Is fetal CTG a reliable indicator of fetal distress? A prospective study on relationship between CTG suspected fetal distress and immediate postpartum umbilical cord blood pH

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Abstract

Introduction: Perinatal asphyxia is one of the major causes of neonatal morbidity and mortality. Fetal Cardiotocography (CTG) has been used for long to predict fetal asphyxia. Despite its popularity, it has not been proved to be an ideal tool for monitoring as, although a normal trace is indicative of a normal acid-base status at birth, in about 98% of cases, an abnormal trace has a low positive predictive value in term of fetal acidosis (pH less than 7.25) .An undisputed evidence of perinatal asphyxia is metabolic acidosis on arterial cord blood or very early neonatal samples: pH< 7 and base deficit >12 mmol/L

Aim: To see the correlation between suspicious/pathological CTG and umbilical cord blood pH at birth in term pregnancies.

Material and methods: This was a hospital based prospective randomized observational study over a period of 1 year. It was conducted on 165 pregnant women with singleton term pregnancy admitted to labour ward for delivery and having suspicious / pathological CTG trace or meconium stained liquor with normal CTG trace. Immediately after the birth of the neonate, umbilical cord was clamped, cut and umbilical artery cord blood was collected in a pre - heparinized syringe and sent for pH analysis. Cord blood pH of less than 7.2 was interpreted as acidosis.

Results: The number of acidotic cases (as determined by cord blood pH less than 7.2) was 2(5.6%) in normal traces whereas 34 cases (94.4%) of normal traces were non acidotic. In the suspicious traces, 2 cases (3.2%) were acidotic and 59 cases (96.8%) were non acidotic. In the pathological category, 13 cases (19.1%) were acidotic and 55 cases (80.9%) were non acidotic. There was no significant association of CTG category with cord blood pH, acidosis, pO2 or pCo2 values but that with presence of MSL and grade of MSL was statistically significant.

Conclusion: Abnormal CTG while being a good predictor of the presence of MSL and also the grade of MSL, is a poor predictor of the presence of fetal acidosis and neonatal status after birth. Fetal monitoring using cardiotocography was associated with considerable false positive results. Thus, using fetal heart rate abnormalities alone as a measure of diagnosis of fetal distress during labour is a contributing factor of increasing rate of cesarean sections.

Key words: CTG, fetal cardiotocography, fetal distress, cord blood pH

Introduction

Labour is a stressful event for the fetus. Fetal distress is defined as a condition in which fetal physiology is so altered to make death/ permanent injury a probability within a relatively short period of time and usually considered to denote disruption of normal fetal oxygenation, ranging from mild hypoxia to prolonged fetal asphyxia [1].

Perinatal asphyxia is one of the major causes of neonatal and childhood morbidity and mortality. WHO states that about nine million neonates develop birth

asphyxia every year and out of these, around one million die, while the same number develop severe consequences like cerebral palsy, epilepsy and delayed developmental milestones.

There are various methods to recognize perinatal asphyxia. The easiest method is intermittent auscultation of fetal heart rate (FHR); but it focuses only on the determination of basal heart rate. Another method is Cardiotocography (CTG). Cardiotocography (sometimes known as electronic fetal monitoring), records changes in the fetal heart rate and their temporal relationship to uterine contractions. In addition to estimating the basal heart rate, it also assesses other parameters like variability, accelerations and decelerations of fetal heart rate [2]. CTG has now become a very popular tool in labour wards. Despite its popularity, it has not been proved to be an ideal tool for monitoring as, although a normal trace is indicative of a normal acid-base status at birth, in about 98% of cases, an abnormal trace has a low positive predictive value in term of fetal acidosis (pH less than 7.25) [3].

Fetal scalp blood sampling gives an accurate intrapartum fetal oxygenation status, but it is invasive, requires expertise, needs relatively large amount of blood, often require to be repeated and is associated with a sampling failure rate of 11-12% making it relatively less popular [4-6]. One more method is ST analysis (STAN) that involves a combination of the fetal electrocardiogram interpretation and analysis of the fetal electrocardiogram. This analysis requires special machines that are not available widely.

An undisputed evidence of perinatal asphyxia is metabolic acidosis on arterial cord blood or very early neonatal samples: pH< 7 and base deficit >12 mmol/L [7]. Acute fetal distress induces asphyxia, leading to hypoxia of most of the organs which causes increase in lactic acid level along with alteration in pH and HCO3.

