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Original Research Article

A study to correlate admission non stress test and immediate post-partum umbilical cord arterial pH with neonatal outcome

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ABSTRACT

Background: Continuous electronic fetal monitoring in labour has become a standard practice in developed countries; this may not be possible in low middle-income countries. So, this study was conducted to correlate admission non stress test (NST) and immediate post-partum umbilical cord arterial (UCA) pH with neonatal outcome.

Methods: This prospective observational study was conducted at tertiary care centre in North India. After informed and written consent, 100 pregnant women with singleton live pregnancy of gestational age ≥ 32 weeks admitted in labour, were subjected to admission NST and immediately after delivery sample for UCA pH was taken. Clinically relevant neonatal outcome was correlated with admission NST and UCA pH. Appropriate statistical tests were used and p-value < 0.05 taken as significant.

Results: Admission NST was normal, suspicious, pathological in 67%, 27%, 6% subjects, respectively. Study found statistically significant correlation between admission NST and UCA pH with neonatal outcomes (i.e. fetal distress, need of advanced resuscitation, delayed oral feeding). Fetal distress was seen in 9 newborns, in these 8 delivered by CS and 1 required ventous application. Admission NST had high sensitivity (88.89%) and NPV (98.5%) for detection of fetal distress. The optimal cut off for pH and lactate was 7.25 and 2.55 mmol/L, respectively to predict fetal distress.

Conclusions: Admission NST can be considered as a screening modality to detect fetus in distress and it showed good correlation with umbilical cord arterial pH for predicting short term neonatal outcome.

Keywords: Admission non stress test, Fetal distress, Neonatal outcome, Umbilical cord arterial pH

INTRODUCTION

The National Institute for Health and Care Excellence (NICE) states that the monitoring of fetus in labour aims to identify hypoxia before it is sufficient to lead to damaging acidosis and long-term neurological sequelae for the baby.¹ Various methods are used for intra-partum monitoring across the world, it includes clinical methods i.e. intermittent fetal heart auscultation; biophysical methods i.e. electronic fetal monitoring, non-stress test, fetal acoustic stimulation test, fetal scalp stimulation test, umbilical artery doppler velocimetry etc.; biochemical

methods i.e. fetal blood sampling, fetal pulse oxymetry, lactate level measurement, near infrared spectroscopy.

Routine and continuous electronic monitoring of fetal heart rate (FHR) has become a standard of care in high-risk pregnancies; however, this may not be possible in low middle-income countries like India. So, admission non stress test (NST) can be used to pick-up high-risk cases. Freeman, Lee and colleagues (1975) introduced the NST to describe FHR acceleration in response to fetal movement as a sign of fetal health.² A 20 minutes NST tracing with a few contractions on arrival to the labour

ward is called the Admission NST.³ This may identify already compromised and likely to compromise fetus at a stage early enough in labour to allow timely intervention; furthermore a normal admission NST offers reassurance. Immediate post-partum umbilical cord blood gas is the first post-delivery record of intra partum condition of fetus and is considered as gold standard objective tool for the assessment of intrauterine asphyxia.⁴

Various studies have been carried out in past to correlate admission NST and neonatal outcome with near term/term gestation but a few studies conducted with aim to correlate both admission NST and umbilical cord arterial (UCA) pH with neonatal outcome including preterm gestation.⁵⁻¹¹ So we carried out this study to correlate the admission NST during labour and immediate post-partum UCA pH with neonatal outcome in ≥ 32 weeks pregnancy.

METHODS

This prospective observational study was conducted from June 2016 to December 2017, on all pregnant women ≥ 32 weeks gestation, attended inpatient department of obstetrics and gynecology at a tertiary care centre in North India. The study was approved by institutional ethics committee. Women aged 20-35 years with singleton live pregnancy with ≥ 32 weeks gestation admitted in labour, irrespective of risk factors were included. Pregnancy with acute hypoxic events in which we don't have enough time to perform admission NST i.e. abruption of placenta, cord prolapsed, uterine scar rupture; and ultrasound confirmed congenital anomaly of the fetus excluded. Primary objective was to correlate admission NST and immediate post-partum UCA pH with neonatal outcome and secondary outcome was to evaluate the role of admission NST as screening method for fetal distress. Sample size was calculated to be 99 subjects at 95% confidence interval assuming the specificity of NST to be 94.8% and prevalence of fetal distress to be 21.8% (as per study of Rahman H et al) and taking 10% relative allowable error.¹²

Eligible women were explained about the study in their local language and informed written consent was taken. Then patient was subjected to 20 minutes admission NST. In case patients were admitted with preterm labour, admission NST was considered if patient delivers within 24 hours of admission; otherwise NST of the day when patient re-entered into labour was taken. After the admission NST, monitoring of the patient was done by continuous FHR recording. The patient was observed throughout the labour and progress was recorded on partogram. Wherever intervention was required either by assisted delivery or caesarean section, indication was noted. Immediately after birth sample for UCA blood gas was taken.

