bulgular: Uzamış gebeliklerde, kontrol grubuna göre, umblikal arter rezistivite indeks değeri daha yüksek, pulsatilite indeks değeri daha düşük bulundu. Uzamış gebeliklerde ölçülen orta serebral arter rezistivite indeks ortanca değeri kontrol grubuna göre anlamlı derecede daha düşüktü ve bu, beyin için oluşturulan koruma mekanizması lehine bir bulgu olarak değerlendirildi. Orta serebral arter rezistivite indeks / umblikal arter rezistivite indeks ortanca değeri çalışma grubunda (1.11) kontrol grubununkine (1.25) göre istatistiksel olarak daha küçüktü, nitekim uzamış gebelikler için kötü perinatal sonuç %64 sıklıkla kontrol grubuna göre istatistiksel olarak anlamlı derecede daha fazla bulundu. Uzamış gebeliklerde kötü perinatal sonucu öngörmede orta serebral arter rezistivite indeks / umblikal arter rezistivite indeks oranı <1.155 (%76.6 sensitivite ve %85.2 spesifite) olarak bulundu.
Sonuç: Doppler ultrasonografi, uzamış gebeliklerde perinatal mortalite ve morbiditenin azaltılmasında kullanılabilecek bir yöntem olarak gözükmektedir.
Anahtar Kelimeler: Doppler; Postterm Gebelik; Perinatal Mortalite; Perinatal Morbidite.

INTRODUCTION

The terms postterm pregnancy, prolonged pregnancy, outdated or post-mature pregnancy are all terms used for pregnancies that exceed the accepted upper limit of normal gestational period. The standard definition of postterm pregnancy suggested by American College of Obstetricians and Gynaecologists and International Federation of Gynaecology and Obstetrics is the pregnancy that lasts for more than 294 days or 42 gestational weeks starting from the first day of the last menstrual period (1-3). However, this definition belongs to the period when fetal well-being assessment and obstetric ultrasonography were not widely used. New studies find it more appropriate to define prolonged pregnancy as pregnancy that has completed 41 weeks (and over) of gestational age (4). The incidence rate of the postterm pregnancy ranges from 3% to 12% (5).

Among the known risk factors of postterm pregnancy we can mention advanced maternal age, primigravida, postmaturity in previous pregnancies, and use of medications. In addition to these factors, recent studies demonstrate that maternal overweight and excessive weight gain during pregnancy increase the risk of postterm pregnancy while regular exercises reduce the risk (6,7).

Postterm pregnancy carries serious fetal risks like oligohydramnios, meconium aspiration syndrome, macrosomia, placental insufficiency and dysmaturity, and fetal mortality as well as maternal risks like emotional stress, anxiety, increase in birth traumas, increase in stress incontinence, dysfunctional labor, obstructed labor, and fetopelvic impropriety. Studies in recent years regard postterm pregnancy as a serious obstetric complication much like fertility issues, diabetes mellitus, hypertensive disorders, and intrauterine retardation; it is also emphasised that postterm pregnancy alone is an independent perinatal mortality risk factor (8).

It is important to determine and appropriately manage prolonged pregnancies that are prolonged so as to have negative effects on perinatal mortality and morbidity. To identify uteroplacental, umbilical, and fetal circulation anomalies that coexist with prolonged pregnancies, various methods are used by many researchers (1). Some researchers argue that Doppler ultrasonography can help in the identification of prolonged pregnancy patients with adverse perinatal outcomes (9,10).

In this study, we aim to investigate the relationship between Doppler ultrasonography findings and perinatal outcomes in prolonged pregnancies.

MATERIAL AND METHODS

We conducted our study on a total of 101 patients who were followed at Dr. Zekai Tahir Burak Training and Research Hospital for Women's Health between September 2007 and March 2008. 51 of these patients were in their 37-41 weeks of gestation while the remaining 50 were in their ≥41 gestational weeks. The approval for the study, which was prepared in accordance with the Helsinki declaration, was obtained from Dr. Zekai Tahir Burak Training and Research Hospital for Women's Health Ethics Committee. We have also got the consent of all our patients.

