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# Fetal heart tracing and colour doppler: A comparative analysis with respect to maternal and neonatal outcome

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**Abstract**
CTG is a test usually done in the third trimester of pregnancy. The basic objective of a CTG is to assess coordination between foetal nervous system and the cardiovascular system based on the fact that a well oxygenated healthy foetus with an intact CNS-cardiac functioning will show accelerations with foetal movements.
In normal pregnancy, resistance to blood flow in the uteroplacental unit decreases as pregnancy advances resulting in an increase in the diastolic flow and the abnormality in this is detected by Colour Doppler.
We aim to compare the efficacy of Electronic Foetal Monitoring and COLOUR DOPPLER as a means of foetal monitoring in utero in order to prognosticate the perinatal and neonatal outcome in high risk pregnancy.
**Conclusion:** Both the test are complementary to one another in the fetal surveillance of high risk pregnancies and no single test should be considered for decision making because each test reflects different aspects of maternal and fetal pathophysiology. The choice of test can be dictatded by the clinician.

**Keywords:** Fetal heart tracing, colour Doppler, maternal, neonatal outcome

## Introduction
India contributes to one-fifth of the live births in world and one fourth neonatal mortality of the world is also lend by our country. The current NMR is 28 per 1000 live births, causes of this high neonatal mortality can be attributed to the following [1, 2]:

- Prematurity:43.7%
- Infections-20.8%
- Intrapartum causes-19.2%
- congenital malformations-8.1%
- Other causes-8.2%
- Pneumonia:3.7%

Antepartum foetal surveillance is of immense importance for detection of fetal compromise in utero in high risk pregnancies like hypertensive disorders of pregnancy, diabetes mellitus, fetal growth restriction, post-dated pregnancy [3].
Accurate and timely antenatal identification of the fetus at risk, fetal haemodynamic monitoring and serial assessment are crucial to ensure fetal wellbeing, particularly in the setting of complex high risk pregnancies [4].
Most of the tests depend upon the maturity of the foetal CNS and its synchronicity with other systems, which would not have developed before 32 weeks.
CTG is a test usually done in the third trimester of pregnancy. It is done to see the foetus heart rate and variability. The basic objective of a CTG is to assess coordination between foetal central nervous system and the cardiovascular system based on the fact that a well oxygenated healthy foetus with an intact CNS-Cardiac functioning will show accelerations (rise of FHR 15 beats/minute for 15 sec above baseline) with foetal movements.
In normal pregnancy, resistance to blood flow in the uteroplacental unit decreases as preganancy advances resulting in an increase in the diastolic flow and the abnormality in this is detected by Colour Doppler.
A decrease in the umbilical artery end diastolic velocity and increase in the Resistance Index or Pulsatility Index can be witnessed once 30% or more of the placental vasculature is abnormal.

Once 60-70% of the vasculature is affected when absent or reversed end diastolic flow results.
We aim, to compare the efficacy of Electronic Foetal Monitoring (EFM) and Colour Doppler as a means of foetal monitoring in utero in order to prognosticate the perinatal and neonatal outcome in high risk pregnancy.

**Methodology**
The present study was prospective longitudinal study which was conducted in Department of Obstetrics and Gynaecology of Upper India Sugar Exchange Maternity hospital, G.S.V.M Medical College, Kanpur for a total duration of 18 months with 200 cases being subjected to our study.
All antenatal cases with > 32 weeks pregnancy with following high risk factors were included:

1. Hypertensive disorders in pregnancy
2. Diabetes mellitus complicating pregnancy
3. Antepartum haemorrhage
4. Liquor abnormalities
5. Rh negative pregnancy (irrespective of isoimmunization)
6. Multiple pregnancy
7. Bad obstetric history
8. Heart disease in pregnancy
9. Foetal growth restriction (IUGR)
10. Preterm labour
11. Post dated pregnancy
12. Severe anaemia in pregnancy
13. Preterm premature rupture of the membrane

All antenatal cases with history of trauma (acute obstetric emergencies), pregnancy<32weeks, foetus with congenital anomalies and antenatal cases with no risk factors were excluded.
At the time of admission, all antenatal cases falling in the inclusion criteria, after doing routine antenatal examination and investigations, were simultaneously subjected to:-

- Electronic foetal monitoring
  - NST / Cardiotocography
- Colour Doppler velocimetry