Immediately after delivery, neonate was handed over to neonatologist, gender and birth weight of baby was

recorded. Need of admission in NICU was judged by attending neonatologist. Following outcome were recorded - need of resuscitation, admission to NICU, time for oral feeding initiation and duration of hospital stay of neonate. It was NICU policy to start feed in all neonates as early as neonate became hemodynamically stable; neonates were discharged when they were able to receive full spoon/breast feed.

UCA pH ≤ 7.25 was taken as a threshold for metabolic acidosis in fetus and fetal was considered in distress if any one of the following was present-

- Pathological FHR changes leads to caesarean section/assisted delivery
- Presence of meconium stained liquor
- Admission in NICU for perinatal asphyxia.

Admission NST Procedure: After emptying urinary bladder, patient was placed in a semi-recumbent or left lateral recumbent position to avoid supine hypotension. Admission NST was done with GE Coro metrics 170 series fetal monitor machine, with the record paper using speed of 1cm/minute. The fetal heart was located with a stethoscope to place the external cardiac transducer on the maternal abdomen with a strap. Toco probe was placed on the fundus of the uterus to record the uterine pressure during contraction. An event marker was given to the patient to press the button on perceiving the fetal movement.

On the NST trace, the upper channel has the fetal heart rate recording. Four features related to the FHR i.e. baseline heart rate, baseline variability, accelerations and decelerations were identified. The lower channel has the uterine contraction recording and provides a relative measure of amplitude, a near approximation of the duration and an accurate measure of the frequency. Definition of individual features of fetal heart trace was taken as described by NICE.¹³ Categorization of FHR features as reassuring, non-reassuring and abnormal; and categorization of NST as normal, suspicious and pathological was done as per RCOG guidelines.¹³

UCA blood gas analysis after the delivery of baby, the cord was doubly clamped at a minimum length of 10 cm with the placenta in situ. 2 ml blood sample from umbilical artery was taken in heparin rinsed pre-labeled syringe and ABG analysis was done with ABL800 basic blood gas and electrolytes analyzer within 30 minutes.

Statistical analysis

Data was collected and compiled into MS excel spread sheet. Continuous variables were summarized as mean/median and standard deviation/range; and were analyzed by using unpaired 't' test/ Mann Whitney test for two group comparison and one-way ANOVA test/ Kruskal Wallis test for more than two group comparison, based on distribution of data. Categorical variables were

summarized as proportion (%); and were analyzed by using Chi-Square test. Receiver operating characteristic (ROC) curve was made and cut off value was estimated depending on the specificity and sensitivity. p value <0.05 was taken as significant. All analysis was performed by using SPSS 21.0v software.

RESULTS

A total of 100 subjects were enrolled (50 were with preterm gestation and rest were with term gestation). All were booked cases; mean age of subjects was 28.82 (± 3.50) years and period of gestation ranges from 32 to 40+6 weeks. Admission NST was normal, suspicious, pathological in 67%, 27%, 6% subjects, respectively. Risk factors observed were anaemia (34%), IUGR (13%), hypertension (8%), diabetes mellitus (6%), hypothyroid (6%), preterm premature rupture of membranes (6%). Seventeen neonates delivered vaginally, while 83 required caesarean section (CS). In 9 subjects fetal distress was seen, in these 8 delivered by CS and 1 required ventous application, as shown in Table 1. Rest CS were elective for various indications.

Correlation between admission NST and UCA pH with neonatal outcomes summarized in Table 2 and 3. Fetal distress was significantly correlated with admission NST and UCA pH. Risk of fetal distress increases by 21times in abnormal NST than normal NST ($p=0.00$; OR=21.12, 95% CI: 2.51-177.58). In suspicious NST 7.40% and with pathological NST 100% had CS with fetal distress while none of the subject with normal NST had CS with fetal distress.