Cardiotocography is the most commonly used method to suspect perinatal asphyxia. CTG monitoring is a modern and non-invasive method for assessing both antepartum and intrapartum fetal status. Intrapartum CTG tracings are classified into Normal (category I trace), Suspicious and Pathological trace according to the NICE 2017 guideline [8]:

1. Normal-All features are reassuring
2. Suspicious- 1 non-reassuring AND 2 reassuring features.
3. Pathological-1 abnormal feature OR 2 non-reassuring features.

Aim: To see the correlation between suspicious/pathological CTG and umbilical cord blood pH at birth in term pregnancies.

Objectives: Primary: Correlation of suspicious/pathological CTG or those with a normal CTG but having meconium stained liquor with cord blood pH.

Secondary:
1. Correlation of suspicious/pathological CTG with Apgar at 1 minute and 5 minutes
2. Correlation of suspicious/pathological CTG with meconium stained liquor (MSL)
3. Correlation of suspicious/pathological CTG with cord blood acidosis in Meconium stained liquor cases.
4. Correlation of suspicious/pathological CTG with Neonatal ICU admission, need for resuscitation and convulsions in the first 24 hours after birth.

Material and methods

The present study included women with term singleton pregnancies in labour with suspicious/pathological CTG tracings or those with a normal CTG but having meconium stained liquor, who were admitted for delivery in the labour ward at a tertiary care hospital and this was correlated with the cord blood pH immediately at birth. This hospital based prospective randomized observational study was conducted over a period of 1 year (from September 2019 to September 2020)

Intrapartum CTG tracings were taken and classified into Normal (category I trace), Suspicious (category II trace) and Pathological trace (category III trace) according to the NICE 2017 guidelines [8].

Umbilical cord arterial blood was taken immediately after birth, in a pre-heparinized syringe and was sent to the laboratory for pH study to detect acidosis. A cord blood pH of less than 7.2 was interpreted as acidosis and a cord blood pH equal to or more than 7.2 as normal, as described by Saling [9].

Statistical Analysis

Sample size for the study was calculated as:

n = Z2× (p) × (1-p)/Δ2

Where n is the sample size,

Z is confidence interval i.e., 1.96 for 95%

Δ is confidence level i.e., 0.05 for ±5%

p=prevalence of the event in the population as determined by previous studies.

Taking incidence of fetal acidosis in term singleton pregnancies as per previous studies as 12.2% [10] sample size for my study is calculated to be:

n = (1.96)2× (0.122) × (1-0.122)/ (0.05)2 = 165

Data was analyzed and statistically evaluated using SPSS-PC-20 version.

Inclusion Criteria

All term (> 37 weeks) singleton pregnancies with vertex presentation in labour with documented suspicious/pathological CTG or Normal CTG with MSL.

Exclusion criteria

All high-risk pregnancies (anemia, hypertension, thyroid disorders, diabetes, epilepsy, asthma, teenage, elderly)

Intrauterine growth restriction, oligohydramnios, preterm deliveries

Multiple gestation, malpresentations

Abruptio placenta

Fetus with congenital anomalies

Maternal infections and Premature rupture of membranes (PROM)

Patients not giving consent.

Baseline data recording

All women with term singleton pregnancies in labour with suspicious/pathological CTG and women who may be having a normal CTG but had MSL ,fulfilling the inclusion criteria and admitted to our labour ward, were enrolled in the study, after taking an informed consent. On admission, all patients underwent general, systemic and obstetrical examination to rule out any fetal compromise. Labour was monitored by 4-hourly CTG when the cervix was less than 6cm dilated and thereafter, continuous CTG monitoring was done. Details were recorded including gestational age at onset of labour, mode of onset of labour (spontaneous or induced), cervical dilatation on admission, membranes status, time of rupture of membranes (spontaneous or artificial), nature/color of liquor after rupture of membranes, CTG tracings, mode of delivery, Apgar score at 1 and 5 minutes, nursery stay, cord blood pH values, need for resuscitation, occurrence of neonatal seizures were all recorded

in study proforma sheets. Intrapartum cardiotocography was recorded using Philips Avalon FM20 EF Monitor machine. Tracings were taken by the machine at a speed of 1 cm/min for 20 minutes 4 hourly till 6 cm dilation. Continuous CTG tracings were taken when the patient was in active labour i.e.>6cm dilation. Fetal heart rate patterns were interpreted using the NICE guidelines 2017 [8].