And classified in Electronic Fetal Monitoring, as:-

i. Normal
ii. Suspicious
iii. Pathological

And classified in Colour Doppler velocimetry, as:-

i. Normal colour Doppler flow
ii. Abnormal colour Doppler changes

The main justification for admission CTG in women with labour is that the uterine contractions put stress on the placental circulation; an abnormal tracing indicates a deficiency and hence identifies foetal compromise at an early stage to allow intervention. Patients with reactive CTG trace were monitored intermittently by auscultation for one minute every 30 minute in the first stage of labour and every five minutes in the second stage of labour post contraction.
Cases with equivocal trace were put on continuous EFM monitoring.
In those with ominous tracings, appearance of late, significant variable or prolonged decelerations, delivery was hastened by operative or instrumental intervention depending upon stage of labour.

**Results**
Maximum number of patients 40.8% belonged to the age group 26-30 years. Only 3.1% belonged to the extreme age groups, 18-20 years and >35 years, 45.4% belonged to the lower socio economic class and least number of patients i.e 10% belonged to the upper class. Around 39.2% were primigravida while 26.9% were of > G3 gravidity.
Mean Period of Gestation was 36 ± 2.35 weeks with maximum number of patients i.e 47.7% having period of gestation of 35 – 37 weeks.

**As mentioned in table no. 1.**
Maximum number of patients i.e 20.7% were having pregnancy induced hypertension followed by foetal growth restriction, 15.4%. High risk contributed by both PIH and foetal growth restriction was 6.9%.

**As mentioned in table no.2**
Maximum number of patients i.e 40% showed normal cardiotocograph/non stress test trace. Among 130 patients, least i.e 27.7% belonged to the category with pathological CTG/NST trace.

**As mentioned in table no.3**
Maximum number of patients i.e 79.2% were having normal Doppler velocimetry.
20.7% of patients were having abnormal Doppler velocimetry i.e either umbilical artery Doppler indices were abnormal or middle cerebral artery Doppler indices were abnormal or both were abnormal.
48.5% patients underwent lower segment caesarean section whereas 51.5% had normal vaginal delivery as mode of termination.

**As mentioned in table no.4**
GROUP A- Efm (NST) Normal + Doppler Velocimetry Normal GROUP B- Efm (NST) Normal + Doppler Velocimetry Abnormal GROUP C- Efm (NST) Suspicious + Doppler Velocimetry Normal GROUP D- Efm (Nst) Suspicious + Doppler Velocimetry Abnormal GROUP E-Efm (NST) Pathological + Doppler Velocimetry Normal GROUP F-Efm (NST) Pathological + Doppler Velocimetry Abnormal.

**As mentioned in table no.5**
As p-value less than 0.05 is considered as significant, P-value highlighted above are significant. Therefore for high risk factors, liquor abnormalities, pregnancy induced hypertension along with Intra uterine growth restriction, and intra uterine growth restriction along with oligohydromnios, the values are statistically significant. In the rest of the high risk factors, it is non significant.

**As mentioned in table no.6**
There is non-significant difference while comparing Middle Cerebral Artery Doppler vs Umbilical Artery Doppler in all the EFM groups. However while comparing EFM with MCA and UA, there is highly significant difference and abnormal cases are higher in Pathological followed by suspicious and normal cases in EFM. The mean value of SD Ration of Umbilical artery Doppler in the population was 2.58±0.63.

**As mentioned in table no.7**
There is significant difference between the groups in all the variables except APGAR and Still birth. In case of APGAR, all

the groups have similar values with p-value 0.597 and in case of still birth, the p-value is 0.244.

**As mentioned in table no.8**

There is significant difference between the Cerebro placental Ratio and all the variables except APGAR. In case of APGAR, MCA/UA have similar distribution of values with p- value 0.119.The mean of PI of middle cerebral artery is 1.53±0.39.and that of umbilical artery is 1.08±0.35.

**As mentioned in table no.9**

Percentage of NICU admissions required is higher in patients have EFM pathological followed by suspicious as compared to EFM normal. Perinatal mortality are also higher in these two groups only.

