Original Research Article

To Study the Association of Abnormal Fetal Rate Patterns and Meconium Stained Liquor with Umbilical Cord Artery Ph at Birth and its Clinical Application in Obstetric Unit

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Abstract:

Introduction: Umbilical cord artery blood pH analysis provides important information about newborn's biochemical status prior to delivery.

Aims and Objectives: To evaluate association between abnormal fetal heart rate patterns (FHR) and meconium stained liquor (MSL) with umbilical cord artery blood pH at birth and its clinical application in obstetric unit.

Material and Method: The observational prospective study, carried out in the Department of Obstetrics and Gynaecology, Geetanjali medical college and hospital, Udaipur for 1 Year. The study was conducted in 150 terms parturient, who were diagnosed clinically to have non-reassuring fetal status in labor and were considered for vaginal delivery or for emergency caesarean section for the same reason. Non-reassuring fetal status was diagnosed clinically by presence of MSL (thick/thin) and by abnormal FHR patterns classified as Normal CTG (cardiotocography)/Suspicious CTG/Pathological CTG

Immediately after delivery, umbilical cord artery blood sample was sent for pH analysis. Neonatal outcome in terms of weight of new-born, Apgar score at 1 and 5 minutes, NICU admission, duration of stay in NICU, perinatal outcome were recorded. Thereafter, study of association of all these factors was done accordingly. Statistical testing performed by SPSS 24.0 by using independent student t-test.

Results: Presence of thin MSL and suspicious CTG were not significantly associated with fetal acidosis and poor neonatal outcome. Only thick MSL and FHR showing pathological CTG that fetus had significant association with acidosis (Umbilical cord artery blood pH < 7.20).

Conclusion: Umbilical cord artery blood pH can be considered as the most sensitive parameter to diagnose fetal asphyxia. This may help in providing appropriate care to the new-born at birth and in preventing as well as decreasing neonatal morbidity and mortality. In addition, normal umbilical cord blood pH results can usually provide a defense against a suggestion that an infant had an intrapartum hypoxic-ischemic event.

Keywords: Umbilical cord artery blood pH, Meconium stained liquor, Non-reassuring fetal heart rate, CTG (Cardiotocography), Acidosis.

Introduction

Umbilical cord blood gas assessment is considered to be the most objective determination of fetal metabolic condition at birth. [1] Decreasing fetal morbidity and mortality is a golden aim in obstetrics. Additionally, decreasing unnecessary cesarean sections is also a significant consideration in the field of obstetrics, thereby making the diagnosis of fetal distress. ACOG committee also reaffirms that the term fetal distress is imprecise and nonspecific and replaces the term fetal distress with non-reassuring fetal status [2] .

Routine methods of intrapartum fetal surveillance are:

- Intermittent fetal heart auscultation.
- Cardiotocography (CTG).
- Observation of meconium staining of liquor.
- Fetal scalp blood sampling

Although the CTG has a good sensitivity but the results of randomized trials have showed little benefit with respect to long term neurological outcome despite wide spread use of the CTG [3,4].

Furthermore, the significance of meconium in amniotic fluid is also a widely debated subject.

The passage of meconium can either be a normal physiological event reflecting fetal maturity or it can be a consequence of fetal hypoxia or increased vagal activity resulting from umbilical cord compression.[5] Fetal scalp blood sampling on the other hand needs expertise, it is invasive and requires large volume of blood (30-50 ml).

Umbilical cord artery blood pH analysis provides important information about newborn's biochemical status prior to delivery.(6) According to ACOG(7), " An intrapartum event sufficient to cause fetal distress may be defined by :-

1. Fetal umbilical cord artery blood pH less than 7.0, or base deficit greater than or equal to 12 mmol/L, or both, increases the probability that neonatal encephalopathy.
2. If cord arterial blood gas pH levels are above 7.20, it is unlikely that intrapartum hypoxia played a role in causing neonatal encephalopathy.

Keeping above criteria in consideration, we have taken a cut off level of umbilical cord artery blood pH of 7.20 for fetal acidosis in the study.