Cord blood collection

Immediately at birth, possibly before the baby's first breath and before delivery of the placenta, the umbilical cord was clamped at two points, 10 cm apart, with Kocher's clamps and cut. The umbilical artery was immediately identified in the cord and 5 ml of blood was aspirated with a pre-heparinized syringe. In order to prevent air contact, the syringe tip was sealed with a plastic cover. Cord blood was analyzed by Radiometer ABL800 Basic Machine used at our institute within 30 minutes of collection. Fetal acidosis was assessed using umbilical cord blood pH. An umbilical artery pH <7.20 was defined as fetal acidosis.

Results

The study included 165 term labouring women who had been admitted in a tertiary care hospital who had either MSL or abnormal CTG and had cord blood ABG taken immediately after delivery of the fetus. 21.8% (n=36) cases had a normal CTG but with MSL, 41.2% (n=68) had a pathological CTG and 37 % (n=61) had a suspicious CTG (Table 1).

Table 1	CTG Category	
CTG Category	Frequency	Percentage
Normal (but having MSL)	36	21.80%
Pathological	68	41.20%
Suspicious	61	37.00%
Total	165	100%

There was no statistically significant association between maternal age and CTG category (Table 2).

There were 106 primigravidas and 59 multigravidas. The frequency of pathological trace was higher in primigravidas than in multigravidas (44.3% vs 35.6%, i.e. 47 cases and 21 cases respectively). However, it was not statistically significant (Table 3).

Similarly, there was no statistically significant association between period of gestation and CTG category (Table 4).

In our study, 21.2 % (35 cases) were induced and 78.8 % (130 cases) had a spontaneous onset of labour. Frequency of pathological trace was similar in both induced and spontaneous labour, 40% (14 cases) and 41.5% (54 cases) respectively, making it statistically insignificant (p value- 0.981) (Table 5). There was no statistical association between the mode of onset of labour and CTG category (Table 5).

In our study, 79 (47.9%) cases had MSL while 86 (52.1%) cases did not. Out of the 79 cases with MSL, 36 (45.6%) cases had a normal trace, 21 (26.6%) cases had a pathological trace and 22 (27.8%) cases had a suspicious trace. Out of the 86 cases without MSL, 47 cases (54.7%) had a Pathological trace and 39 cases (45.3%) had a suspicious trace. The p value for this association between presence of MSL and abnormal CTG category was <0.001 for both suspicious and pathological traces, making it statistically significant (Table 6).

Of the 79 (47.9%) cases that had MSL, 19 (24%) cases had Grade 1 MSL, 32 (40.5%) cases had Grade 2 MSL and 26

(35.5%) cases had Grade 3 MSL. 10 (52.6%) cases of Grade 1 MSL had a normal trace, 3 (15.8%) cases had a pathological trace and 6 (31.6%) cases had a suspicious trace. In cases with Grade 2 MSL, 15 (46.9%) cases had a normal trace, 6 (18.8%) cases had a pathological trace and 11 (34.4%) cases had a suspicious trace. Amongst the cases with Grade 3 MSL, 11 (39.3%) cases had a normal trace, 12 (42.9%) cases had a pathological trace and 5 (17.9%) cases had a suspicious trace. The p value for this association between grade of MSL and abnormal CTG category was <0.001 for both suspicious and pathological cases and was statistically significant (Table 7).

There was no statistical association between the Apgar scores at 1 and 5 minutes and abnormal CTG category (Table 8).

The mean pH for a normal CTG but having MSL was found to be 7.35 with a standard deviation of 0.08, the mean pO_2 was 91.56 with a standard deviation of 12.46 and mean pCO_2 was 43.51 with a standard deviation of 9.53. The mean pH for a pathological CTG was found to be 7.34 with a standard deviation of 0.1, the mean pO_2 was 88.09 with a standard deviation of 15.29 and mean pCO_2 was 45.22 with a standard deviation of 10.15. The mean pH for a suspicious CTG was found to be 7.36 with a standard deviation of 0.07, the mean pO_2 was 91.43 with a standard deviation of 11.45 and mean pCO_2 was 42.89 with a standard deviation of 7.11. All p values are not significant (Table 9).

