

Umbilical cord arterial blood base excess as gold standard for foetal well being screening test validity at term delivery

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Abstract

Objective: To assess the validity of cardiotocography and meconium staining of amniotic fluid, as a predictor of neonatal acidaemia.

Methods: It was a cross sectional analytical study, carried out at a tertiary care private hospital from 1st Jan 2006-31st Dec2006. After due exclusion 122 cords samples were selected for study. Classification of foetal heart patterns were from FIGO-Guidelines (1987) and grading of meconium staining of amniotic fluid as thin, moderate and thick on subjective assessment. Cord samples collected at birth and subsequent analysis was usually achieved within 30 minutes of delivery

Results: Total deliveries during the study period were 960. One hundred and twenty two (12.7%) cord results were studied. Umbilical cord arterial base excess (≥ 12 mmol/L) at birth was used as gold standard to determine the validity of cardiotocography and meconium staining of amniotic fluid.

Validity tests of cardiotocography: Sensitivity 15.38%, Specificity 86%, Positive predictive value 11.76%. Negative predictive value 89%. Validity tests of meconium staining of amniotic fluid: Sensitivity 18.75%, Specificity 79.2%, Positive predictive value 12%, Negative predictive value 86%.

Conclusion: Electronic foetal monitoring (cardiotocography) is an objective assessment of foetal well being. Normal reactive trace correlates highly with absence of acidaemia at birth. However cardiotocography alone is not a diagnostic test for detecting foetal distress. Similarly clear liquor is an indication of foetal well being and meconium staining of amniotic fluid is not always associated with an ill infant (JPMA 60:347; 2010).

Introduction

The aim of foetal surveillance is simple and straightforward, to identify foetuses at risk for neonatal and long term injury due to asphyxia and prevent morbidity and mortality by timely intervention.¹

Clinicians continue to be limited by use of technology with an imprecise ability to identify the development of perinatal asphyxia. Routine tools of intrapartum foetal surveillance are intermittent foetal heart auscultation, observation for meconium staining of amniotic fluid (MSAF), cardiotocography (CTG) and foetal scalp blood sampling.

MSAF occurs in 7-22% of term and 23-52% of post term deliveries.² The passage of meconium may be normal physiologic event reflecting foetal maturity. It may on the other hand reflect foetal hypoxia or increased vagal activity from cord compression.³ Electronic foetal monitoring (EFM) is a worldwide method for foetal surveillance during labour. It supplies continuing information about foetal heart patterns. There is much concern about the ever rising caesarean sections rate probably partly due to this technique with no significant effect on foetal outcome.^{1,4} Foetal scalp blood sampling gives an accurate intrapartum foetal oxygenation, but it requires expertise, its invasive, needs relatively large amount of blood (30-50 micro L), sampling failure rate of 11-

12% have been reported and has often required to be repeated during labour, as a consequence it is not widely applied.⁵⁻⁷

In 1958 James showed correlation between umbilical cord pH and depression of neonate.⁸ Umbilical cord blood pH, base excess and gas measurement can be used to assess validity of CTG and MSAF as foetal being screening tests during labour. Umbilical artery offers an easily accessible pathway to investigate foetal oxygenation during labour. Cord arterial pH has historically been used as a primary marker of hypoxic/ischaemic injury, "base excess" is currently often reported as it has more significant usefulness than umbilical cord pH values, because base excess doesn't change significantly with respiratory acidosis and gestational age. It indicates duration of insult by direct measure of foetal metabolic acidosis.^{1,9} Mean value for base excess is -2.3 ± 0.6 mmol /l.⁹ Acidosis is 2 standard deviation (SD) below the mean. Normal foetus enters labour with base excess of approximately -2 mmol /l and development of mild acidosis in normal labour occurs in almost all labours which reduces base excess by an additional 3mmol /l and normal stress of second stage of labour decreases base excess by approximately 1mmol/L/hr in the normal foetus so its assumed that asphyxial injury does not occur until foetal base excess ≥ 12 mmol /l, which is 2 SDs below the mean.⁹ At level of severe acidosis base excess ≥ 16 mmol /l,

the newborn either dies or survives normally, with a small proportion exhibiting cerebral palsy.⁹

Adverse neonatal outcome and cases involving neurological injuries are frequently attributed to intrapartum asphyxia. Rationale of this study is to assess validity of cardiotocography and meconium staining of amniotic fluid, in the prediction of neonatal acidemia, using umbilical cord arterial blood base excess as gold standard. It provides documented evidence of intrapartum foetal well being if the diagnosis of cerebral palsy is made in later childhood.