Admission NST had high sensitivity and negative predictive value (NPV) for detection of fetal distress. Sensitivity, specificity, positive predictive value (PPV), NPV of admission NST for fetal/neonatal distress

observed were 88.89%, 72.53%, 24.24%, 98.5%, respectively. UCA pH showed statistically significant correlation with admission NST ($p=0.000$).

Table 1: Fetal distress criteria.

Criteria	No.	Mode of delivery
Pathological NST leads to CS/ assisted delivery and NICU admission for perinatal asphyxia	4	All CS
Meconium stained liquor (MSL)	2	1-CS, 1-Ventous vaginal delivery
Pathological NST leads to CS/ assisted delivery and MSL	1	All CS
Pathological NST leads to CS/ assisted delivery, MSL and NICU admission for perinatal asphyxia	1	All CS
NICU admission for perinatal asphyxia	1	All CS

Resuscitation at birth was required in 12% new-borns, 4% needed initial steps of resuscitations only and rest 8% needed resuscitation with bag and mask ventilation (advanced resuscitation). None required chest compression and drugs for resuscitation.

None of the new-borns with normal admission NST and none of new-borns with $pH > 7.25$ required advance resuscitation. Advance resuscitation was significantly correlated with admission NST and UCA pH. Birth weight of the new-born showed no correlation with admission NST ($p=0.074$) and UCA pH ($p=0.292$).

Table 2: Correlation of neonatal outcomes with admission NST.

Parameters	Admission NST			p-value	OR (95% CI)
	Normal (N=67)	Suspicious (N=27)	Pathological (N=6)		
Fetal distress	1 (1.5%)	2 (7.4%)	6 (100%)	0.000*	21.12 (2.51-177.58)
UCA pH ≤ 7.25	3 (4.5%)	11 (40.7%)	6 (100%)	0.000*	22.67 (5.91-86.92)
UCA mean pH (SD)	7.32 (0.039)	7.27 (0.065)	7.18 (0.076)	0.000*	-
Birth weight mean in kg (SD)	2.67 (0.73)	2.36 (0.66)	2.19 (0.74)	0.074	-
Advanced resuscitation	0 (0%)	2 (7.4%)	6 (100%)	0.000*	-
NICU admission	9 (13.4%)	7 (25.9%)	5 (83.3%)	0.000*	7.03 (2.39-20.67)
Oral feeding initiation median (range); hours	0.59 (0.17-168)	0.84 (0.34-144)	30 (2-48)	0.000*	-
Hospital stay duration median (range); days	3 (2-34)	4 (3-28)	6.5 (3-12)	0.000*	-

*Statistically significant, OR: odds ratio, SD: standard deviation.

Probability of NICU admission increases by 7 times in suspicious and pathological NST than normal NST (p=0.00; OR=7.03, 95% CI: 2.39-20.67). More new-borns with pH ≤7.25 required NICU admission than new-born with pH >7.25, however the difference was statistically not significant (p=0.158). Oral feeding was delayed in subjects with pathological NST as compared with normal

and suspicious NST and in new-borns with pH ≤7.25 as compared with new-borns with pH >7.25. Median duration of hospital stay was significantly longer in new-born with suspicious and pathological admission NST than normal NST (p=0.000). Median duration of hospital stay was longer in new-born with pH ≤7.25 than >7.25, but the difference in medians was statistically not significant (p=0.146).

Table 3: Correlation of neonatal outcomes with umbilical cord arterial pH.

Parameters	Umbilical cord arterial pH		p-value
	pH ≤7.25 (N=20)	pH >7.25 (N=80)	
Fetal distress	9 (45%)	0 (0%)	0.000*
Advanced resuscitation	8 (40%)	0 (0%)	0.000*
NICU admission	7 (35%)	14 (17.5%)	0.158
Oral feeding initiation median (range); hours	1 (0.34-144)	0.67 (0.17-168)	0.017*
Hospital stay duration median (range); days	4 (2-28)	3 (2-34)	0.146
Birth weight mean in kg (SD)	2.40 (0.71)	2.59 (0.72)	0.292

*Statistically significant.