The number of acidotic cases (as determined by cord blood pH less than 7.2) was 2 (5.6%) in normal traces whereas 34 cases (94.4%) of normal traces were non acidotic. In the suspicious traces, 2 cases (3.2%) were acidotic and 59 cases (96.8%) were non acidotic. In the pathological category, 13 cases (19.1%) were acidotic and 55 cases (80.9%) were non acidotic. There was no significant association of CTG category with cord blood pH, acidosis, and pO_2 or pCO_2 values (Table 9, Table 10).

Only 5.4% (9 cases) cases required NICU stay. All of these had acidosis on ABG. In patients who had a normal CTG but had meconium stained liquor 91.7% (33 cases) did not require any NICU care. Only 8.3% (3 cases) were admitted to NICU. In patients who had a pathological CTG 92.6% (63 cases) did not require any NICU care. Only 7.4% (5 cases) were admitted to NICU. In patients who had a suspicious CTG, 98.4% (60 cases) did not require any NICU care. Only 1.6% (1 case) were admitted to NICU. The p-value came out to be 0.25, making the strength of association statistically insignificant (Table 11).

7.8% (12 cases) required resuscitation. Only 8.3% cases (3 cases) with a normal trace along with MSL required resuscitation and the rest 91.7% (33 cases) did not. In the pathological trace category, 11.8% cases (8 cases) required resuscitation while the rest 88.2% (60 cases) did not. Interestingly, only 1 case (1.6%) of suspicious trace cases required resuscitation while the rest 60 cases (98.4%) did not. The p value was 0.084, making the association statistically insignificant (Table 12).

In our study, 3 cases (1.8%) had convulsions within the first 24 hours after birth. All of these had acidosis on ABG. Of these, 2 cases had a pathological trace (2.9% of pathological cases) and 1 case had a suspicious trace (1.6% of suspicious traces). None of the normal CTG cases with MSL had convulsions within the first 24 hours after birth. The p value of 0.56 was statistically insignificant (Table 13).

The sensitivity and specificity of a pathological trace was 86.6% and 38.2% respectively while that of a suspicious trace was 50% and 36.5% respectively. The positive predictive value and negative predictive value of a pathological trace was 19.2% and 94.5%, while that of a suspicious trace was 3.27% and 94.5% respectively.

Table 2 — Maternal Age

Maternal Age	Total Cases	CTG Category			p value
		Normal (with MSL)	Pathological	Suspicious	
		Frequency (%)	Frequency (%)	Frequency (%)	
20-25 years	48	07 (14.6%)	27 (56.2%)	14 (29.1%)	0.572- not significant
26-30 years	63	18 (28.6%)	16 (25.4%)	29 (46%)	
31-35 years	46	08(17.4%)	23(50%)	15(32.6%)	
36-40 years	8	03(37.5%)	2(25%)	3(37.5%)	
Total	165	36 (21.8%)	68 (41.2%)	61 (37.0%)	

Table 3 — Parity

Obstetric History	Total Cases	CTG Category			p value
		Normal (with MSL)	Pathological	Suspicious	
		Frequency (%)	Frequency (%)	Frequency (%)	
Primigravida	106	20 (18.9%)	47 (44.3%)	39 (36.8%)	0.389- not significant
Multigravida	59	16 (27.1%)	21 (35.6%)	22 (37.3%)	
Total	165	36 (21.8%)	68 (41.2%)	61 (37.0%)	

Table 4 — Gestational Age

Period of Gestation	Total Cases	CTG Category			p value
		Normal (with MSL)	Pathological	Suspicious	
		Frequency (%)	Frequency (%)	Frequency (%)	
37 - 37+6 wks	21	8 (38.1%)	6 (28.6%)	7 (33.3%)	0.254 -not significant
38 - 38+6 wks	48	6 (12.5%)	23 (47.9%)	19 (39.6%)	
39 - 39+6 wks	57	11 (19.3%)	26 (45.6%)	20 (35.1%)	
40 - 40+6 wks	39	11 (28.2%)	13 (33.3%)	15 (38.5%)	
Total	165	36 (21.8%)	68 (41.2%)	61 (37.0%)	

