Experimental
&
Clinical Article

Comparison of Modified Biophysical Profile with Doppler Ultrasonographic Analysis in Determining Fetal well Being in the Third Trimester

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OBJECTIVES: In this study we aim to compare modified biophysical profile with Doppler ultrasonographic analysis in determining fetal well being in the third trimester.

STUDY DESIGN: Our research is based on 99 voluntary pregnant patients ahead of 36 weeks who admitted to our hospital for labor between December 2009 and March 2010. Doppler ultrasonography and biophysical scoring were applied to all patients admitted to the study group. Following delivery, birth weight and APGAR scores of the 1st and 5th minute were noted down by the pediatrician. Prognosis and survey of all newborns admitted to the Neonatal Intensive Care Unit after delivery were closely monitored. The effectiveness of modified biophysical profile and obstetric Doppler analysis in determining the perinatal outcome was based on the evaluation of certain parameters such as; fetal distress, presence of meconium, admittance to NICU and APGAR score of the 5th minute.

RESULTS: Our research is based on 99 voluntary pregnant patients between 18 and 40 years old and who are ahead of 36 weeks that were admitted to our hospital for labor between December 2009 and March 2010. Patients' median age was 23.30±4.91, gravida changing between 1 and 5 with a median of 2 and parity changing between 0 and 2 with a median of 1. Birth weight measurements varied from 2680g to 3900g with a median of 3192.22±277.42 grams. Caesarean section was performed on 20 patients (20.2%). The remaining 79 (79.8%) were delivered vaginally

CONCLUSION: Modified biophysical profile was found to be a more reliable tool than Doppler analysis in determining perinatal outcome and in prediction of acute fetal distress. But combining modified biophysical profile with Doppler analysis has yielded a higher sensitivity aiding in the diagnosis of perinatal outcome and acute fetal distress. In conclusion, in order to effectively predict acute fetal distress and to maintain a reliable screening method, combined use of these tests, namely modified biophysical profile and umbilical artery Doppler analysis, has proven to be the most valuable and effective method as shown in our study.

Key Words: Fetal distress, Biophysical profile, Doppler, Ultrasonography, Perinatal

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Introduction

The chance to examine and evaluate intra uterine growth had always been an interesting focus point for obstetricians. To be able to evaluate fetal health antenatally is to prevent intra uterine fetal demise or to avoid complications due to asphyxia.

Thanks to technological contributions to science in the last 50 years, much has been learned of the fetus and its environment. Being able to monitor fetal physiology and organogenesis up to the point of birth eventually made the fetus a patient with its own risks for mortality and morbidity, maybe even surpassing the mother in terms of that.

Therefore when faced with a patient in labor, an obstetrician has to provide all resources flawlessly to the best of his ability and training to ensure the safest outcome for both the mother and the baby.

Most common methods used by obstetricians to assess antepartum evaluation are:

1- Non-stress test (NST)
2- Biophysical profile (BP)
3- Doppler ultrasonography
4- Examining fetal anatomy by ultrasound

None of these antenatal methods are adequate when used alone therefore it is common practice to combine them to reach a healthy and effective decision. This is also true for

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Doppler ultrasonography which had been recently incorporated into the use of obstetrics.

Doppler ultrasonography is a rather new method enabling the computer to create images for functional evaluation based on B-mode sonography.

The desire to examine fetal-maternal circulation without using invasive methods marks the point of origin for all the research performed in the field of Doppler ultrasonography in obstetrics.

Doppler effect was first described mathematically by the physicist Johann Christian Doppler (1803-1853) but it is Satamura[1] who first used it to measure blood flow velocity for experimenting in medicine.

Aside from monitoring fetal growth, one of the major contributions of ultrasonography in obstetrics is making it possible to assess certain biophysical activities to determine fetal health and viability hence the "Biophysical Profile".

Back in 1980 this was first described by Manning and Platt by examining fetal breathing movements, fetal body and extremity movements, fetal tonus and amniotic fluid volume using real time ultrasonography to evaluate fetal health.[2]

Biophysical profile (BP) makes it possible for the obstetrician to diagnose fetal asphyxia before it becomes an irreversible process.

False negativity of the test is extremely rare, in a prospective study that was run by Ashlesha et al.[3] for 18 years in two different centers, fetal death was encountered only in 65 subjects among 86955 of which all had normal biophysical profile thus making the false negativity ratio 0.748 to 1000.