This study is designed to evaluate the cases of both vaginal delivery and emergency cesarean sections done for abnormal fetal heart rate or meconium stained liquor, in term deliveries and its association with perinatal outcome using umbilical cord artery blood pH.

Aim

To study the association of abnormal fetal heart rate patterns and meconium stained liquor with umbilical cord artery blood pH at birth and its clinical application in obstetric unit.

Objectives

1. To evaluate association between abnormal fetal heart rate patterns and meconium stained liquor with umbilical cord artery blood pH at birth.
2. To examine relationship between umbilical cord artery blood pH at term and serious neonatal outcome.
3. To allow early and appropriate intervention for the neonate when required

Material and Methods

Study site: Department of Obstetrics and Gynaecology, Geetanjali medical college, Udaipur. This is a tertiary care hospital.

Study duration was 1 year.

Study population: All pregnant women with term gestation with non-reassuring fetal status.

Study design: Prospective, observational study.

Sample size: Our sample size estimation was based on pH. Previously researchers have performed studies on correlation between non-reassuring fetal status and umbilical cord artery blood pH at birth. The incidence of acidosis found in various studies ranged from 20 – 40%. In study done by Kumar N et al (8), incidence of acidosis was 33.34 %. Therefore, assuming (p) = 25% with 7% margin of error, the minimum required sample size at 5% level of significance is 147 patients.

The formula for calculated sample size is as follows:

$$n = \frac{Z^2_{\alpha/2}\, pq}{d^2}$$

Where,
P is the proportion of pH < 7.20 (p = 25 % or 0.25)
q = 1 – p (q = 1 – 0.25; = 0.75)
d = is the margin of error (d = 7 % or 0.07) is the ordinate of standard normal distribution at α% level of significance, (Zα/2 = 95 % Confidence interval = 1.96)

Based on the above calculations we have taken a sample size of 150 patients for our study.

Method of collection of data

After taking written and informed consent and fulfilling the inclusion criteria, cases were included in the study

Inclusion criteria:

1. Patients who were willing to give informed consent.
2. Term gestation.
3. Meconium Stained Liquor.
4. Abnormal FHR patterns.

Exclusion criteria:

1. Patients who were not willing to give informed consent.
2. Congenital abnormality.
3. Intrauterine fetal demise.
4. Elective cesarean section.
5. All high risk pregnancies (anemia, hypertension, thyroid, epilepsy, asthma)
6. Intrauterine growth retardation, oligohydramnios.
7. Preterm delivery.
8. Abruption placentae.
9. Multiple gestations, malpresentation.
10. Maternal infection.

Methodology:

After obtaining approval from Institutional Review Board and Ethical Committee and written informed consent from the patients, the study was conducted in 150 term parturient, who were diagnosed

clinically to have non-reassuring fetal status in labor and were considered for vaginal delivery or for emergency caesarean section for the same reason.

Non-reassuring fetal status was diagnosed clinically by presence of meconium stained liquor and by abnormal FHR patterns. Meconium stained liquor was graded as:

Thin: (Only greenish discoloration)
Thick: (Pea soup viscosity and appearance)

Electronic fetal heart rate monitoring was done and FHR patterns were classified as per FIGO guidelines (2015) as -

- Normal CTG
- Suspicious CTG
- Pathological CTG

After delivery, umbilical cord artery blood sample was collected and sent for pH analysis. Neonatal outcome in terms of weight of new-born, Apgar score at 1 minute and at 5 minutes, NICU admission, duration of stay in NICU, perinatal outcome were recorded. Thereafter, study of association of all these factors was done accordingly

Statistical methods:

Statistical testing was conducted with the statistical package for the social science system (SPSS) version 24.0.

The analysis included profiling of patients on different demographic, clinical and laboratory parameters. Quantitative data were presented in terms of means and standard deviation. Qualitative/categorical data were presented as absolute numbers and proportions. Cross tables were generated and Chi-square test was used for testing of significance. Independent Student t test was used for comparison of quantitative outcome parameters. P -value < 0.05 is considered statistically significant.