**Table 1:** Distribution of patient profile according to presenting risk factors

| High risk factor | Number of cases | % |
|---|---|---|
| 1) PIH | 42 | 21 |
| 2) GDM | 9 | 4.5 |
| 3) APH | 8 | 4 |
| 4) Liquor ABN | 21 | 10.5 |
| 5) Rh Negative Preg | 7 | 3.5 |
| 6) Multiple Preg | 7 | 3.5 |
| 7) Bad Obs History | 5 | 2.5 |
| 8) Heart Disease In Preg | 5 | 2.5 |
| 9) Foetal Growth ABN | 31 | 15.5 |
| 10) Preterm Labour | 5 | 2.5 |
| 11) Post Term Preg | 8 | 4 |
| 12) Severe Anemia In Preg | 18 | 9 |
| 13) Pprom | 5 | 2.5 |
| 14) PIH With IUGR | 14 | 7 |
| 15) APH With PIH | 5 | 2.5 |
| 16) Oligo With IUGR | 5 | 2.5 |
| 17) Severe Anemia With IUGR | 5 | 2.5 |

**Table 2:** Distribution of patient According to different EFM (CTG/NST) parameters

| CTG/NST | No. of Cases | % of Cases |
|---|---|---|
| 1) Normal | 80 | 40 |
| 2) Suspicious | 65 | 32.5 |
| 3) Pathological | 55 | 27.5 |
| Total | 200 | 100 |

**Table 3:** Distribution of patient accoring to different colour doppler test parameters

| Colour Doppler | Number of Cases | % |
|---|---|---|
| A) Normal | 158 | 79% |
| B) Abnormal Doppler (Either Mca or Ua or Both) | 42 | 21% |
| Total | 200 | 100 |

**Table 4:** Distribution of patient profile accoring to groups based on test result

| Group | Frequency | Percentage |
|---|---|---|
| Group A | 77 | 38.5 |
| Group B | 3 | 1.5 |
| Group C | 52 | 26 |
| Group D | 12 | 6 |
| Group E | 29 | 14.5 |
| Group F | 27 | 13.5 |

**Table 5:** Correlation of high risk factors with diffferent test parameter groups

| High Risk Factor | GRP A (N=77 ) | | GRP B (N=3 ) | | GRP C (N=52 ) | | GRP D (N= 12) | | GRP E (N=29) | | GRP F (N=27) | | P- Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | |
| 1) PIH | 17 | 22 | 0 | 0 | 14 | 27 | 1 | 8.4 | 5 | 17.24 | 5 | 18.5 | 0.854 |
| 2) GDM | 7 | 9 | 0 | 0 | 0 | 0.00 | 0 | 0.00 | 2 | 6.9 | 0 | 0.00 | 0.281 |
| 3) APH | 3 | 4 | 0 | 0 | 0 | 0.00 | 3 | 25.0 | 2 | 6.9 | 0 | 0.00 | 0.36 |
| 4) Liquor ABN | 3 | 4 | 2 | 66 | 3 | 6 | 7 | 58.3 | 0 | 0.00 | 8 | 29.62 | <0.001 |
| 5) Rh Negative Preg | 6 | 8 | 0 | 0 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 2 | 7.4 | 0.411 |
| 6) Multipl E Preg | 5 | 6 | 0 | 0 | 2 | 4 | 0 | 0.00 | 0 | 0.00 | 2 | 7.4 | 0.842 |
| 7) Bad Obs History | 0 | 0 | 0 | 0 | 3 | 6 | 0 | 0.00 | 0 | 0.00 | 1 | 3.7 | 0.446 |
| 8) Heart Disease In Preg | 0 | 0 | 0 | 0 | 3 | 6 | 0 | 0.00 | 2 | 6.9 | 0 | 0.00 | 0.482 |
| 9) Foetal Growth Abn | 9 | 12 | 1 | 34 | 9 | 17 | 0 | 0.00 | 3 | 10.34 | 4 | 14.8 | 0.318 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10) Preter M Labour | 5 | 6 | 0 | 0 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0.427 |
| 11) Post Term Preg | 0 | 0 | 0 | 0 | 6 | 11 | 0 | 0.00 | 3 | 10.34 | 0 | 0.00 | 0.177 |
| 12) Severe Anemia In Preg | 9 | 12 | 0 | 0 | 6 | 11 | 1 | 8.3 | 2 | 6.9 | 2 | 7.4 | 0.929 |
| 13) Pprom | 5 | 6 | 0 | 0 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0.427 |
| 14) PIH With Iugr | 2 | 3 | 0 | 0 | 3 | 6 | 0 | 0.00 | 7 | 24.13 | 1 | 3.7 | 0.017 |
| 15) APH With PIH | 3 | 4 | 0 | 0 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 2 | 7.4 | 0.687 |
| 16) Oligo With IUGR | 0 | 0 | 0 | 0 | 0 | 0.00 | 0 | 0.00 | 3 | 10.34 | 0 | 0.00 | 0.003 |
| 17) Severe Anemia With IUGR | 3 | 4 | 0 | 0 | 3 | 6 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0.776 |