Material and Method

Our research is based on 99 voluntary pregnant patients who are ahead of 36 weeks that were admitted to our hospital for labor between December 2009 and March 2010.

All patients were asked to fill out a specific form for our study and following routine obstetric examination and laboratory tests; number of fetus', intrauterine situs and habitus, fetal heart rate and rythm, measurements of Biparietal diameter (BPD), head circumference (HC), femur length (FL) and abdominal circumference (AC) were taken using a Siemens Acuson Antares 4D ultrasound with a 5.71 megahertz (Mhz) convex abdominal probe to also determine estimated fetal weight using the Hadlock formula.

After ruling out major fetal anomalies and confirming singleton pregnancies, amniotic fluid volume (AFV) in four quadrants was measured for evaluation. The criteria for oligohydramnios that was described by Rutherford et al. formed the basis in our study group for determining oligohydramnios. Therefore all patients whose amniotic fluid volume measurement of 4 quadrants, when taken in the vertical plane, below 5cm are considered to be oligohydramniotic.[4]

Later, utero-placental circulation was examined for both left and right uterine artery when there was no uterine contraction using color-pulsed wave (PW) Doppler ultrasonography and any uterine notch observed was noted along with Doppler indexes.

Afterwards, by locating the freely floating umbilical cord, doppler indexes of the umbilical artery were measured and noted by PW Doppler. Extra care was taken to take at least 3 flow-wave measurements for umbilical artery when the fetus was motionless.

During Doppler analysis, systolic/diastolic index (S/D) greater than 2.6 in one of the uterine arteries, presence of notch in the uterine artery or a difference of greater than 1 between uterine artery S/D indexes and an umbilical artery S/D index greater than 2.6 was considered to be abnormal and pathological.

Following Doppler analysis patients were put to non stress test (NST) in semifowler position using a HEWLETT PACKARD 804/A cardiotocography (CTG) device for at least 30 minutes. During this period intrauterine resucitation methods were used when a non-reactive NST was observed to minimize false positivity. Persistence to be non-reactive for 30 minutes despite intrauterine resucitation methods was considered to be an absolute non-reactive NST.

A Modified biophysical profile (MBP) was formed with both amniotic fluid volume (AFV), which is a definitive marker for chronic hypoxia, and NST which shows acute hypoxia. Presence of oligohydramnios and/or non-reactive NST was considered to be an abnormal MBP and its ability to foresee fetal distress and perinatal outcomes was based on this.

During labor, CTG's were classified according to the functional classification described by Cabaniss and those showing the patterns listed below were considered fetal distress.

1. Atypical properties and changes in fetal heart rate
2. Tachyarythmia, bradyarythmia
3. Loss of variability
4. Variable decelerations showing atypical accelerations
5. Late decelerations along with loss of variability
6. Severe variable decelerations presenting with a loss of base variability along with tachycardia and atypical findings.
7. Late variable decelerations along with loss of base variability (S sign)

8. Prolonged decelerations failing to return back to baseline
9. Persistent prolonged decelerations
10. Distinct sinusoidal pattern
11. Agonal patterns

Following delivery, birth weight and APGAR scores of the 1st and 5th minute were noted down by the pediatrician. Prognosis and survey of all newborns that were admitted to the Neonatal Intensive Care Unit (NICU) after delivery were closely monitored.

The effectiveness of MBP and obstetric Doppler analysis in determining the perinatal outcome was based on the evaluation of certain parameters such as; fetal distress, presence of meconium, admittance to NICU and APGAR score of the 5th minute.

Results

Our research is based on 99 voluntary pregnant patients between 18 and 40 years old and who are ahead of 36 weeks that were admitted to our hospital for labor between December 2009 and March 2010. Patients' median age was 23.30 ±4.91, gravida changing between 1 and 5 with a median of 2 and parity changing between 0 and 2 with a median of.[1]

Birth weight measurements varied from 2680g to 3900g with a median of 3192.22±277.42 grams.

Caesarean section was performed on 20 patients (20.2%). The remaining 79 (79.8%) were delivered vaginally (Table 1,2,3).

The ratio of Caesarean section when compared to patients that have an abnormal score of MBP (88.2%) against patients with a normal MBP score (6.1%) is noticeably greater ($p<0.01$).