Results: Presence of thin MSL and suspicious CTG were not significantly associated with fetal acidosis and poor neonatal outcome. Only thick MSL and FHR showing pathological CTG that fetus had significant association with acidosis (Umbilical cord artery blood pH < 7.20). Out of 150 cases of non-reassuring fetal status, we had 83 cases with MSL and 67 cases had clear liquor with abnormal FHR patterns.83 cases with MSL were further divided in 51 cases of thick MSL and 32 cases of thin MSL cases of thick MSL were found to have a significant association with abnormal FHR patterns as compared to cases of thin MSL.67 cases of clear liquor with abnormal FHR patterns were further categorized as; 22 cases with suspicious CTG and 45 cases with pathological CTG.

Table 1: Distribution of Cases between Type of MSL and FHR Patterns

FHR Pattern (According to CTG)	Meconium Type			
	None [N = 67]	Thick [N = 51]	Thin [N = 32]	Total [N = 150]
Normal CTG	0 (0.0)	28 (54.9)	27 (84.4)	55 (36.7)
Suspicious CTG	22 (32.8)	9 (17.6)	4 (12.5)	35 (23.3)
Pathological CTG	45 (67.2)	14 (27.5)	1 (3.1)	60 (40.0)

Chi Square value = 79.211; p-value < 0.0001*; ( ) = values are expressed in percentage. Maximum number of cases were delivered by LSCS (70.7%), followed by normal vaginal delivery (NVD) (20%), followed by instrumental vaginal delivery (IVD) (9.3%). We observed high incidence of LSCS in cases of thick MSL and pathological CTG as compared to cases of thin MSL and suspicious CTG. An Apgar score of < 7 at 1 minute and at 5 minutes was significantly lower among cases of thick MSL and pathological CTG as compared to cases of thin MSL and suspicious CTG Improvement in Apgar scores at 5 min was more seen in cases of thin MSL and suspicious CTG.

Table 2: Correlation of Apgar score at 1 Minute and 5 Minute with Umbilical Cord Blood pH

PARAMETER		Umbilical cord blood artery pH		total	P-value
APGAR Score less than 7		<7.20	≥7.20		
	At 1 minute	32 newborn(38.6%)	51 newborn(61.4%)	83	p-<0.001
	At 5 minutes	26 newborn(55.3%)	21 newborn(44.6%)	47	P<0.001

In our study, the Apgar score <7 at 1 minute and at 5 minutes was significantly associated with acidosis. The overall incidence of acidosis in all 150 cases with non-reassuring fetal status was 22.7 %
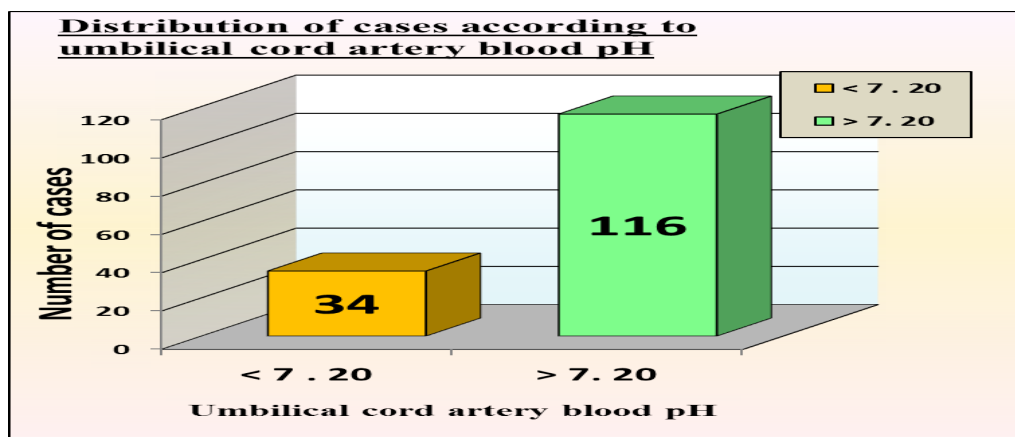