**Table 6:** Correlation between EFM versus doppler velocimetry

| EFM | MCA Doppler | | UA Doppler | | |
|---|---|---|---|---|---|
| NST | Normal | Abnormal | Normal | Abnormal | P-Value |
| 1) Normal | 80 | 0 | 77 | 3 | 0.56 |
| 2) Suspicious | 60 | 5 | 54 | 11 | 0.178 |
| 3) Pathological | 38 | 17 | 32 | 23 | 0.326 |
| p-value | <0.001 | | <0.001 | | |

**Table 7:** Perinatal outcome in the test paratmeter groups

| | | Group | | | | | | Total | Pearso n Chi- Square | p- value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Group A | Group B | Group C | Group D | Group E | Group F | | | |
| Apgar Score | <=7 | 60 | 3 | 40 | 11 | 23 | 24 | 160 | 3.677 | 0.597 |
| | >7 | 18 | 0 | 12 | 1 | 6 | 2 | 40 | | |
| Liquor | Clear | 72 | 3 | 35 | 9 | 17 | 9 | 144 | 24.449 | <0.001 |
| | MSL/SCANT Y | 6 | 0 | 17 | 3 | 12 | 17 | 56 | | |
| Nicu Admission At Birth | No | 75 | 0 | 40 | 6 | 15 | 6 | 142 | 46.17 | <0.001 |
| | Yes | 3 | 3 | 12 | 6 | 14 | 20 | 58 | | |
| Neonatal Complicat Ions | No | 75 | 0 | 40 | 6 | 15 | 6 | 142 | 46.17 | <0.001 |
| | Yes | 3 | 3 | 12 | 6 | 14 | 20 | 58 | | |
| Condition At Discharge | Healthy | 78 | 3 | 51 | 12 | 27 | 13 | 184 | 46.243 | <0.001 |
| | Expired | 0 | 0 | 1 | 0 | 2 | 13 | 16 | | |
| Still Birth | Yes | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 6.699 | 0.244 |
| | No | 78 | 3 | 52 | 12 | 29 | 25 | 199 | | |
| Mode of Terminati | NVD | 58 | 2 | 29 | 6 | 9 | 0 | 103 | 31.476 | <0.001 |
| | LSCS | 20 | 1 | 23 | 6 | 20 | 26 | 97 | | |
| On | | | | | | | | | | |
| Total | | 78 | 3 | 52 | 12 | 29 | 26 | 200 | | |

**Table 8:** Pulsatility index (PI) of MCA/UA (Cerebroplacental Ratio) correlation with perinatal outco

| Perinatal Outcome | | MCA/UA (Cerebroplacental Ratio) | | Total | Pearson Chi-Square | p-value |
|---|---|---|---|---|---|---|
| | | >=1.08 | <1.08 | | | |
| Apgar Score | <=7 | 135 | 25 | 160 | 2.436 | 0.119 |
| | >7 | 38 | 2 | 40 | | |
| Liquor | Clear | 135 | 9 | 144 | 13.381 | <0.001 |
| | MSL/SCANTY | 38 | 18 | 56 | | |
| Nicu Admission At Birth | No | 134 | 8 | 143 | 18.231 | <0.001 |
| | Yes | 39 | 18 | 57 | | |
| Neonatal Complications | No | 134 | 8 | 143 | 18.231 | <0.001 |
| | Yes | 39 | 18 | 57 | | |
| Condition At Discharge | Healthy | 169 | 15 | 184 | 33.1 | <0.001 |
| | Expired | 4 | 12 | 16 | | |
| Still Birth | Yes | 0 | 1 | 1 | 6.699 | 0.01 |
| | No | 173 | 26 | 199 | | |
| Total | | 173 | 27 | 200 | | |