The inclusion criteria were having routine follow-ups at our hospital and undergoing a singleton pregnancy. The exclusion criteria were the presence of a chronic disease in the mother, smoking history, gestational diabetes, preeclampsia, eclampsia, the presence of additional diseases such as Rh incompatibility, intrauterine fetal growth retardation, malformation, and chromosomal anomalies.

For the ultrasonographic evaluation, we used an ultrasound device with pulsed and coloured Doppler options (Aloka Prosound SSD-5500 Tokyo, Japan). For the ultrasound examinations patients were positioned in supine position and tilted slightly to the left. During the coloured Doppler ultrasonography, we examined the flow patterns of the umbilical and middle cerebral arteries and measured their Doppler indices. To assess the flow in these vessels, we calculated pulsatility index (PI), resistivity index (RI), and systolic/diastolic (S/D) ratio; patients with ≤5 cm amniotic fluid index (AFI) were considered as oligohydramnios.

For the Doppler examination from the umbilical artery, the measurements were done from the free loop of the umbilical cord, remote from the foetus, closer to the placenta. After identifying the vascular structures that belongs to Willis measurements with the help of colour coding, the fetal middle cerebral artery measurements were done from one of the mid-cerebral arteries.

We used a Hewlett-Packard 50A, USA device for the electronic fetal monitoring of all cases. Cardiotocography results revealed abnormal presence of late deceleration, variability reduction, complicated variable decelerations, and prolonged bradycardia; in the event of persistent presence of such issues, we terminated the pregnancy by administrating cesarean section (C/S) with fetal distress diagnosis.

In every case, we recorded the meconium staining status of the amniotic fluid after amniotomy, the 1st and 5th minute Apgar scores of all the newborns, their weight, and whether they had any intensive care requirements.

The patients who underwent C/S with diagnosis of fetal distress and had oligohydramnios, amniotic fluid with meconium, low birth weight (SGA), first and fifth minute Apgar scores lower than 7, and need for postpartum intensive care were all classified as infants with poor perinatal outcomes.

We based the data analysis on SPSS 11.5 (Statistical Package for Social Sciences, SPSS Inc., Chicago, IL, United States) software package. The appropriation of the distribution of continuous measurement variables was studied with Shapiro Wilk test. For descriptive statistic and continuous measurement variables, we used mean ± standard deviation or median value (minimum - maximum); for nominal variables, we used the number of observations and percentages. To identify statistically significant differences in terms of normally distributed continuous measurement variables among the independent samples we used the Student's t test. We analysed the significance of the difference concerning irregularly distributed continuous measurement variables by using Mann-Whitney U test.

The nominal variables were evaluated by using Pearson's chi-square test. To determine whether each Doppler parameter was decisive on the adverse perinatal outcome we calculated the area under the Receiver operating characteristic (ROC) curve. When the area under the curve was significantly large, we determined the best cut-off point of the Doppler measurements by using the Youden index to be able to predict the adverse perinatal outcomes. Also, we calculated the sensitivity for this point, selectivity, and positive and negative predictive values. p<0.05 was considered statistically significant for the results.

RESULTS

There was no statistically significant difference between the study and control groups in terms of mean age (24.6±4.2 vs 23.6 ± 4.1, respectively; p=0.241), gravity (1.7±0.9 vs 1.7±0.9; p=0.889), parity (0.5±0.7 vs 0.5±0.7; p=0.747) and number of living children (0.5±0.7 vs 0.4±0.7; p=0.620). The mean gestational age was 288.9±1,86 days for the pregnant women in the study group; the same parameter was 274.9±6.91 days for the control group and the difference between the two groups was statistically significant (p<0.05).

Given the way birth, the caesarean section rate was (48%) in the study group and (19.6%) in the control group; the difference was notably higher in the study group (p=0.003). 40% of the prolonged pregnancies had oligohydramnios; it was 13.7% in pregnant women in the control group and the difference was statistically significant (p=0.003). Meconium stained amniotic frequency was statistically significantly higher in the study group with (30%) while the same rate was (11.8%) in the control group; (p=0.024). While, with more than 64%, adverse perinatal outcomes were higher in the study group compared to the control group, normal perinatal outcomes in the control group (76.5%) were more compared to the study group (p<0.034). The average birth weight of babies in the study group (3552±391grams) was considerably more than those in the control group (3370±342 grams) (p=0.013).