The probability of an APGAR score lower than 7 in patients with an abnormal MBP score (35.3%) is considerably higher than patients with a normal MBP score (1.2%) ($p<0.01$).

Table 1: General results of the antenatal tests

	Normal Results n (%)	Abnormal Results n (%)
NST	87 (87.9%)	12 (12.1%)
AFV	87 (87.9%)	12 (12.1%)
MBP	82 (82.8%)	17 (17.2%)
Uterine Artery S/D	84 (84.8%)	15 (15.2%)
Umbilical Artery S/D	79 (79.8%)	20 (20.2%)
MBP/Uterine Art/Umb. Art	73 (73.7%)	26 (26.3%)

Table 2: Perinatal outcomes

(n=99)	N	%
FD	17	17.2
Meconium	8	8.1
NICU	12	12.1
Mortality	-	-
Apgar<7	7	7.1
TA	7	7.1
Proteinuria	6	6.1
Preeclampsia	6	6.1

Table 3: Median of uterine and umbilical artery parameters

	Min-Max	Med±SD
Uterine Art S/D	1.58-3.71	2.12±0.56
Uterine Art PI	0.51-1.80	0.80±0.32
Uterine Art RI	0.31-1.21	0.50±0.21
Umbilical Art S/D	1.84-4.33	2.47±0.55
Umbilical Art PI	0.54-1.62	0.80±0.20
Umbilical Art RI	0.30-0.99	0.56±0.15

The ratio of admittance to NICU when compared to patients that have an abnormal score of MBP (64.7%) against patients with a normal MBP score (1.2%) is noticeably greater ($p<0.01$).

The ratio of FD when compared to patients that have abnormal Uterine/Umbilical artery S/D values (68%) against patients with normal Uterine/Umbilical artery S/D values (0%) is noticeably greater ($p<0.01$) (Table 4,5,6).

The ratio of FD when compared to patients that have an abnormal score of MBP (94.1%) against patients with a normal MBP score (1.2%) is noticeably greater ($p<0.01$) (Table 7,8,9).

The ratio of Caesarean section when compared to patients that have an abnormal score of Uterine/Umbilical artery S/D value (76%) against patients with a normal Uterine/Umbilical artery S/D value (1.4%) is noticeably greater ($p<0.01$).

The probability of an APGAR score lower than 7 in patients with an abnormal Uterine/Umbilical artery S/D value (28%) is considerably higher than patients with a normal Uterine/Umbilical artery S/D value (0%) ($p<0.01$).

The ratio of admittance to NICU when compared to patients that have abnormal Uterine/Umbilical artery S/D values (48%) against patients with normal Uterine/Umbilical artery S/D values (0%) is noticeably greater ($p<0.01$).

Statistical Study Methods

NCSS 2007&PASS 2008 Statistical Software (Utah, USA) program was used to statistically assess and evaluate the data in the study. Chi-square test, Mc Nemar test and Kappa statistics were also used for comparing data along with statistically defining methods such as; frequency and standard deviation. Results were evaluated in a 95% safety zone and a P value lower than 0.05.

Table 4: Uterine-Umbilical artery S/D combination sensitivity table

		FD						p
		Yes		No		Total		
		n	%	n	%	N	%	
Uterine-Umbilical Art S/D	Abnormal	17	17.2	8	8.1	25	25.3	0.0008**
	Normal	0	0	74	74.7	74	74.7	
	Total	17	17.2	82	82.8	99	100	
Sensitivity		100						
Specificity		90.24						
Positive predictive value		68.00						
Negative predictive value		100						

Mc Nemar test *** p<0.01*

Table 5: Umbilical artery S/D sensitivity table

		FD						p
		Yes		No		Total		
		n	%	n	%	N	%	
Umbilical Art S/D	Abnormal	16	16.2	4	4.0	20	20.2	0.375
	Normal	1	1.0	78	78.8	79	79.8	
	Total	17	17.2	82	82.8	99	100	
Sensitivity		94.12						
Specificity		95.12						
Positive predictive value		80.00						
Negative predictive value		98.73						

Mc Nemar test *** p<0.01*

Table 6: Realtionship of Uterine/Umbilical Artery S/D values with neonatal outcome