Figure 1:

Table 3: Correlation of Type of MSL, Abnormal FHR Patterns, MDDI, Mode of Delivery with Umbilical Cord Blood Artery

Parameter		Umbilical cord blood artery pH (Mean)	
MSL	Thick	7.31 + 0.18	P < 0.001
	Thin	7.44 + 0.12	
Abnormal FHR patterns	Suspicious CTG	7.33 + 0.11	P < 0.001
	Pathological CTG	7.20 + 0.40	
MDDI[#]	At delivery	7.37 + 0.41	
	< 1 Hour	7.27 + 0.62	
	1 – 3 Hours	7.15 + 0.15	
	> 3 Hours	7.10 + 0.57	
MODE OF DELIVERY	NVD	7.39 + 0.03	
	LSCS	7.32 + 0.15	
	IVD[##]	7.14 + 0.19	

Acidosis was found to be significantly associated with cases of thick MSL and pathological CTG as compared to thin MSL and suspicious CTG. Umbilical cord artery blood pH levels were significantly low among the cases who were delivered by IVD followed by LSCS then NVD.
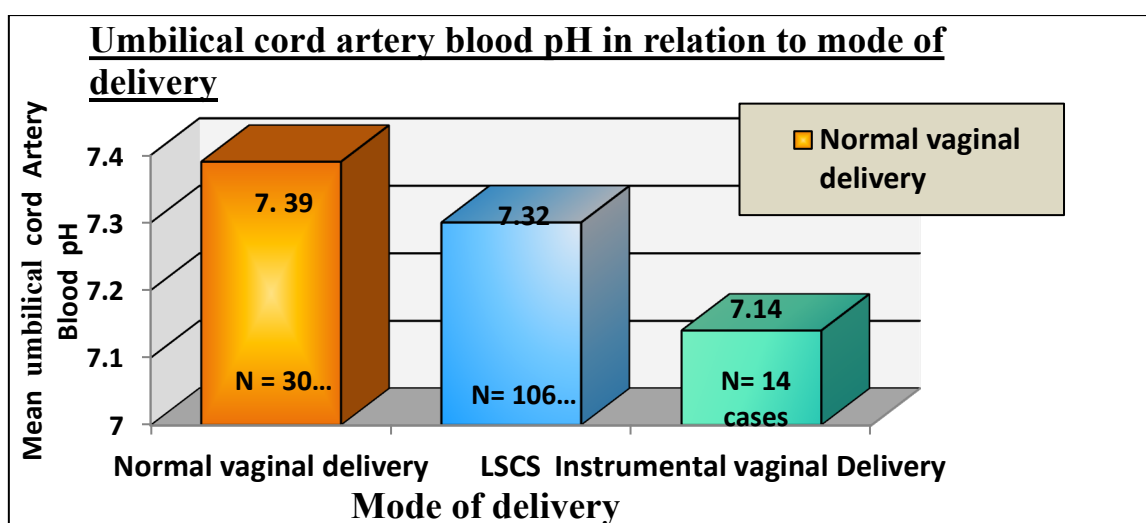

Figure 3:

- MDDI (Meconium Detection Delivery Interval)
- IVD (Instrumental Vaginal Delivery)