Table 5 — Mode of Onset of Labour

Labour type	Total Cases	CTG Category			p value
		Normal (with MSL)	Pathological	Suspicious	
		Frequency (%)	Frequency (%)	Frequency (%)	
Induced	35	8 (22.9%)	14 (40.0%)	13 (37.1%)	0.981-not significant
Spontaneous	130	28 (21.5%)	54 (41.5%)	48 (36.9%)	
Total	165	36 (21.8%)	68 (41.2%)	61 (37.0%)	

Table 6 — Presence of Meconium Stained Liquor

Meconium	Total Cases	CTG Category			p value
		Normal (with MSL)	Pathological	Suspicious	
		Frequency (%)	Frequency (%)	Frequency (%)	
Absent	86	0 (0.0%) Not included in the study	47 (54.7%)	39 (45.3%)	<0.001 -significant
Present	79	36 (45.6%)	21 (26.6%)	22 (27.8%)	
Total	165	36 (21.8%)	68 (41.2%)	61 (37.0%)	

Table 7 — Grade of Meconium Stained Liquor

Grade	Total Cases	CTG Category			p value
		Normal (with MSL)	Pathological	Suspicious	
		Frequency (%)	Frequency (%)	Frequency (%)	
-	86	0 (0.0%)	47 (54.7%)	39 (45.3%)	<0.001- significant
1	19	10 (52.6%)	3 (15.8%)	6 (31.6%)	
2	32	15 (46.9%)	6 (18.8%)	11 (34.4%)	
3	28	11 (39.3%)	12 (42.9%)	5 (17.9%)	
Total	165	36 (21.8%)	68 (41.2%)	61 (37.0%)	

Table 8	Apgar score			
	CTG Category			P Value
	Normal (with MSL)	Pathological	Suspicious	
	Mean ± SD	Mean ± SD	Mean ± SD	
APGAR 1 MIN	8.03 ± 1.03	7.78 ± 1.29	8.10 ± 0.87	0.231
APGAR 5 MIN	8.75 ± 0.60	8.60 ± 0.98	8.85 ± 0.57	0.187

Table 9	ABG Characteristics			
	CTG Category			p value
	Normal (with MSL)	Pathological	Suspicious	
	Mean ± SD	Mean ± SD	Mean ± SD	
pH	7.35 ± 0.08	7.34 ± 0.1	7.36 ± 0.07	0.609
pO2	91.56 ± 12.46	88.09 ± 15.29	91.43 ± 11.45	0.28
pCO2	43.51 ± 9.53	45.22 ± 10.15	42.89 ± 7.11	0.321

Table 10	Presence of Acidosis				
	Total Cases	CTG Category			p value
		Normal (with MSL)	Pathological	Suspicious	
		Frequency (%)	Frequency (%)	Frequency (%)	
Acidotic	17	2 (05.6%)	13 (19.1%)	2 (3.2%)	0.0904 – not significant
Non acidotic	148	34 (94.4%)	55 (80.9%)	59 (96.8%)	
Total	165	36 (21.8%)	68 (41.2%)	61 (37.0%)	

Table 11	NICU Stay				
NICU Stay	Total Cases	CTG Category			p value
		Normal (with MSL)	Pathological	Suspicious	
		Frequency (%)	Frequency (%)	Frequency (%)	
No	156	33 (91.7%)	63 (92.6%)	60 (98.4%)	0.25- not significant
Yes	9	3 (8.3%)	5 (7.4%)	1 (1.6%)	
Total	165	36 (21.8%)	68 (41.2%)	61 (37.0%)	

Table 12	Need for Fetal Resuscitation				
Resuscitation	Total Cases	CTG Category			p value
		Normal (with MSL)	Pathological	Suspicious	
		Frequency (%)	Frequency (%)	Frequency (%)	
No	153	33 (91.7%)	60 (88.2%)	60 (98.4%)	0.084- not significant
Yes	12	3 (8.3%)	8 (11.8%)	1 (1.6%)	
Total	165	36 (21.8%)	68 (41.2%)	61 (37.0%)	

Table 13	Occurrence of Convulsions within the first 24 hours after Birth				
Convulsions	Total Cases	CTG Category			p value
		Normal (with MSL)	Pathological	Suspicious	
		Frequency (%)	Frequency (%)	Frequency (%)	
No	162	36 (100%)	66 (97.1%)	60 (98.4%)	0.56- not significant
Yes	3	0 (0.0%)	2 (2.9%)	1 (1.6%)	
Total	165	36 (21.8%)	68 (41.2%)	61 (37.0%)	