Subjects and Methods

Cross sectional analytical study was carried out at a tertiary care private hospital from 1st January 2006 to 31st December 2006. Considering sensitivity and specificity of CTG 33.8% and 81.2%¹⁰ respectively, a recent study showed that a prevalence of 50% is regarded as well being and not well being. The required sample size of 10% was calculated as 122. Sampling technique was non-probability purposive. All women at term gestation (≥ 37 weeks) with singleton, cephalic foetus in labour were eligible for the study. All cases with malpresentation, major congenital anomaly, maternal age ≥ 18 years, multiple gestation, moderate to severe medical disorder, absent informed consent, rupture of membranes >12 hours and fever during labour were excluded from the study. Classification of foetal heart rate pattern (FHR) patterns as normal, intermediary and abnormal were according to FIGO - Guidelines¹¹ (Table-1). Grading of MSAF as thin (only

mode and time of delivery was on the basis of stage of labour and degree of abnormality of CTG and MSAF. Interval between delivery and abnormal CTG or thick MSAF was usually <1 hour. Umbilical cord blood analysis was performed at birth. Samples were collected by trained doctors and nursing staff. A segment of cord (min10 cm) was double clamped immediately after delivery and before first birth, 3ml blood was drawn in preheparinized plastic syringe and placed in ice and subsequent analysis was usually achieved within 30 minutes of delivery. A Ciba Corning 248 blood gas analyzer (Chrion Diagnostic UK) was used throughout the study. Results were analyzed by using SPSS version 12.0 and Chi-square test was applied.

Results

Total deliveries during the study period were 960. Cases included for study were 122 (12.7%). Gold Standard for validity test is cord arterial blood base excess (≥ 12 mmol/L). Demographic features of subjects are given in Table-2. Majority 76.2% were between 20-30 years of age, 84% were para 0-2, 55.7% were at 39-40 weeks of gestation. Variation in base excess levels of cord blood sample (Gold standard) and its relationship with intrapartum foetal heart rate patterns and MSAF is presented in Table-3 and 4. Subjects (77%) with normal FHR patterns had normal CBS base excess levels and only 1.6% were severely acidotic. All (6.5%) with abnormal FHR patterns had normal CBS base excess values. Majority (68.8%) with clear amniotic fluid had normal CBS base excess levels and all (1.6%) with thick MSAF had normal

Table-1: Classification of cardiotocographic patterns according to FIGO- Guidelines.

CTG Classification	Baseline heart Frequency	Variability Reactivity	Deceleration
Normal	110-150b/min	5-25b/min accelerations	Early deceleration
Intermediary	100-110b/min 150-170/min short bradycardia episode	>25 b/min, no acceleration <5 b/min for >40 /min	Sporadic deceleration of any type unless severe
Abnormal	150-170b/min, reduced variability >170 b/min	<5 b/min for >40 min, <5 b/min for >60 min, sinusoidal pattern	Repeated late deceleration, complicated variable deceleration for > 60 sec

Table-2: Demographic features of subjects: (n=122).

Age in years	No	%	Parity	No	%	Gestational age in weeks	No	%
<20	23	18.8	0-2	84	68.8	37-38	37	30.3
20-30	93	76.2	5-Mar	26	21.3	39-40	68	55.7
>30	6	4.9	>5	12	9.8	41-42	17	13.9

discoloration), moderate (particulate suspension) and thick (pea soup viscosity and appearance) were on subjective assessment. Eligible women were informed and asked for consent by the attending doctor or mid wife. Decision about

CBS base excess values. Validity (sensitivity, PPV, specificity, NPV) of these screening tests was calculated by putting these values in formula (Table-5). Sensitivity and PPV of CTG and MSAF is $< 20\%$, specificity and NPV of CTG and MSAF was

Table-3: Intrapartum foetal heart rate patterns and base excess levels of cord blood sample (n=122).