		Uterine/Umbilical Artery S/D Combination		p
		Abnormal (n=20) n (%)	Normal (n=79) n (%)	
Delivery	Vaginal	6 (24,0%)	73 (98.6%)	0.001**
	Caesarean section	19 (76.0%)	1 (1.4%)	
Apgar<7		7 (28.0%)	0 (0%)	0.001**
NICU		12 (48.0%)	0 (0%)	0.001**
FD		17 (68.0%)	0 (0%)	0.001**

*Chii-square test ** p<0.01*

Table 7: MBP/Uterine/Umbilical artery sensitivity table

		FD						p
		Yes		No		Total		
		n	%	n	%	N	%	
Umbilical Art S/D	Abnormal	17	17.2	9	9.1	26	26.3	0.004**
	Normal	0	0	73	73.7	73	73.7	
	Total	17	17.2	82	82.8	99	100	
Sensitivity		100						
Specificity		89.2						
Positive predictive value		65.38						
Negative predictive value		100						

*Mc Nemar test ** p<0.01*

Table 8: Relationship of MBP with neonatal outcome

		MBP		p
		Abnormal (n=17)	Normal (n=82)	
		n (%)	n (%)	
Delivery	Vaginal	2 (11.8%)	77 (93.9%)	0.001**
	Caesarean section	15 (88.2%)	5 (6.1%)	
Apgar<7		6 (35.3%)	1 (1.2%)	0.001**
NICU		11 (64.7%)	1 (1.2%)	0.001**
FD		16 (94.1%)	1 (1.2%)	0.001**

*Chi-square test ** p<0.01*

Table 9: MBP sensitivity table

		FD						p
		Yes		No		Total		
		n	%	n	%	N	%	
MBP	Abnormal	16	16.2	1	1.0	17	17.2	1.000
	Normal	1	1.0	81	81.8	82	82.8	
	Total	17	17.2	82	82.8	99	100	
Sensitivity		94.11						
Specificity		89.2						
Positive predictive value		94.11						
Negative predictive value		98.78						

*Mc Nemar test ** p<0.01*

Discussion

It has been shown that evaluations to predict fetal outcome can help decrease perinatal mortality rates.[5] CTG is still being used in many clinics for intrapartum evaluation and management of labor as gold standard.

Aside from its shortcomings, CTG is practically the most widely used method in deciding acute FD intrapartum.

NST, as a CTG based method, along with contraction stress test and biophysical profile is considered to be a reliable tool in determining the healthy fetus in routine practice [6,7,8] But these methods have high false positive rates ranging from 30% to 60%. While this false positivity is considered to be 2-5% in a reactive CTG, it is fairly high in a non reactive CTG, (50-80%)[9]

According to previous studies perinatal mortality rates in the week following a reactive CTG are 3-5/1000.[10] Therefore a good perinatal outcome is expected if the CTG is reactive. But the same cannot be said for the opposite.

In our study group we aimed to predict perinatal outcome and acute fetal distress in pregnant patients that are ahead of 36 weeks with the help of Doppler ultrasonography and cardiotocography using MBP and Doppler analysis methods. Results obtained were compared both individually and in combinations.

While determining perinatal outcome; acute fetal distress (AFD), presence of meconium, perinatal mortality, admittance to NICU and APGAR scores were all evaluated and the effectiveness of MBP and Doppler analysis were discussed according to these parameters.

According to data gathered; those who had abnormal MBP and abnormal Doppler analysis had the worst prognosis and the difference between the normal and the abnormal group was statistically meaningful.

AFD was observed in 94.1% of the group that had an abnormal MBP along with 64.7% admittance to NICU (Table 8).

When Doppler analysis results were evaluated, AFD was observed in 68% of the group that had an abnormal uterine/umbilical artery S/D ratio along with 48% of admittance to NICU (Table 9).

When Doppler analysis results of uterine/umbilical artery and MBP results were compared in combination for effectively determining AFD, method's sensitivity and specificity results were quite high, 100% and 89.2% respectively (Table 7) (Figure 1).

