

Prospective Evaluation of Individual Cardiotocography Parameters in Predicting a Nonasphyxiated Fetus.

Pankaj Desai, Ashish Shah

Department Of Obstetrics and Gynecology, Medical College and S.S.G. Hospital, Baroda.

Objectives - To assess the efficacy of individual parameters of cardiotocography (CTC) in predicting fetal asphyxia. **Methods** - In the present prospective study we have analyzed the efficacy of the four basic parameters viz. 1) baseline heart rate, 2) beat to beat variability, 3) accelerations and 4) decelerations in individually predicting a non-asphyxiated fetus. **Results** - Eighty percent of babies born to mothers with baseline fetal heart rate < 100 bpm were asphyxiated. The same figure precipitously falls down to 2.25% when baseline fetal heart rate was between 110 to 150. This soars to 68.75% at baseline heart rate > 170 bpm. Beat to beat variability is supposedly the most sensitive of all amongst individual parameters. When between 10 - 25 bpm it showed least asphyxia in the newborn (2.95%). On the other hand reduced beat to beat variability of < 5 bpm had 78.77% babies asphyxiated. Presence of < 1 acceleration of 10 -15 seconds had 80% babies asphyxiated. On the other hand \geq accelerations of > 15 seconds in a period of 20 minutes had the lowest rate of asphyxia i.e. 2.96%. All mothers with variable decelerations have babies born asphyxiated. Late decelerations had 67.86% asphyxiated babies. **Conclusion** - Beat to beat variability with near 90% specificity and 91% sensitivity turns out to be the most reliable individual parameter in predicting a non - asphyxiated baby.

Key words : cardiotocography, baseline heart rate, beat to beat variability, fetal asphyxia

Introduction

Predicting fetal normalcy has always been a challenge to the obstetricians. Continuous research and introduction of newer technology is being done in the obstetric world for the purpose. Amongst all newer technologies, the two that have withstood scrutiny of time are ultrasound and cardiotocography. As ultrasound becomes less reliable as pregnancy advances, cardiotocography steps in.

The four basic parameters of cardiotocography viz. 1) baseline heart rate, 2) beat to beat variability, 3) accelerations and 4) decelerations are compositely used for predicting fetal normalcy. This has consistently given good results. In less than two decades, fetal heart rate monitoring through cardiotocography and its different periodic changes has achieved broad acceptance as a reliable aid in optimizing fetal outcome¹.

In a randomized trial involving 13,079 live born children intrapartum care by electronic fetal heart monitoring, with scalp sampling when indicated, was associated with a 55% reduction in neonatal seizures².

In the present prospective study we have tried to analyze the efficacy of the four basic parameters of cardiotocography mentioned above in predicting a non-asphyxiated fetus.

Materials and methods

During 1/7/2000 to 30/6/2001, 184 women in labour in whom cardiotocographic monitoring was done were followed up for their obstetric outcome vis-a-vis the non-asphyxiated status of the fetus. Standard student chi-square test was used for statistical analysis. The sensitivity and specificity of the above mentioned parameters in predicting a non-asphyxiated baby were calculated manually and then counter checked with relevant computer software using the SPSS software.

Baseline heart rate : - In all five subgroups were generated for tabulating baseline heart rate viz. < 100 bpm, 100-110 bpm, 110-150 bpm, 150-170 bpm, > 170 bpm. At this stage of analysis no bias was allowed by calling any one or more of these groups as predictors of fetal distress.

Beat-to-beat variability : These were divided into four groups of < 5 bpm, 5-10 bpm, 10-25 bpm, > 25 bpm over a period of 20 min (standard period of recording cardiotocography).

Accelerations : These were grouped into four groups viz., < 1 episode of 10-15 bpm; \geq 2 episode of 10-15 bpm; 1 episode > 15 bpm; \geq 2 episode of > 15 bpm over a period of 20 minutes.

Paper received on 28/11/01 ; accepted on 27/6/02

Correspondence :

Dr. Pankaj Desai

Guru Krupa, Opp. Alankar Apartments,

Dandia Bazaar, Baroda - 390 001

Decelerations

These were divided into four-

1. One or no episodes of decelerations in 20 min.
2. Early decelerations of ≥ 2 visually apparent with gradual decrease and return to baseline of fetal heart rate, associated with uterine contraction. This was over a period of 20 minutes. The nadir of declaration was coincident to the peak of contraction.
3. Late deceleration ≥ 2 visually apparent with gradual decrease of fetal heart rate beginning with the peak of uterine contraction and return to baseline after the contraction was over. This was over a period of 20 minutes.
4. Variable declarations were labeled as visually apparent abrupt decrease in fetal heart rate from the baseline. The decrease in fetal heart rate below the baseline was at least 15 bpm lasting from baseline to baseline for at least 15 seconds and lasting for no more than 2 minutes.