The overall incidence of NICU admission was 16 % (24 cases). In our study, we have observed that, umbilical cord artery blood mean pH at birth in healthy neonates was 7.35 + 0.41.However, for cases with NICU admissions, the mean umbilical cord artery blood pH was found to be 7.17 + 0.61.
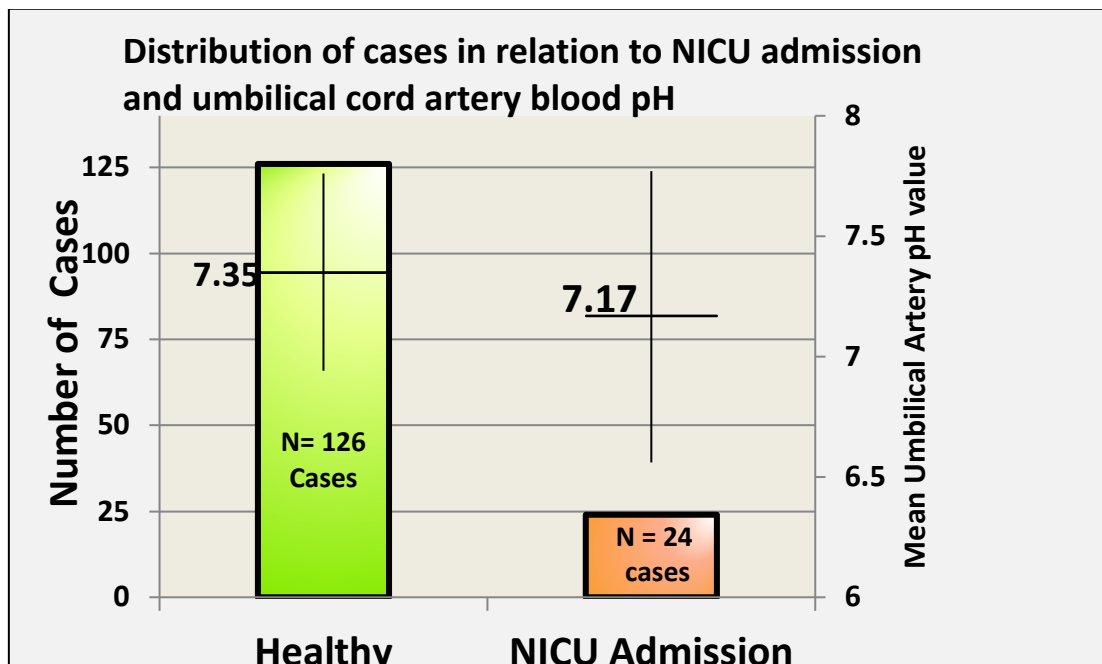

Figure 4: Distribution of Cases in Relation To NICU Admissions And Umbilical Cord Artery Blood PH

Table 5: Correlation Of Neonatal Outcome and Duration of Stay in Nursery with Umbilical Cord Blood Artery pH

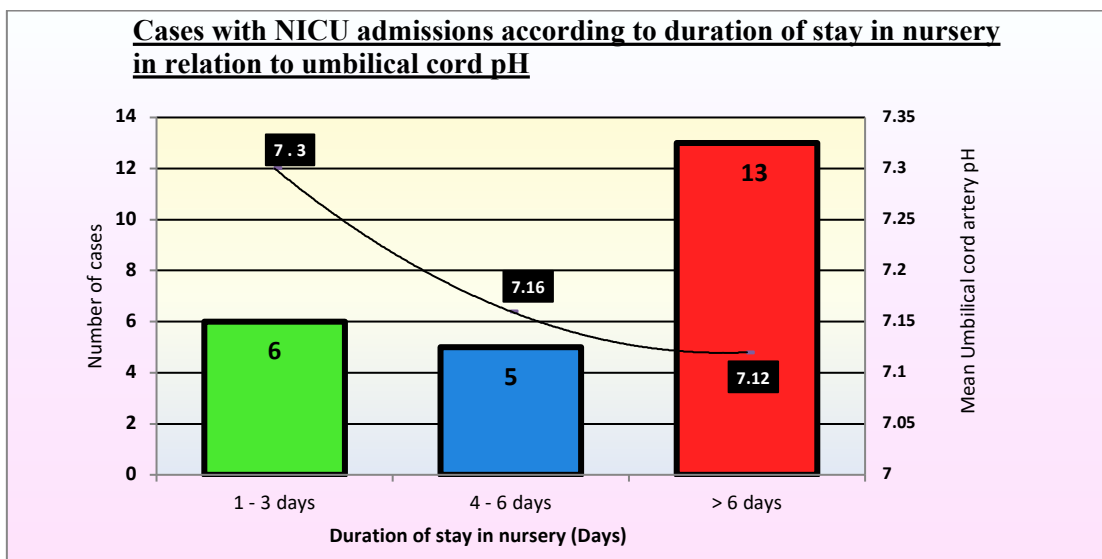| PARAMETER		Umbilical cord blood artery pH (Mean)	
Neonatal Outcome	Healthy	7.35 + 0.41	P < 0.0001
	NICU Admission	7.17 + 0.61	
Duration of stay in NICU	1 -3 days	7.36 + 0.19	P < 0.0001
	4 – 6 days	7.16 + 0.23	
	> 6 days	7.12 + 0.17	