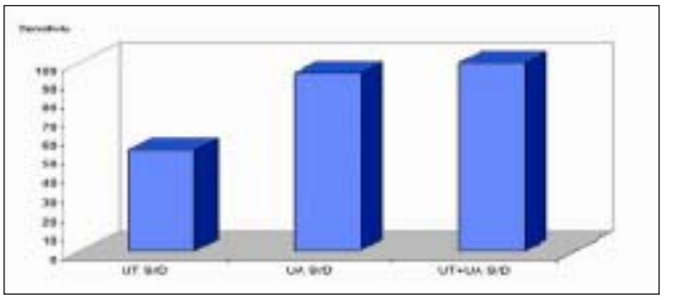

Figure 1: Sensitivity distribution of Doppler ultrasonography results

When MBP was combined with Uterine/Umbilical artery Doppler ultrasonography to determine AFD, the method's sensitivity was 100% and specificity 89.2% making it the most sensitive test in the study. MBP alone had a sensitivity of 94.12% and specificity of 98.78% (Table 6,7).

Highest negative predictive value was obtained from the combination of MBP with Doppler analysis (100%) (Table 7).

Various studies by various researchers were performed in the past to evaluate the effectiveness of antenatal tests in determining AFD.

Krebs et al.[11] had shown that the number of accelerations observed in 30 minutes of CTG and the probability of intrapartum fetal distress are inversely proportioned in a study based on randomly selected patients from a series 1996 pregnant patients.

AFD was observed only in 1.4% of patients that had a reactive CTG while on the other hand this ratio was statistically higher in the presence of fewer accelerations.

Sarno et al. had shown in a similar study[12] that AFD was observed in only 5.9% of patients that were reactive to acoustic stimulation while 35.7% of non-reactive patients had AFD and as a method CTG's effective diagnose and prediction of AFD that would require SCA was based on CTG's sensitivity, specificity, positive and negative predictive values which are 83%, 84%, 23% and 98% respectively.

Visser et al. had also shown in a similar study[13] that reactive CTG patterns when verified by postpartum umbilical artery gas parameters have sensitivity, specificity, positive and negative predictive values of 79%, 85%, 68% and 91% respectively, while predicting AFD intrapartum.

Our results were in correlation with Sarno and Visser's studies.

Aside from these studies we also measured AFV using ultrasonography and when combined with NST it gives us MBP which is known to be more reliable than the whole of BP.[14] In

the study group we assumed MBP as abnormal in the presence of a non reactive CTG and/or oligohydramnios. We have observed that using MBP instead of CTG alone had increased the sensitivity of predicting perinatal outcome by 23%, from 70.58% to 94.11% which is statistically meaningful. There was no significant difference in specificity, NTD or PTD (Table 6).

AFV is an important marker for fetal well being and its decrease should be considered as a serious obstetric condition. This is usually in relation with the underlying cause which can be of placental origin and/or because of IUGR, postmaturity, prematurity. It has been shown by various researchers that oligohydramnios is related with poor perinatal outcome[14-16]

In our study there was significant difference in predicting AFD between AFV normal and AFV abnormal (oligohydramnios) groups which is in correlation with the current literature.

In a study by Feinkind et al.[17] umbilical artery Doppler analysis performed on 273 pregnant patients that were without previously noted risk factors revealed that the probability of intrapartum AFD was higher in the group with pathological Doppler results (abnormal S/D ratio).

Fairlie et al. also came up with similar findings in a study based on 103 patients.[18]

Sarno et al., in a study based on a randomized population had shown that in determining AFD, UA Doppler S/D ratio has a sensitivity of 100%, specificity of 92% and a positive predictive value of 100%.[19]

These researchers are suggesting Doppler analysis to be a routine procedure just like the CTG.

Our results were in correlation with these previously mentioned studies and the incidence of AFD was statistically higher in the group that had pathological Doppler results.

Devoe et al., in a study[20] based on 1000 high risk pregnant patients had shown that when predicting the fetal outcome according to parameters of perinatal mortality, AFD, 5th min. APGAR score of lower than 7 and neonatal acidosis the combined method of NST and AFV (MBP) and Doppler analysis had a specificity higher than 90% and a negative predictive value higher than 85%. Positive predictive value was 100% if all tests were abnormal and 54% for each individual method.

In our study when considered individually, the highest sensitivity was observed in MBP and UA Doppler analysis, 94.11% and 94.12% respectively. But if combined, MBP and UA Doppler analysis had a sensitivity of 100% which is in consistence with the previously mentioned study (Figure 1, Table 5,7).

Admittance to NICU is also an important parameter while evaluating perinatal outcome. In studies based on high risk pregnancies this parameter was found to be statistically higher in the presence of abnormal UA Doppler analysis.[21-23]

We also have found that all the parameters that are used for evaluation of perinatal outcome were poor if UA Doppler analysis was abnormal.