Table 14	Sensitivity, Specificity, Positive and Negative predictive value of pathological and suspicious trace	
	Pathological	Suspicious
Sensitivity	86.6%	50%
Specificity	38.2%	36.5%
Positive predictive value	19.2%	3.27%
Negative predictive value	94.5%	94.5%

Discussion

The foetus undergoes physiological stress during labour. Fetal morbidity and mortality may occur as a consequence of labour even in low risk patients. Cardiotocography is a simple, non-invasive recordable method of intrapartum fetal monitoring which can be used as a tool to detect hypoxemic events in the foetus-in utero during labour, enabling initiation of appropriate management. We studied the correlation between intrapartum

CTG in term labouring women with cord blood pH in their neonates in order to predict acidosis in the foetus and thus to detect the number of cases with actual distress in cases with abnormal CTG traces.

We recruited 165 labouring women who had either a suspicious or pathological CTG, or had a normal CTG but having meconium stained liquor. The study recruited women in the age group of 20 to 40 years. In our study, maximum number of cases were between the ages of 26 to 30 years while the least were between 36 to 40 years. This correlates well with the normal pattern of maximum fertility between 20-30 years of age.

Most cases were between 38 to 38 weeks 6 days of gestation with a decline on either side of this interval. The least number of cases were in the 40 weeks to 40 weeks 6 days period of gestation due to higher rate of spontaneous labour before 40 weeks and also due to most cases that reach 40 weeks of gestation being induced for postdatism in our centre.

The number of cases that went into spontaneous labour were almost four times those that were induced as most cases that were induced due to some medical comorbidity were excluded from our study. Frequency of pathological trace was similar in both induced and spontaneous labour (40% and 41.5% respectively), making it statistically insignificant (p value-0.981).

79 cases were associated with MSL. Out of these, 36 cases (45.6%) had a normal CTG, 21 cases (26.6%) had a pathological CTG and 22 cases (27.8%) had a suspicious CTG. We also had 86 cases without MSL. A pathological trace was seen in 47 (54.7%) cases of these 86 cases and a suspicious CTG was seen in 39 (45.3%) cases. The association of CTG category with presence of MSL was statistically significant (p-value <0.001). This showed that in the presence of a pathological/suspicious trace, there was a strong possibility of the presence of MSL.

MSL was strongly associated with a pathological trace. It also correlated well with the Grade of MSL. Hence, Grade 1 had more normal traces than Grade 2 and 3 where pathological or suspicious were more. In a study performed by Sunitha C et al. [11] on 100 women, 4% of normal traces had the presence of meconium stained liquor and 44% of abnormal traces had the presence of meconium stained liquor. Similar to our study, they found a positive correlation between the presence of MSL with CTG category. Similar result was obtained in the study conducted Kumar N et al. [12] in which, out of 30 cases, 5 (16.7%) had a normal CTG while 10 (33.4%) had an abnormal CTG, with a positive correlation between CTG category and the presence and grade of MSL.

The mean Apgar score at 1 minute was similar for normal and suspicious traces with slightly lower Apgar for a pathological case. However, the mean Apgar at 5 minutes was similar for all categories of CTG traces. CTG traces did not correlate well with the Apgar score and was a poor predictor of neonatal outcome. This was in contrast to the study by W M Aboulghar et al. [13], where there was a positive correlation between the Apgar score at 1 and the CTG category, but not with the 5 minute Apgar score. The 1 minute Apgar was less than 4 in 29.2 % cases of pathological traces and 9.6% of suspicious cases. The 5 minute Apgar score was less than 6 in 8.3% of pathological and 3.6% of suspicious traces. In the study by Agrawal SK et al. [14], the mean Apgar scores at 1 minute were 7.5± 0.6 for normal category CTG and 7.6± 0.3 for abnormal category CTG. The 5-min Apgar score was 8.8± 0.2 and 8.7± 0.2 respectively. Their result was similar to our study with no significant correlation between CTG category and Apgar score. In the study by van den Berg P et al. [15] on 2659 women, the

proportion of infants who had low modified Apgar scores (less than 7) in the group with normal CTG was 8% (19 of 236) and 0.9% (22 of 2433) for those with abnormal CTG. Similar to our study, there was no statistical correlation with Apgar score and CTG category. In a study by Sowmya D et al. [16], 100 women with either suspicious or pathological traces were recruited. In their study, 25% of cases in the suspicious category and 38.46% in the pathological category had 1-minute Apgar less than 7. The 5-minute Apgar was less than 7 in 75% pathological cases and in 61.53% suspicious cases. Unlike our study, they showed a positive association between CTG category and Apgar score.