Figure 5:

Neonates who required longer duration of stay in NICU had significant acidosis at birth. Neonatal complications were reported in 7 neonates out of 150 cases of non-reassuring fetal status. Among them 3 neonates had meconium aspiration syndrome, 1 neonate had sepsis and 3 neonates had birth asphyxia. All babies with complications had significant acidosis at birth.
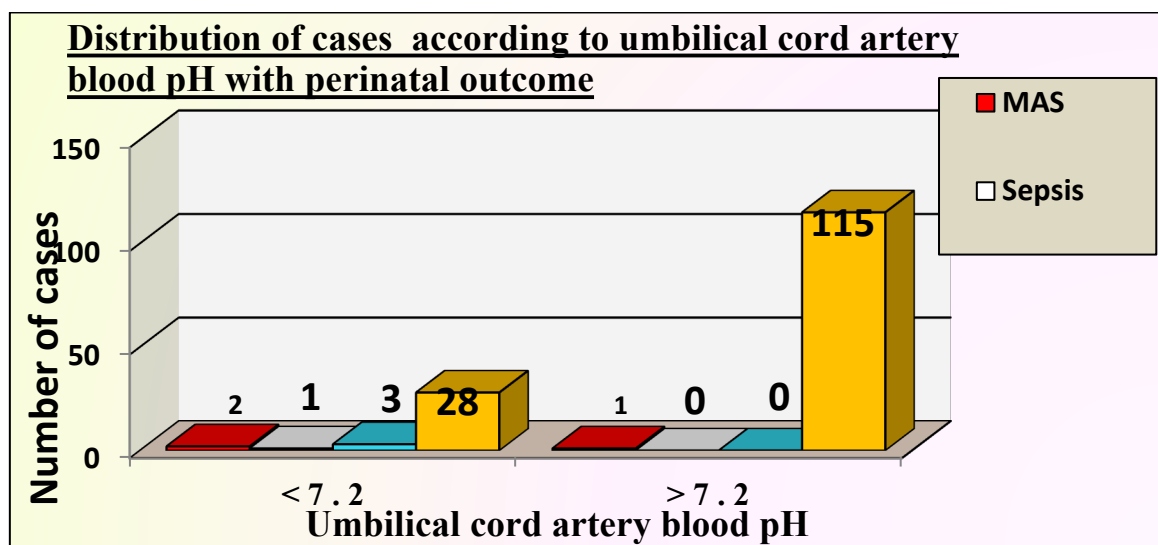

Figure 6:

All newborns were discharged healthy from nursery and no mortality happened in our study.

Discussion: Umbilical cord artery blood pH can be used to assess validity of CTG and MSL as screening test of intrapartum fetal monitoring [9].

Demographic Distribution of Cases: The mean maternal age in our study was 28 + 2.82 years, and is comparable to the study done by Mojibian Mahdieh et al [10], in which mean maternal age was 27.18 ± 4.81 years.

Distribution of Cases of Non –Reassuring Fetal Status: Distribution of cases according to MSL and FHR patterns has come out to be comparable with the following studies.