**Table 9:** Correlation between EFM and the perinatal outcome with doppler normal

| Doppler (N=158) | EFM | Healthy Baby (At Discharge) | Nicu Admission Required | Expiry |
|---|---|---|---|---|
| 1) Normal | Normal | 77 | 3 | 0 |
| 2) Normal | Suspicious | 51 | 12 | 1 |
| 3) Normal | Pathological | 28 | 14 | 1 |

## Discussion

In this study, maximum number of patients, 20.7% had pregnancy induced hypertension and 6.9% of the patients had a high risk contributed by both PIH and foetal growth restriction. The study conducted by N Chaudhary *et al*. also had maximum (63%) patients belonging to pregnancy induced hypertension (PIH) group [3].

In our study 38.5% of patients were in GROUP A where both

EFM (NST) Normal and Doppler Velocimetry were Normal and 13.1% patients were in GROUP F where EFM (NST) is Pathological and Doppler Velocimetry is Abnormal. Anand R. Tambat *et al*. stated in his study that there were 54.3% patients in Group A whereas 11.4% patients had both NST and Doppler abnormal, Group F. [5].

In group A, where both tests were normal, around 22% cases belonged to PIH and in group F where both tests were abnormal, had maximum cases of oligohydromnios (29%). A study by Amandeep raj *et al*. stated that in Group A where both test results were normal had majority of cases (58.8%) with only Foetal growth restriction and had the least morbidity and Group D which had the maximum number of cases of combined preeclampsia with FGR (73.68%), had both the test results abnormal, and had the worst perinatal outcome [6].

Comparing Middle Cerebral Artery Doppler vs Umbilical Artery Doppler in all the EFM groups is statistically insignificant. However while comparing EFM with MCA and UA, there is highly significant difference and abnormal cases of Doppler are higher in Pathological followed by suspicious and normal cases in EFM. Mantel-Haenszel test indicated that the results of the UA and NST tests were in harmony in good and poor outcome groups (p=0.859) which may be due to low sample size.

In group A, with both tests normal, no. of term vaginal delivery cases are significantly higher as compared to other groups and group F, where both tests are abnormal, is having higher number in LSCS as compared to other groups. There is significant difference in between the groups when comparing the mode of termination.

Similar findings were corroborated by Verma *et al*. in which on statistical analysis it was found that the rate of caesarean section were significantly higher (p=0.011) on comparison of group D (both tests abnormal) with group A(both tests normal).In group D caesarean section was deferred when neonatal survival prospects were poor [4]. In Padmagirison *et al*. study also the caesarean delivery rate was found to be 56.2% in group D where both tests were abnormal [7]. Subramaniam *et al*. also stated p value <0.001 and hence highly significant correlation between mode of termination with NST and Doppler results [8] 46 out of 95 deliveries with clear liquor belonged to the group with both tests normal. 11 out of 36 cases with meconium stained liquor were from group with both tests abnormal. P value<0.001 and hence is highly significant.

Among the total 38 cases admitted in the NICU, only 2 were from the normal tests group whereas 13 were from the group with both tests were abnormal. *P* value is <0.001 and hence highly significant. According to Yelikar *et al*. in comparing the APGAR scores babies of women with only an abnormal Doppler (group II) were compared to those of women with only an abnormal NST (Group III), it was seen that Group II had a better perinatal outcome than Group III, again suggesting that NST reflects changes late in the course of the disease process [9].

On correlation of EFM with perinatal outcome, only 4 NICU admissions occurred in normal NST and 22 admissions with pathological NST. Also, 9 out of 10 neonatal deaths occurred in group with pathological NST, hence being highly significant.

Similar findings were shown in study by Lohana *et al*. that of the total, 9 children had birth asphyxia out of which 66.7% cases had Non Reactive NST, 12 babies had low birth weight (<2.5 kg) out of which 5(41.67%) had non reactive strip, 4 children at birth had meconium aspiration syndrome out of which 75% had a non reactive NST [10].

There is significant difference in the Cerebroplacental Ratio and all the variables except APGAR. In case of APGAR, MCA/UA have similar distribution of values with p-value 0.119.The mean of PI ratio is 1.47±0.41. This shows that PI ratio is highly significant indicator of adverse perinatal outcome.