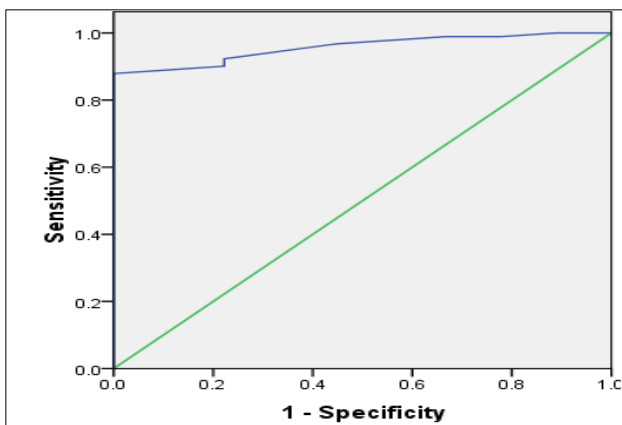


Figure 1: Receiver operating characteristic curve for decreasing umbilical cord arterial pH and fetal distress (AUC = 0.96; 95% C.I. 0.92-0.99).

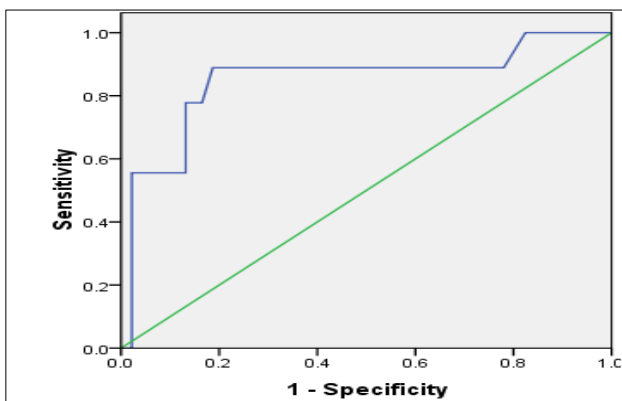


Figure 2: Receiver operating characteristic curve for increasing umbilical cord arterial lactate and fetal distress (AUC = 0.85; 95% C.I. 0.68-1.00).

A ROC curve was plotted for decreasing UCA pH and fetal distress. The area under curve (AUC) was 0.96 (95% CI 0.92-0.99). The optimal cut off for pH was 7.25 to predict fetal distress with a sensitivity of 90.1% and specificity of 77.8%. (Figure 1) Similarly a ROC curve was plotted for increasing UCA lactate and fetal distress. The AUC was 0.85 (95% CI 0.68-1.00). The optimal cut off for lactate was 2.55 mmol/L to predict fetal distress with a sensitivity of 88.9% and specificity of 76.9% (Figure 2).

DISCUSSION

Aim of intrapartum monitoring is to detect fetal hypoxia and acidosis at the earliest, so that timely intervention can be taken to improve neonatal outcome. In low middle-income countries, there is large burden of high-risk pregnancies and is being monitored by intermittent fetal heart auscultation as continuous electronic fetal monitoring is not possible. In these settings’ admission NST may be used to detect intrauterine fetal hypoxia already present on admission or likely to develop in labour. Study have correlated admission NST and UCA pH (gold standard marker of fetal hypoxia) with neonatal outcome and evaluated the role of admission NST as screening tool for fetal distress.

In present study none of the subject with normal NST had CS with fetal distress while in suspicious NST 7.40% and with pathological NST 100% had CS with fetal distress. Similarly, in previous studies by Gurung G et al, Nikita V et al and Rahman H et al observed rising incidence of operative delivery for fetal distress from reactive/normal NST to suspicious NST and pathological NST CS.^{5,10,12} On correlating the admission NST and fetal distress, all previous studies shows an increase incidence of fetal

distress when NST changes from normal to suspicious and pathological.^{5,6,9,10,12} Hence pathological NST is a significant finding to detect fetal distress. Fetal distress was 21 times more in abnormal NST than normal NST ($p=0.000$; OR=21.12, 95% CI: 2.51-177.58). In study by Verma A et al fetal distress was almost 10-11 times more in non-reactive compared to reactive group.⁶ In this study sensitivity, specificity, PPV and NPV of admission NST for fetal distress was 88.89%, 72.53%, 24.24% and 98.50%, respectively. Study observed higher sensitivity than Verma A et al (63.63%), Nikita V et al (73.60%) and Rahman H et al (60%), but Verma A et al (93.33%), Nikita V et al (94%) and Rahman H et al (94.8%) found higher specificity of admission NST for fetal distress than us and NPV was comparable to this study.^{6,10,12}