Vintzileos et al.[24] had shown, in a study based on 62 patients, that UA Doppler analysis for prediction of fetal outcome and fetal acidosis was not statistically meaningful when all components of the BP were evaluated individually and in combination with UA Doppler analysis.

Our study, in contradiction with Vintzileos', has proven that in determining fetal acidosis-asphyxia, UA Doppler analysis is a valuable tool assisting MBP in diagnosis with a sensitivity of 94.12% and a negative predictive value of 98.73%[25] (Table 5).

In a similar study [26] by Turan S et al., based on 58 pregnant patients, it was observed that instead of using individual methods combining 2 or more antenatal tests yielded much better results in sensitivity while evaluating fetal outcome.

We also have observed similar results in sensitivity increase when antenatal tests are combined.

And just like Baschat et al. [27] we also concluded that combining MBP with Doppler analysis is statistically more effective in the prediction of perinatal outcome.

Conclusion

MBP was found to be a more reliable tool than Doppler analysis in determining perinatal outcome and in prediction of AFD. But combining MBP with Doppler analysis has yielded a higher sensitivity aiding in the diagnosis of perinatal outcome and AFD.

In conclusion, in order to effectively predict AFD and to maintain a reliable screening method, combined use of these tests, namely MBP and UA Doppler analysis, has proven to be the most valuable and effective method as shown in our study.

More research projects including larger study groups are needed to further experiment on this subject.

Fetal İyilik Hali Öngörüsünde Modifiye Biyofizik Profil ve Üçüncü Trimester Doppler Ultrasonografi Bulgularının Karşılaştırılması

AMAÇ: Bu çalışmada üçüncü trimesterde fetal iyilik halinin ön-

görülmesinde modifiye biyofizik profil ve Doppler ultrasonografi bulgularını karşılaştırmayı amaçladık.

GEREÇ VE YÖNTEM: Çalışmamız Aralık 2009 ve Mart 2010 ayları arasında doğum için kliniğimize yatırılan 36 haftadan büyük 99 gebe üzerinde yapıldı. Çalışmaya alınan tüm gebelere biyofizik skorlama ve Doppler ultrasonografi yapıldı. Doğumu takiben pediatrist tarafından doğum ağırlığı, 1. ve 5. dakika APGAR değerleri not edildi. Yeni doğan yoğun bakım ünitesine alınan tüm bebeklerin prognozu yakından takip edildi. Perinatal sonuçların öngörülmesinde modifiye biyofizik profil ve Doppler ultrasonografi bulgularının etkinliği; yenidoğanlarda fetal distress, mekonyum varlığı, yeni doğan yoğun bakım ünitesine alınma ve 5. dakika APGAR skorlarına göre değerlendirildi.

BULGULAR: Çalışmamız Aralık 2009 ve Mart 2010 ayları arasında doğum için kliniğimize yatırılan 36 haftadan büyük 18-40 yaşları arasında 99 gönüllü gebe üzerinde yapıldı. Hastaların ortalama yaşı 23.30 ±4.91, gravidası 1 ve 5 arasında ortalaması 2 ve paritesi 0 ile 2 arasında ortalaması 1 idi. Yenidoğanların ağırlık ölçüleri 2680g ile 3900g arasında değişmekte ve ortalaması 3192.22±277.42 idi. 20 hasta (%20.2) sezaryen ile, kalan 79 hasta ise (%79.8) vajinal yolla doğurtuldu.

SONUÇ: Perinatal sonuçların öngörülmesinde ve fetal distresi tahmin etmede modifiye biofizik profil, Doppler ultrasonografiden daha değerli bulundu. Fakat modifiye biyofizik profil ve Doppler ultrasonografinin kombinasyonunun daha yüksek sensitiviteye sahip olduğu gözlendi. Sonuç olarak fetal distresin etkin bir biçimde öngörülmesinde ve bunun güvenilir bir tarama testi olarak kullanılmasında modifiye biyofizik profil ve Doppler ultrasonografi kombinasyonu çalışmamızda en etkin yöntem olarak gözlendi.

Anahtar Kelimeler: Fetal distres, Biyofizik profil, Doppler, Ultrasonografi, Perinatal

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