When cord blood ABG characteristics were compared, there was not much difference in pH for all 3 categories. The pO2 and pCO2 for normal and suspicious category were similar. The pO2 was lower and pCO2 was higher for the pathological category, but this difference was not statistically significant.

The number of acidotic cases were similar for normal and suspicious CTGs. Of all the cases that had a pathological trace, 13 cases (19.1%) had acidosis (pH less than 7.2). Acidosis was present in 2 cases (3.2%) of suspicious and 2 cases (5.6%) of normal CTG category. There was no statistical significance between CTG category (suspicious/pathological) and presence of acidosis.

The total percentage of acidotic cases was 10.3 % (17 cases) while 89.7% (148 cases) were non acidotic which is comparable to the study by Kaban et al. [17] (13.26%) who studied 101 term pregnant women admitted for delivery. In their study 85 neonates had normal cord arterial pH and 13 had fetal acidosis as diagnosed by cord arterial pH values less than 7.2. Of the 13 neonates with acidosis, 5 had non-reactive CTG tracings intrapartum. A similar study was performed by Aboulghar et al. [13]. The mean cord blood pH was 7.24 ± 0.07 (range: 7.05 – 7.39). The acidosis group comprised only 34% of their neonates, while the rest 66% had normal cord blood pH. This difference from our study could be attributed to the fact that they included only abnormal CTG cases and did not include any normal cases. Similar to our study, there was no significant association of CTG category with cord blood pH, acidosis, and pO2 or pCo2 values. In a study conducted by Kumar N et al. [12] on 30 women, 13 had abnormal CTG. Out of the 13 women having abnormal CTG results, only 3 (23.07%) showed acidosis (fetal distress in true sense) and required NICU admission. They observed that CTG wasn't a very effective tool for fetal assessment and correlation between cord blood pH and CTG was not significant.

The sensitivity of a pathological trace for acidosis was good (86.6%) but the specificity was poor as it was only 38.2%. The positive predictive value was poor at 19.2%. However, the negative predictive value was good at 94.5%. The sensitivity of a suspicious trace for acidosis was poor at 50%, with an equally poor specificity of 36.5%.The positive predictive value was poor at 3.27%, but the negative predictive value was good at 94.5%. A pathological trace is highly sensitive for detecting fetal acidosis but the specificity for detecting it is poor in our study. However, the presence of a normal trace rules out the presence of fetal acidosis due to a good negative predictive value. A suspicious trace had a poor sensitivity, specificity and positive predictive value, but it had a high negative predictive value like a pathological trace.

These findings are comparable with those found by Parveen et al. [18] who concluded that a normal CTG trace correlates highly with absence of fetal acidosis. Parveen studied 122 cord blood samples using umbilical cord arterial base excess (more than 12mmol/l) at birth to diagnose fetal acidemia. From their study they found that cardiotocography has a sensitivity of

15.38%, specificity of 86%, positive predictive value 11.76% and a negative predictive value 89%. This difference may be because of the fact that they took umbilical artery base excess at birth to diagnose fetal acidosis, while in the present study, umbilical cord arterial pH value of less than 7.2 was taken to diagnose fetal acidosis.

Steer PJ et al. [19] conducted a prospective study to find correlation among FHR patterns, MSL, umbilical cord arterial blood pH and Apgar score in 698 cases and found that sensitivity of an abnormal CTG at any time for fetal acidosis (cord arterial pH less than 7.17) was 80% and for severe acidosis (pH less than 7.08) was 83%. However positive predictive value was low: 32% foetuses had abnormal CTG but no acidosis. If only CTG abnormality in I stage labour was considered sensitivity was 47% for acidosis & 67% for severe acidosis and false positive was 14%. These results were comparable to those found in our study. In a study by Tasnim et al. [1], positive predictive value of CTG was 18% for fetal hypoxia, 21% for fetal hypercarbia, 26% for fetal acidosis and 37% for base excess. Predictive value of suspicious trace for similar blood indices was 13%, 13%, 17% and 35% respectively. For pathological trace, predictive value was 50%, 83 %, 100% and 66% and respectively. From the findings of this study, although the sensitivity of CTG was found to be low, its high negative predictive value, low cost and ease of carrying out the monitoring supported its use in intrapartum fetal monitoring and in alerting the obstetrician regarding an intrauterine hypoxic event.