In this study neither admission NST nor UCA pH showed correlation with birth weight of neonates ($p=0.074$, $p=0.292$). In contrast, study by Raouf S et al showed statistically significant difference in birth weight between non-reactive NST and reactive NST group. As per institutional protocol we have taken UCA pH ≤ 7.25 as a threshold for metabolic acidosis in fetus.⁸ Probability of metabolic acidosis increases by 22-23 times when NST changes from reactive to non-reactive ($p=0.000$; OR=22.67, 95%CI: 5.91-86.92). Kaban A et al observed that all neonates with normal pH had reactive NST and 38.5% neonates with pH < 7.2 had non-reactive NST.¹⁵ Rahman H et al observed pH < 7.20 in 4.1% in normal NST, 17.4% in suspicious NST and 57.1% in pathological NST ($p < 0.001$).¹²

In present study mean pH was 7.32 ± 0.04 in normal NST, 7.27 ± 0.07 in suspicious NST and 7.18 ± 0.08 in pathological NST ($p=0.000$). Dellinger EH et al observed lower mean pH in all NST group than this study (7.27 ± 0.06 in normal, 7.21 ± 0.08 in suspicious and 7.06 ± 0.14 in pathological NST; $p < 0.05$).¹¹ Perveen F et al observed similar and significant difference in mean cord blood pH between normal CTG and abnormal CTG groups (7.29 ± 0.08 versus 7.26 ± 0.10 ; $p=0.007$), but Kaban A et al observed non-significant and reverse difference in mean pH in reassuring NST and non-reassuring (7.28 ± 0.08 versus 7.31 ± 0.07 ; $p=0.497$).^{14,15} Study obtained optimal cut off for pH (7.25) and lactate (2.55 mmol/L) to predict fetal distress with reasonably good sensitivity and specificity. None of the previous studies reported this outcome.

In this study advance resuscitation was required in 40% newborn with metabolic acidosis while none of the newborn with pH ≥ 7.25 required advance resuscitation ($p=0.000$). Ahmadpour-kacho M et al observed that resuscitation at birth was required in 70% newborn with pH < 7.20 and 21.7% in pH > 7.20 new-borns ($p < 0.001$).¹⁶ In present study need of advanced resuscitation was significantly higher with abnormal NST as seen in study by Gurung G et al ($p=0.029$).⁵ As NST worsened from normal to suspicious and pathological admission to NICU increases significantly ($p=0.00$; OR=7.03, 95% CI: 2.39-

20.67). This finding matches well with previous studies.^{7,9-12} In present study slightly higher (35%) neonates were admitted in NICU with pH ≤ 7.25 as compared to pH > 7.25 (17.5%) ($p=0.158$). Yeh P et al observed in their cohort study that risk for NICU admission is significantly raised from pH < 7.20 (RR=1.20; 95%CI: 1.08-1.33).¹⁷ This might be because they have observed more extremes of pH than us.

Oral feeding was delayed in subjects with pathological NST as compared with normal and suspicious NST and in newborns with pH ≤ 7.25 as compared with newborns with pH > 7.25 . Median duration of hospital stay of newborn was significantly longer in non-reactive admission NST than reactive NST ($p=0.000$). None of the previous studies correlated these outcomes. In present study median duration of hospital stay was 4 days and 3 days in newborn with or without metabolic acidosis, respectively. ($p=0.146$); however, Ahmadpour-Kacho M al observed mean duration of hospital stay was 3.78 days in pH < 7.20 and 2.28 days in pH > 7.20 ($p < 0.001$).¹⁶

CONCLUSION

Admission NST have good correlation with UCA pH for predicting neonatal outcomes and can be used as a screening modality to detect fetus in distress. Study recommend admission NST for triaging high-risk pregnant woman admitted in labour and UCA blood gas should be taken to quantify fetal distress whenever admission NST records are abnormal; as umbilical cord blood pH is the best method to quantify fetal distress. Further we also concluded that UCA pH ≤ 7.25 can be used as cut off point for referral of neonates to tertiary care centre. Scope of this study was limited to discharge of neonate from hospital, so further studies with larger samples are required to know long term outcome of neonates and to determine supplemental diagnostic modalities for fetal distress which can enhance the predictive value of suspicious/pathological admission NST.

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