Cord blood sample base excess	Foetal heart rate patterns					
	Normal		intermediary		Abnormal	
	No	%	No	%	No	%
Normal						
5.6±3.6mmol /l	94	77	7	5.7	8	6.5
Moderately acidotic						
≥ 12mmol /l	9	7.3	1	0.8	0	0
Severely acidotic						
≥ 16mmol /l	2	1.6	1	0.8	0	0

Table-4: Meconium staining of amniotic fluid and base excess levels of cord blood sample (n=122).

Cord blood sample Base excess	Grading of meconium staining of amniotic fluid					
	Clear		Thin /moderate		Thick	
	No	%	No	%	No	%
Normal						
5.6±3.6mmol /l	84	68.8	20	16.3	2	1.6
Moderately acidotic						
≥ 12mmol /l	10	8.1	3	2	0	0
Severely acidotic						
≥ 16mmol /l	3	2	0	0	0	0

Table-5: Validity of CTG & MSAF.

Validity tests	Validity of CTG	Validity of MSAF
Sensitivity	15.38%	18.75%
PPV	11.60%	12%
Specificity	86%	79.20%
NPV	89%	86%

around 80%. These results showing poor ability to correctly identify the diseased and appropriate ability to correctly identify non disease by means o these tests.

Discussion

Clinicians caring for women during labour must have an understanding of intrauterine asphyxia as well as awareness of the capabilities and limitations of available intrapartum foetal assessment tools to diagnose intrauterine foetal hypoxia or predict neurological outcome. Sampling of umbilical cord blood provides objective documentation about the foetal oxygenation, which can be used as an objective measure to assess intrapartum care.

In this study sensitivity and PPV of CTG is around 20%, which is comparable with studies by Low et al 31-50% and Xe et al where sensitivity was 33.8%.^{10,12} This poor sensitivity and PPV of CTG makes it less reliable to predict intrapartum asphyxia even with appropriate assessment. One local study also found no significant association between abnormal CTG and acidaemia at birth on pH analysis of umbilical CBS.¹³ Reason for this poor sensitivity could be

variability in interpretation of CTG. Individuals considered expert in interpretation of FHR patterns agreed on 60% of normal and 25% of abnormal patterns.¹⁴

Specificity is ability of test to correctly identify those who don't have disease out of healthy population and negative predictive value (NPV) is the probability of a person being healthy, if the test is negative. Specificity and NPV of CTG is 86% and 89% respectively, while it was 81.2% in a recent study.¹⁰ Other studies also favour FHR patterns with normal rate, moderate variability, and presence of acceleration with absence of deceleration which correlates highly with absence of acidaemia at birth.^{15,16}

Sensitivity and positive predictive value of meconium passage during labour is <20%. One recent study also found poor sensitivity and PPV of MSAF during labour (17.6% and 13.3% respectively) and even worse (6.7% and 10.5% respectively) for meconium passage just before delivery.¹⁷ Therefore meconium passage during labour may not be a direct response to hypoxia and many risk factors like prolonged labour, epidural analgesia and the use of oxytocin are identified for it. Increasing gestational age is a very important contributing factor for MSAF. Specificity and negative predictive value is around 80% almost comparable with 96.6% and 96.3% for meconium passage during labour and just before delivery respectively.¹⁷ Clear liquor is associated with foetus's good condition.

It is recommended that routine practice of umbilical cord arterial blood acid base analysis at delivery to exclude diagnosis of intrapartum asphyxia should be done, It is cost effective and should be part of the delivery protocol. Audits of cases of poor foetal outcome should be regularly performed. Validity of new techniques of foetal surveillance should be carried out.

Conclusion

Association of abnormal FHR pattern and MSAF with acidaemia at birth is insignificant while normal trace of CTG and clear amniotic fluid is reassuring. These routine-screening tools of intrapartum foetal surveillance might be responsible for increasing caesarean section rate. To avoid unnecessary intervention additional test to differentiate hypoxic from non hypoxic foetuses is necessary.

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