The 1st minute Apgar scores of the newborns in the study group (6.6±0.73) were significantly lower compared to the scores of the babies in the control group (6.8±0.61) (p=0.038). However, the 5th minute Apgar score difference between the two groups of babies (8.8±0.48 and 8.9±0.41, respectively) was not statistically significantly (p=0.192). The number of babies that required to be taken to neonatal intensive care services with a 1st minute Apgar score of <7 was higher in the study group (by 30%) than the control group (11.8%) (p=0.024).

Comparing the Doppler findings of pregnancies over 41 weeks with pregnancies in 37-41 weeks we noticed significantly higher levels of umbilical artery RI, and lower cerebral artery RI and middle cerebral middle RI/R umbilical artery RI values in the study group (Table 1).

Table 1. The Doppler parameter values of the foetuses in each group.

	Study Group (Median)	Control Group (Median)	P
Umb. Artery S/D	2.13 (1.7-3.75)	2.20 (1.58-3.76)	0.057
Umb. Artery RI	0.65 (0.45-0.95)	0.60 (0.47-0.89)	0.014
Umb. Artery PI	0.88 (0.64-1.10)	0.89 (0.69-1.21)	0.082
Mid. Cerebral Artery S/D	4.55 (2.98-8.42)	4.49 (3.12-7.58)	0.922
Mid. Cerebral Artery RI	0.71 (0.52-0.82)	0.75 (0.41-0.87)	0.001
Mid. Cerebral Artery PI	1.47 (1.10-1.97)	1.46 (0.64-2.19)	0.801
Mid. Cerebral Artery RI/Umb. Artery RI	1.11 (0.62-1.60)	1.25 (0.72-1.63)	0.002

Dividing the prolonged pregnancies into two groups we noticed that those who had oligohydramnios had notably lower values than those with normal amniotic indexes in terms of middle cerebral artery RI/umbilical artery RI Doppler parameters. The middle cerebral artery RI values in oligohydramnios group was lower in comparison to the group with normal amniotic index (Table 2).

Table 2. Doppler parameters of the study group according to amniotic characteristics.

	Oligohidramnios (n=20)	Normal amniotic value (n=30)	P
Umb. Artery S/D	2.29 (1.71-3.75)	2.24 (1.7-3.69)	0.672
Umb. Artery RI	0.68 (0.50-0.80)	0.64 (0.45-0.95)	0.149
Umb. Artery PI	0.86 (0.64-0.87)	0.86 (0.65-1.10)	0.952
Mid. Cerebral Artery S/D	4.49 (2.98-8.42)	4.8 (2.98-7.12)	0.398
Mid. Cerebral Artery RI	0.67 (0.52-0.78)	0.72 (0.56-0.82)	0.050
Mid. Cerebral Artery PI	1.50 (1.23-1.97)	1.46 (1.10-1.78)	0.577
Mid. Cerebral Artery RI/Umb. Artery RI	1.01 (0.71-1.29)	1.16 (0.62-1.60)	0.026

After the administration of amniotomy to the patients in the study group. we divided them into two groups: those who had meconium amnion and those who did not (i.e those who had clear amniotic fluid). While the mean umbilical artery RI value. one of the Doppler parameters. was significantly higher (p=0.026) in the group with meconium amnion (0.71 (0.50 to 0.95)) compared to those who did not have meconium amnion (0.63 (0.45 to 0.79)). the group with meconium amnion had significantly lower values (0.62 to 1.28)) compared to the group with clear amniotic fluid in terms of middle cerebral artery RI (0.64 (0.52 to 0.79)) and middle cerebral artery RI/umbilical artery RI (0.93 (0.72 (0.56 to 0.82) and 1.17 (0.82-1.60). respectively) (p=0.001). Other Doppler parameters did not show statistically significant differences (p> 0.05).