Table 6:

	MSL with normal FHR pattern	MSL with abnormal FHR patterns	Clear liquor with abnormal FHR patterns
Kumar N et al (8)	16.67%	33.33%	50%
Kumar BV et al (11)	38.7%	23.8%	37.5%
Our Study	**36.66%**	**18.66%**	**44.67%**

Among 83 MSL cases, we had 51 cases of thick MSL and 32 cases of thin MSL. Among 51 cases of thick MSL, 17.6 % had suspicious CTG, and 27.5% had pathological CTG. Among 32 cases with thin MSL, 12.5% had suspicious CTG and 3.1% had pathological CTG.

Here, it was seen that cases with thick MSL were more associated with abnormal FHR patterns rather than cases with thin MSL,it is comparable to study of Qadir S et al [12], which states that FHR abnormalities were noticed in 62.5% cases of thick MSL and 29.6% cases of thin MSL.In study done by Supriya K et al [13], 47.39% of cases with thick MSL had FHR abnormalities compared to 13.33% of cases in thin MSL group.

Meconium Detection- Delivery Interval (MDDI)

Out of 83 cases with MSL, we had maximum 35 cases who were delivered in 1 to 3 hours interval after meconium detection. 28 cases were delivered after 3 hours and 6 cases were delivered within 1 hour of meconium detection and 14 cases delivered at the time of meconium detection. In our study, we have seen that there was not much difference in MDDI between thick and thin MSL group.

Mode of Delivery

In our study, 106 cases out of 150 cases of non-reassuring fetal status were delivered by LSCS. 30 cases had NVD and 14 cases were delivered by IVD. Similar results were obtained in studies done by Kumar N et al [8], Fouzia Perveen et al [14], Naqvi et al[15], Mundhra et al[16]Among cases with MSL, thick MSL had high incidence of LSCS (76.5%) and IVD(11.8%) as compared to thin MSL.

This is comparable to study by Desai DS et al[17], in which thick MSL with pathological CTG had

highest (46.51%) caesarean section rate as compared to thin MSL with suspicious CTG (19.16%).

In our study as MDDI increased, more number of cases was delivered by LSCS than vaginal delivery. But as per statistical results, mode of delivery was not found to be significant with MDDI. In our study there were 67 cases of clear liquor with abnormal FHR pattern. Out of them, in 22 cases of suspicious CTG, 68.2% cases were delivered by LSCS, 22.7 % were delivered by NVD, and 9.1 % cases delivered by IVD. However, in 45 cases of pathological CTG 82.2% cases were delivered by LSCS and NVD was seen as the least commonly employed mode of delivery (6.7 %).This is similar to study by Banu S[18], in which 73.9% patients of suspicious CTG and 81.8% patients of pathological CTG underwent LSCS. Similar observation was seen in studies given by Amena et al[19], Bogdanovic G[20].As per our study higher rate of operative deliveries was seen in both suspicious and pathological CTG and thick and thin MSL cases. Thereby, demanding a more accurate test to determine fetal asphyxia and to decrease operative intervention.

Apgar Score

Apgar score at 1 minute and at 5 minutes was assessed after birth in all 150 cases of non-reassuring fetal status in the study. There were 71.1% cases of pathological CTG and 54.3% cases of suspicious CTG who had Apgar score < 7 at 1 minute. At 5 minutes Apgar score < 7 was observed in 62.2% cases of pathological CTG, and in 9.1% cases of suspicious CTG. Apgar score at 1 minute in both thick and thin MSL cases were poor but comparatively much poorer in thick MSL cases. We observed that improvement in Apgar score at 5 minutes was relatively more in cases of suspicious CTG and thin MSL than in pathological CTG and thick MSL. This has been found similar to the study done by Sunitha C et al [21], Samiyappa D et al.[22]According to mode of delivery, low Apgar score (< 7) at 1 minute was seen maximum in neonates who were delivered by IVD ,followed by LSCS ,followed by NVD. Garzoli et al [23], found significant relation between Apgar score and delivery modes.