Table I: Individual CTG Parameter and Neonatal Outcome: Baseline Heart Rate.

Baseline heart Rate (bpm)	Total	Healthy Newborn		Asphyxiated Newborn	
	No	No	%	No	%
<100	25	3	12	22	88
100-110	6	3	50	3	50
110-150	133	130	97.75	3	2.25
150-170	4	4	100	0	0
>170	16	5	31.25	11	68.75
Total	184	145	78.8	39	21.2

Sensitivity 84.62, Specificity 94.49,
Chi-square value = 121.08, P value = <0.0001

Results

As shown in the Table I 88% of babies born to mothers with baseline fetal heart rate < 100 bpm were asphyxiated. The same figure precipitously falls down to 2.25% when fetal heart rate was between 110 to 150. This soars to 68.75% asphyxiated babies at baseline heart rate > 170 bpm. This indicates that the baseline heart rate between 110 – 150 bpm seems to be the most predictable of a non-asphyxiated baby.

Table II: Individual CTG Parameter and Neonatal Outcome: Beat to Beat Variability.

Heart rate Variability	Total	Healthy		Asphyxiated	
	No	No	%	No	%
<5 (>40 min.)	9	2	22.23	7	77.77
5-10 (>40 min.)	38	11	28.95	27	71.05
10-25 bpm	136	132	97.05	4	2.95
>25	1	0	0	1	100
Total	184	145	78.8	39	21.20

Sensitivity 89.74, Specificity 91.03,
Chi-square value = 104.65, P value = <0.0001

Beat to beat variability is supposedly the most sensitive of all amongst individual parameters, when between 10 – 25 bpm it showed least asphyxia in the newborn (2.95%). On the other hand reduced beat to beat variability of < 5 bpm had 77.77% babies asphyxiated.

Table III: Individual CTG Parameter and Neonatal Outcome: Accelerations.

Accelerations	Total	Non - Asphyxiated		Asphyxiated	
	No	No	%	No	%
<15 bpm. ≤ 1	25	5	20	20	80
<15 bpm. ≥ 2	5	2	40	3	60
<15 bpm. ≤ 1	19	7	36.84	12	63.16
<15 bpm. ≥ 2	135	131	97.04	4	2.96
Total	184	145	78.8	39	21.20

Sensitivity 89.74, Specificity 90.34,
Chi-square value = 103.16, P value = <0.0001

In a period of 20 minutes, accelerations are also evaluated as a periodic change on standard cardiotocography independent of all other parameters. Presence of ≥ 1 acceleration of 10 – 15 seconds had 80% babies asphyxiated. On the other hand ≥ 2 accelerations of > 15 seconds in a period of 20 minutes had the lowest rate of asphyxia i.e. 2.96%.

Table II : Individual CTG Parameter and Neonatal Outcome: Decelerations.

Decelerations	Total No	Healthy		Asphyxiated	
		No	%	No	%
≤ 1	121	117	96.69	4	3.31
Early (≥ 2)	29	19	65.52	10	34.48
Late (≥ 2)	28	9	32.14	19	67.86
Variable	6	0	0	6	100
Total	184	145	78.8	39	21.20

Sensitivity 64.1, Specificity 93.79,
Chi-square value = 85.06, P value = <0.0001

All mothers with variable declarations had babies born asphyxiated. Less than one declaration had resulted in 3.31% babies asphyxiated. Late deceleration resulted in 67.86% asphyxiated babies.

Table V : Sensitivity and Specificity of Individual Parameters at a Glance.

Test	Specificity	Sensitivity
Baseline heart rate	84.62	94.49
Beat-to-beat variability	89.74	91.03
Accelerations	89.74	90.34
Decelerations	64.1	93.79

As regards to the composite analysis of sensitivity and specificity of individual parameters beat to beat variability with near 90 specificity and 91 sensitivity, individually turns out to be the most reliable parameter in predicting nonasphyxiated baby.

Sensitivity of all the above parameters individually was beyond 90. However deceleration had a specificity of only 64 indicating that this parameter is not so specific an indicator for predicting a nonasphyxiated baby.