Studying the pregnant women in terms of fetal distress during labour. we divided them into two groups (those with fetal distress during labour and those without fetal distress during labour). Those who experienced fetal distress during labour had higher umbilical artery RI values (median: 0.72 (0.61 to 0.80)) in contrast to those who did not have fetal distress (0.61 (0.45 to 0.95)) (p=0.002). The pregnancies with fetal distress during labour had notably lower values in terms of umbilical artery PI value (0.80 (0.65-0.90)) and middle cerebral artery RI/R ratio of umbilical artery (0.93 (0.71 to 1.16)) compared to the patients without fetal distress during labour (0.88 (0.64 to 1.10) and 0.88 (0.64 to 1.10). respectively) (p=0.006 and p=0.002. respectively).

When the subjects are divided into another set of groups (as those with normal perinatal outcomes and those with poor perinatal outcomes). we can observe that the group with poor perinatal outcomes had higher umbilical artery RI values and lower umbilical artery PI. middle cerebral artery S/D. middle cerebral artery RI. and middle cerebral artery RI/umbilical artery RI values (Table 3).

Table 3. The distribution of Doppler ultrasound results of the groups according to normal perinatal outcomes and poor perinatal outcomes.

Variables	Normal Result (n=18)	Poor Result (n=32)	P
Umb. Artery S/D	2.25 (1.58-3.60)	2.13 (1.68-3.76)	0.052
Umb. Artery RI	0.60 (0.45-0.75)	0.68 (0.47-0.95)	<0.001
Umb. Artery PI	0.90 (0.64-1.10)	0.85 (0.65-1.02)	0.017
Mid. Cerebral Artery S/D	4.70 (3.13-7.58)	4.52 (2.98-8.42)	0.037
Mid. Cerebral Artery RI	0.76 (0.64-0.87)	0.69 (0.41-0.79)	<0.001
Mid. Cerebral Artery PI	1.46 (1.04-2.19)	1.47 (0.64-1.97)	0.946
Mid. Cerebral Artery RI/Umb. Artery RI	1.30 (0.62-1.60)	1.02 (0.71-1.16)	<0.001

The results of ROC analysis showed that umbilical artery RI. umbilical artery PI. middle cerebral artery S/D. middle cerebral artery RI. middle cerebral artery RI/umbilical artery RI values were statistically significant (p <0.05) for predicting adverse perinatal outcomes (Table 4 and Table 5).

Table 4. The effect of Doppler measurments in predicting poor perinatal outcomes in accordance with ROC analysis.

Variables	Below the curve	p value	95% Confidence interval	
			Bottom limit	Top limit
Umb. Artery S/D	0.612	0.052	0.501	0.723
Umb. Artery RI	0.760	<0.001	0.661	0.859
Umb. Artery PI	0.616	0.044	0.508	0.725
Mid. Cerebral Artery S/D	0.621	0.037	0.511	0.730
Mid. Cerebral Artery RI	0.786	<0.001	0.697	0.875
Mid. Cerebral Artery PI	0.504	0.946	0.390	0.618
Mid. Cerebral Artery RI/Umb. Artery RI	0.839	<0.001	0.757	0.920

Table 5. The cut-off values and performance levels of statistically significant Doppler measurments of the study group in accordance with ROC analysis in predicting adverse perinatal outcomes.

Variables	Cut-off Value	Sensitivity	Specifity	Positive Estimated Value	Negative Estimated Value
Umb. Artery RI	>0.675	%53.2	%96.3	%92.6	%70.3
Umb. Artery PI	<0.965	%93.6	%25.9	%52.4	%82.4
Mid. Cerebral Artery S/D	<3.815	%34.0	%90.7	%76.2	%61.3
Mid. Cerebral Artery RI	<0.695	%55.3	%94.4	%89.7	%70.8
Mid. Cerebral Artery PI	<1.155	%76.6	%85.2	%81.8	%80.7

DISCUSSION

Although prolonged pregnancy is associated with increased perinatal morbidity and mortality rates. an ideal method giving accurate information about the condition of the fetus in prolonged pregnancies has not been defined yet (11). Numerous studies about Doppler applications in obstetrics have been published in recent years. In the light of these publications. it can be said that coloured Doppler application is widely used in the evaluation of fetal well-being while it has also become important in reducing the perinatal mortality and morbidity rates especially in high-risk pregnancies (12-15). Coloured Doppler application is able to provide information about the early diagnosis of fetal distress quicker than other tests and this is its main advantage (12).