Singh G *et al*. stated the diagnostic accuracy in prediction of adverse perinatal outcome in clinically suspected IUGR cases CP ratio has the diagnostic accuracy of 91.6%, and MCA PI was 72.6% and UA PI was 79.6%. Present study results in evaluating the usefulness of MCA PI /UA PI ratio as strong predictor of adverse outcome in IUGR and thus it helps in decreasing perinatal mortality and morbidity. This result is comparable with Lakhar *et al*. Fong KW *et al*. Bahado *et al*. [11, 12, 13, 14].

There is significant difference of Doppler values with perinatal outcome, keeping EFM traces normal. Percentage of NICU admissions required is higher in patients having umbilical artery/middle cerebral artery doppler ABNORMAL as compared to both DOPPLER ARTERY (MCA AND UA) normal. Similarly, there is significant difference between EFM and the perinatal outcome. Percentage of NICU admissions required is higher in patients have EFM pathological followed by suspicious as compared to EFM normal. Expired cases are also in these 2 groups only.

In my study, the sensitivity and specificity of DOPPLER is much more than EFM. The accuracy of correct prediction is more with Doppler velocimetry ie. 79.8%. PPV of Doppler is 73.1% and NPV of EFM is 92.3%.

N Chaudhary *et al*. states that Sensitivity and specificity of Doppler velocimetry was 43% and 100%, respectively, whereas, sensitivity and specificity of NST was 12% and 94%, respectively [3]. Positive predictive value of Doppler velocimetry and NST was 100% and 28%, respectively. Negative predictive value of Doppler velocimetry and NST was 90% and 84%, respectively.

The sensitivity and specificity of Doppler as compared to NST is 82.6% and 63.0% respectively. In this study by Amandeep Raj *et al*. Doppler has negative predictive value of 80.95% and positive predictive value of 65.5%. Color Doppler has diagnostic accuracy of 72%. The likelihood ratio of 2.23 is significant [6].

## Conclusion

40% of the patients showed normal cardiotocography / non stress test trace and 79.2% were having normal Doppler velocimetry. After grouping, 38.5% of patients were placed in GROUP A where both EFM(NST) and Doppler Velocimetry was normal and 13.1% patients were in GROUP F where EFM(NST) was Pathological and Doppler Velocimetry was also abnormal. 72.3% patients had clear liquor after membranes had ruptured whereas 27.7% had meconium stained or scanty liquor. 29.5% of the baby delivered, required NICU admission at birth with maximum admissions occurring in group F i.e where NST and Doppler both were abnormal. In group with normal NST and normal Doppler, no. of term vaginal deliveries were significantly higher as compared to other groups and group F(both NST and Doppler abnormal) is having higher number in LSCS as compared to other groups. In all the groups, perinatal outcome in terms of liquor, NICU admission at birth, neonatal complications and mode of termination were statistically significant. But with respect to APGAR and still birth, all the groups had similar values with p-value 0.597 and 0.244 respectively. Maximum no. of neonatal complications i.e 27.8% were attributed to respiratory distress syndrome followed by low birth weight.

In Cerebroplacental Ratio, all the perinatal outcome variables except APGAR were statistically significant, making it a good predictor of adverse perinatal outcome. Percentage of NICU

admissions required is higher in patients with ONLY umbilical ARTERY ABNORMAL as compared to both DOPPLER ARTERY (MCA AND UA) normal. Percentage of NICU admissions required is higher in patients with pathological EFM as compared to normal EFM. The sensitivity and specificity of DOPPLER is much more than EFM in prediction of perinatal outcome in cases of PIH. The accuracy of correct prediction is more with Doppler velocimetry ie. 79.8%. PPV of Doppler is 73.1% and NPV of EFM is 92.3%.

Both the tests are complementary to one another in the fetal surveillance of high-risk pregnancies and no single test should be considered for decision making because each test reflects different aspects of maternal and fetal pathophysiology. The choice of test can be dictated by the clinical.

**Strength of the study**

Both the tools of antenatal assessment, EFM and colour doppler in all the high risk pregnancies have been studied together in different combination categories which gives us a better overview regarding expectant management vs termination in high risk pregnancies which would have not been very clear if we have studied either of the methods alone**.** We have studied different outcome variables from liquor to nicu admissions, neonatal complications to discharge.

Weakness of the study is small sample size and if the EFM and Doppler in together would have been compared with the results of EFM and colour doppler alone separately as controls then the study would have better analysis to comment on their roles in high risk pregnancy.

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