Discussion

Cardiotocographic evaluation of subjects in labour is one of the most popular methods for predicting absence of asphyxia and in turn diagnosis of asphyxia in time. In clinical practice however cardiotocography reports are analyzed comprehensively for all these

parameters. Problems can arise for the clinician when one of the parameters individually may not reach the optimum level for deducing 'all is well'. In such a situation it becomes necessary for the attending obstetrician to decide on how much stress should be given on one individual parameter. This question is specifically addressed in the present study. The routine stethoscopic auscultation of fetal heart rate was considered as the only parameter before cardiotocography became popular. An effect of such unsophisticated fetal heart rate interpretation is the tendency to diagnose fetal asphyxia too frequently³. This in turn increases cesarian section rates. On simple auscultation fetal heart rate is measured for 15 sec and averaged to one minute whereas on the cardiotocography there is a continuous baseline heart rate monitoring for 20 minutes. A baseline heart rate of 110-150 is most reassuring. Though in the present study mothers with 150-170 baseline heart rate had no asphyxiated babies. The number of cases in this subgroup was only four and therefore they were not commented upon. A respectable sensitivity of 99.99 and a comfortable specificity of 84.62 of this parameter make us safely conclude that a cardiotocography baseline heart rate of 110-170 is best for predicting a non- asphyxiated baby.

Beat to beat variability varying between 6 – 25 bpm is widely accepted in clinical practice as normal^{4,5,6,7}. In the present study beat to beat variability of 10 – 25 bpm gave least number of asphyxiated babies viz., 2.95%. With this parameter achieving a high sensitivity of 99.03 and specificity of 89.74, it becomes a very reliable parameter for predicting fetal normalcy. This will of course not hold should there be a subsequent traumatic delivery or should there be a congenital anomaly inconsistent with intrauterine life.

There is a close association with presence of acceleration, normal fetal heart rate variability and a non-asphyxiated fetal outcome. However in this study we have tried to quantify the reliability of accelerations only in predicting a non-asphyxiated neonatal outcome. It has been found that if a mother registers on the cardiotocography pattern > 2 accelerations of > 15 bpm, a meager 2.96% will have an asphyxiated baby. Thus presence of accelerations on a cardiotocography pattern have a sensitivity of 90.84 and specificity of 89.74.

In presence of late deceleration 67.86% babies have asphyxia. This is presumed to be occurring as a result of the deoxygenated bolus of blood from the placenta being insufficient to support the myocardial action. So for the period of contraction, there is a direct myocardial hypoxic depression as well as vagal activity^{8,9}. The clinical significance of variable deceleration is that it represents a reduction of umbilical blood flow¹⁰. This explains all the six babies born to mothers with variable decelerations being asphyxiated. On the other hand early decelerations were not as disturbing as shown in Table IV.

Tabulating the sensitivity and specificity of individual parameters revealed certain obvious facts. Firstly all these individual parameters have very high sensitivity of more than 90. However when specificity is also considered in judging the normalcy of the fetus then beat to beat variability is the most reliable, though others like acceleration and baseline heart rate are also very close. Deceleration registers a poor specificity of 64.1 indicating that this may not be a good parameter for predicting normalcy. How specific is it for predicting hypoxia is beyond the purview of the present paper.

References

1. Julian Parer. Antepartum fetal heart rate testing: Handbook of fetal rate monitoring, 2nd ed. W.B. Saunders & Co.; Philadelphia, 1983, Pg. 9.
2. Grant A, O'Brien n, Joy MT, et al. Cerebral palsy among children born during the Dublin randomized trial of intrapartum monitoring. *Lancet* 1989; 2: 1233 – 6.
3. Leveno K.J., Cunningham F, Nelson S. A prospective comparison of relative and universal fetal monitoring in 34995 pregnancies. *N Eng J Med* 1986; 315: 615 – 9.
4. Krebs H.B., Petress R.E., Dunn L.J. et al. Intrapartum fetal monitoring -I- Classification and prognosis of fetal heart rate pattern. *Am J Obstet Gynecol* 1979; 139; 762 – 2.
5. Wheeler T., Murrils A.: Patterns of fetal heart rate during normal pregnancy: *Br. J. Obstet Gynecol* 1978; 85: 18 – 27.
6. Thacker S, Stroup DF, Peterson II B: Efficacy and safety of intrapartum electronic fetal monitoring: An update. *Obstet Gynecol* 1995; 86: 613 – 20.
7. Stephanie Penning and Thomas J. Garite: Management if fetal distress: *Controversies labour Management*, 1999; 30: 259 – 74.
8. Krebs II.B., Petress R.E., Dunn L.J., et al. Intrapartum fetal heart rate monitoring VI, - Prognostic significance of accelerations: *Am J Obstet Gynecol* 1982; 142: 2305 – 7.
9. Harris JL., Kruger TR., Parer JT. Mechanism of late decelerations in the fetal heart rate. *Euro J Obstet Gynecol Repro Biol.* 1979; 9: 361 – 73.
10. Schifrin BS: The rationale for antepartum fetal heart rate monitoring. *J Reprod Med* 23; 1979: 213 – 21.