Umbilical Cord Artery Blood pH

In present study out of total 150 cases of non – reassuring fetal status, incidence of acidosis (pH <7.20) was 22.7% .Mean umbilical cord artery blood pH was 7.08 + 0.08 in cases with pH <7.20 and 7.39 + 0.12 in cases with pH >7.20. There was statistically significant acidosis in cases of pathological CTG as compared to suspicious CTG. In total 67 cases of clear liquor with abnormal FHR patterns, 22 cases with suspicious CTG had mean umbilical cord artery blood pH of 7.33 + 0.11, and

45 cases with pathological CTG had mean umbilical cord artery blood pH of 7.20 + 0.14. Here only pathological CTG had significant association with acidosis. This was similar to study by Ray C et al[24],Among cases with MSL, thick MSL had mean umbilical cord artery pH was 7.31 + 0.18 and thin MSL had mean umbilical cord artery pH was 7.44 + 0.12.There is statistically significant association of thick MSL with acidosis than thin MSL.

Kumar N et al [8] ,in their study concluded that cases with thick MSL and NST showing persistant and late decelarations were significantly associated with acidosis,cases with thin MSL and fetal tachycardia and bradycardia on NST were not associated with fetal acidosis.In our study, mean umbilical cord artery pH in cases of NVD was 7.39 + 0.03, in LSCS was 7.32 + 0.15 and in IVD was 7.14 + 0.19. IVD had lowest umbilical cord artery blood pH than by LSCS and NVD.

In present study, we found significant association of Apgar score < 7 at 1 minute and at 5 minutes with acidosis. This was consistent with results of other studies done by Prasanna R et al [25], Ray C et al [24]

Neonatal Outcome

In our study, total 150 cases of non-reassuring fetal status, 24 new borns (16%) were admitted in NICU. Out of them 10 newborns had significant acidosis and the mean umbilical cord artery blood pH was 7.17 + 0.61.FA Kader et al [26], found that high risk babies who needed resuscitation, NICU admission had a median cord blood pH which was significantly lower than the other babies (p value < 0.05). This implies that babies with a low cord blood pH should be carefully monitored during the entire neonatal period. Similar finding observed by Mousa Ahmedpour [27]

Neonatal complications were seen in only 7 neonates out of 150 cases of non-reassuring fetal status. All babies with complications also discharged healthy from nursery, no mortality was seen.In our study the p-value was < 0.0001, showing a statistically significant association of acidosis with neonatal complications

Conclusion

Present study reveals that that presence of thin MSL and suspicious CTG were not significantly associated with fetal acidosis and poor neonatal outcome. It was evident only in cases with thick MSL and FHR showing pathological CTG that fetus had asphyxia and acidosis (Umbilical cord artery blood pH < 7.20). In our study it was found that majority of cesarean sections which were done for non- reassuring fetal status, did not have fetal acidosis in real sense, as majority of neonate after delivery had umbilical cord blood pH within

normal range. Therefore in addition to CTG and MSL, it can be concluded that umbilical cord artery blood pH can be considered as is the most sensitive parameter to diagnose fetal asphyxia and should be performed in all cases of non -reassuring fetal status, as this may help in providing appropriate care to the newborn at birth and in preventing as well as decreasing neonatal morbidity and mortality.

Limitations

1) Being a private set up and time bound study; sample size was small, thereby limiting number of cases. Hence, number of umbilical cord artery blood pH value less than 7.00 were few, therefore effect of severe metabolic acidemia could not be assessed effectively.

2) Long term follow up data was lacking. More local studies with larger sample size are recommended that targets to find out neurological sequelae especially for umbilical cord artery blood pH less 7.0.

Recommendations

1. Umbilical cord blood artery pH is a non -invasive method and cost effective method.
2. Umbilical cord blood pH can be a method for continuous quality improvement where decision in labor ward can be judged against the fetal acid base status.
3. Umbilical cord blood pH may also help to reduce overall unnecessary cesarean section rate in future.
4. Analysis of umbilical cord artery blood pH allows early and appropriate intervention for neonates when required. This may help out in preventing as well as decreasing neonatal morbidity and mortality.
5. A normal umbilical cord blood pH may serve as solid evidence against any alleged association between intrapartum events and poor neonatal outcome.

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