In prolonged pregnancies the timing of the intervention is still an ongoing debate. It has been reported that when prolonged pregnancies are not intervened 24% of these pregnancies may extend into the 41st gestational week while 11% may reach 42nd week and %5 may reach the 43rd gestational week. However. these rates tend to fall down because of induction intervention. Induction may result in increased cesarean rates especially for primigravida mothers while it may cause increased vacuum or forceps applications. hypertonic uterine activity. and fetal distress for foetuses (16). However. many studies in the last years hold the opinion that a routine induction of labour in the 41st week is more effective in preventing fetal risks than the expected method while such an intervention does not increase the cesarean rate either (17.18.19). In our study. the cesarean birth rate in the study group has significantly increased compared to the control group. This was particularly because of the cesarean deliveries due to fetal distress.

In a study conducted by Palacio et al. umbilical artery RI values have decreased while PI values have increased as the duration of pregnancy progress in prolonged pregnancies. which. they believe. is associated with placental insufficiency in such pregnancies (20). In our studies. too. the umbilical artery RI values of the prolonged pregnancies in the study group were high and PI values were low compared to the control group. S/D ratio is the most common way to evaluate middle cerebral artery (12). This ratio is over 3 in the third trimester; below three is revealing in terms of hypoxia (12.21). In our study. this value was 4.55 for the study group and 4.49 for the control group; this difference is statistically significant. Besides the middle cerebral artery RI median value in the prolonged pregnancies was significantly lower than the control group and this is a finding in favor of the protection mechanism established for the brain.

There is a decrease in energy security required for the fetus as a result of placental insufficiency. which may occur with prolonged pregnancies and this may bring about fetal hypoxia. As a result of this. and as Mogren et al. has put it. the risk of oligohydramnios and amniotic meconium passage increases in prolonged pregnancies (22). In this study. too. both in the group with prolonged oligohydramnios frequency and in the group with prolonged amniotic meconium frequency. the passage rate was significantly higher compared to the control group.

P. Olofsson et al. have found low PI values in Doppler evaluation of umbilical artery conducted on prolonged pregnancies and have concluded that the low values may have been a result of chronic hypoxia and acidosis; they have further suggested that these may lead to increase in umbilical artery RI if the case worsens (11). In our study. too. umbilical artery PI values were significantly lower in the study group patients with fetal distress compared to those without fetal distress. In addition. patients with fetal distress had higher umbilical artery RI values and lower middle cerebral artery RI values. The reason behind all these parameters is the presence of a probable chronic hypoxia.

When we compare the groups in terms of poor perinatal outcomes. we see that the frequency of the parameter is notably higher in the study group. Prolonged pregnancies are associated with increased perinatal morbidity and mortality rates due to probably impaired uteroplacental circulation. There is no consensus in the literature about the ideal test in predicting perinatal outcomes of prolonged pregnancies (11). The studies point to increases in perinatal mortality and morbidity as well as neonatal intensive care requirements due to high umbilical artery S/D values in the third trimester though there is no concrete evidence for the latter (23.24). Jörn et al. have similarly detected changes in umbilical artery S/D ratios in pregnancies over 40 weeks but they have also claimed that identification of these changes do not provide much help in predicting perinatal outcomes (25). Arabin et al. in their study in which they have evaluated Doppler and NST findings at the same time to foresee fetal distress and adverse perinatal outcomes. have stated that using these methods may be helpful in predicting fetal distress although they fall short in predicting insufficient Apgar scores (26). Studying 59 postterm pregnancies. Urban et al. have observed strong correlation between 1 and 5 minutes Apgar scores and middle cerebral artery PI/uterine artery PI values and concluded that these Doppler parameters may be useful in foreseeing perinatal outcomes (27). With 76.6% sensitivity and 85.2% specificity. the <1.155 value we have found for middle cerebral artery RI/umbilical artery RI ratio seems to be an applicable value for predicting adverse perinatal outcomes.

CONCLUSION

Even though Doppler ultrasonography appears to be an able method in reducing perinatal mortality and morbidity in prolonged pregnancies. broader efforts are needed to improve the clinical use of ultrasound.

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