CTG abnormality did not correlate well with the need for resuscitation or NICU stay. Again, this showed that it was a poor predictor of adverse fetal outcome.

The presence of a normal CTG ruled out the occurrence of seizures in the first 24 hours after birth but the presence of a suspicious or pathological trace did not necessarily mean that the fetus will have seizures after birth as that was a rare occurrence even with a suspicious or a pathological trace. Similar to our study, the study by W M Aboulghar et al. [13] showed no statistical association between the CTG category and need for NICU stay. In their study, 33.3% of cases with pathological traces required NICU admission and 23.1% of those with a suspicious trace required NICU admission.

In a study by Patil SS et al. [20] who performed a similar study on 295 women, there was no association between need for NICU stay, acidosis at birth and CTG category.

In a study by Sowmya D et al. [16], out of 100 women with either suspicious or pathological traces, 34.6 % cases with pathological CTG and 27.08% with suspicious CTG required NICU admission. This was in contrast to our study and they showed a significant association between the need for NICU stay and CTG category.

In our study, 7.8% (12 cases) required resuscitation. Only 8.3% cases (3 cases) with a normal trace along with MSL required resuscitation and the rest 91.7% (33 cases) did not. In the pathological trace category, 11.8% cases (8 cases) required resuscitation while the rest 88.2% (60 cases) did not. Interestingly, only 1 case (1.6%) of suspicious trace cases required resuscitation while the rest 60 cases (98.4%) did not. The p value was 0.084, making the association statistically insignificant.

In a study by Patil SS et al. [20] who performed a similar study on 295 women, 24 babies required resuscitation and all 24 of these had severe metabolic acidosis. Like our study, their study showed poor correlation with need for resuscitation.

In our study, 3 cases (1.8%) had convulsions within the first 24 hours after birth. All of these had acidosis on ABG. Of these,

2 cases had a pathological trace (2.9% of pathological cases) and 1 case had a suspicious trace (1.6% of suspicious traces). None of the normal CTG cases with MSL had convulsions within the first 24 hrs after birth. The p value of 0.56 was statistically insignificant.

In the study by Patil SS et al. [20], 1.7% cases had convulsions within the first 24 hours after birth. Similar to our study, this was statistically insignificant.

In a large multicentre study on more than 37000 women by Alfirevic et al. [21], there was a significant association between CTG category and neonatal seizures within the first 24 hours of birth.

Conclusion

Abnormal CTG is worrisome from both obstetrician's and pediatrician's point of view. Abnormal CTG while being a good predictor of the presence of MSL and also the grade of MSL, is a poor predictor of the presence of fetal acidosis and neonatal status after birth.

Fetal monitoring using cardiotocography was associated with considerable false positive results and subsequent surgical intervention that may have not been necessary. Thus, using fetal heart rate abnormalities alone as a measure of diagnosis of fetal distress during labour is a contributing factor of increasing rate of cesarean sections.

Recommendations

All patients in active labour should undergo CTG monitoring as although it is not a very specific tool for detecting fetal distress, it's high sensitivity, ease of use and low cost make it a good tool for monitoring.

Decisions for cesarean section based on abnormal CTG findings should be made with caution. Maternal corrective measures as recommended by NICE guidelines should be undertaken first before deciding upon abandoning trial of labour.

In case of an abnormal CTG finding, decision for artificial rupture of membranes should be made wherever feasible to check for the status of liquor and further plan of management should be made accordingly.

Better training in CTG interpretation and its correct interpretation is required to identify, understand and take appropriate corrective measures in those patients that are at a high risk of adverse fetal outcome.

The pediatrician should be kept in the loop in case of any abnormal CTG, as, although the incidence of hypoxia and acidosis is less, the presence of a skilled pediatrician coupled with good resuscitative measures can reduce neonatal morbidity and NICU admissions significantly even in the occasional occurrence of acidosis with abnormal CTG.

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