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Study on umbilical cord arterial blood pH & perinatal outcome in meconium-stained amniotic fluid

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Abstract

Objective: To compare the umbilical artery pH between the neonates delivered with meconium-stained liquor and neonates delivered with clear liquor. To know the correlation between umbilical artery pH and perinatal outcome in neonates with meconium-stained liquor.

Study design: A prospective case control study was conducted from Jan 2018 to June 2019 (18 months) on pregnant women who were admitted to the labor room for delivery. A total of 88 cases were taken, 44 with clear liquor, 44 with meconium-stained liquor. All had umbilical cord arterial blood gas analysis done. Details about the mode of delivery, condition of the baby, need for intensive care was assessed.

Results: The umbilical cord blood pH was assessed for all 88 deliveries, among them 51% delivered Vaginally 43% LSCS 6% instrumental. We found that 32% grade 1 and 2 meconium-stained liquor were delivered vaginally and neonatal outcome was good. Only 10.9% of neonates with cord blood pH <7.2 (p=0.028) needed NICU admissions >72hrs who all had Grade 3 Meconium. There was a positive correlation between cord blood pH and APGAR scores in clear liquor and found to be statistically significant whereas though there was a positive correlation between APGAR and cord blood pH in Meconium-stained babies but it was not statistically significant, as babies with Grade 1 and Grade 2 Meconium had good APGAR scores.

Conclusion: The present study reveals that very few neonates with grade 1 and grade 2 meconium-stained liquor had fetal acidosis and poor neonatal outcome, only cases with grade 3 meconium had severely acidotic pH resulting in fetal acidosis and increased neonatal morbidity and mortality. Thereby concluding unnecessary Caesarean sections in such cases can be avoided/reduced and as grade 3 Meconium had very poor perinatal outcome, early intervention will improve perinatal outcome in these babies.

Keywords: meconium-stained liquor, umbilical cord blood pH, APGAR scores

Introduction

Presence of meconium in amniotic fluid is a danger sign of fetal compromise and it is shown to be associated with poor perinatal outcome, however some researchers believe that many babies born with MSL have shown to have normal umbilical artery pH and are not associated with fetal hypoxia/acidosis/fetal distress [1].

Meconium staining of amniotic fluid (MSAF) occurs in approximately 10% to 26% of all deliveries, with the highest rates reported from North America [2, 3, 4]. out of these 5-10% developed MAS, which increases neonatal morbidity and mortality. The incidence increases as the gestational age advances with reported frequencies at 37, 40, and >42 weeks being 3%, 13%, and 18% respectively [5, 6].

Many recent literatures have proved that MSL alone cannot be taken as a sign of fetal hypoxia [1]. Arterial and venous cord blood gases give us an idea about fetal and placental oxygenation. Umbilical cord arterial blood pH is the best criterion for detecting fetal birth hypoxia during labor [1]. As MSL has been associated with bad perinatal outcome our study was more focused towards observing the correlation between umbilical cord blood pH and perinatal outcome in different grades of MSL, correlating it with different modes of delivery and its relationship with umbilical cord blood pH.

Grading of Meconium

Driscoll *et al.* [7]. studied meconium-stained amniotic fluid and graded according to consistency.

Grade 1: Is light meconium-stained fluid, which remained transparent when, collected in a test tube.

Grade 2: Indicates an opaque solution of meconium in amniotic fluid.

Grade 3: Is meconium undiluted by any amniotic fluid.

Trimmer and Gilstrap⁸ described the “meconiumcrit” using the weight percent of the solid component of meconium, The volume of meconium sediment is expressed as percentage, <10% solid component - light meconium, 10% to 30% - moderate meconium, and > 30% - thick meconium.

Normal fetal metabolism results in the production of acids that are buffered to maintain extracellular pH within a critical range. The major buffers utilized by the fetus for neutralizing hydrogen ion production are plasma bicarbonate and hemoglobin¹⁰

Table 1: Reference range for umbilical artery blood gas values in term newborns

Umbilical arterial blood	Mean	5th to 95th percentile
pH	7.27	7.15 to 7.38
PCO ₂ (mmHg)	50.3	32 to 68
HCO ₃ (mEq/L)	22	15.4 to 26.8
Base excess (mEq/L)	-2.7	-8.1 to 0.9

Umbilical artery PH: Sampling umbilical artery blood is preferable to sampling umbilical vein blood as the arterial pH and base deficit provide the most accurate information on fetal acid-base status and correlate best with newborn morbidity¹¹. This is because umbilical arterial blood primarily reflects fetal metabolism while venous blood primarily reflects placental functions^[12]. To obtain fetal blood for acid-base analysis, a 10 to 20 cm segment of umbilical cord is doubly clamped as soon as possible. Blood is drawn from the umbilical artery into a 1 to 2 mL syringe (preferably glass), which has been flushed with heparin. The two umbilical arteries are smaller than the umbilical vein; either of the arteries can be sampled^[13].

2. Materials and Methods

2.1 Source of Data

Women with term singleton pregnancy, with vertex presentation, admitted to the labor room (37-42 weeks' gestation) in department of OBG, ESIC-MC PGIMSR Hospital, Rajajinagar, and Bangalore between January 2018 to June 2019 were included in the study.

2.2 Study Period: January 2018 to June 2019 (18 months)

2.3 Study Design: Prospective case control study

2.4 Sample Size

According to the study Samiyappa DP *et al.*^[9], with proportion of controls among exposed being 55.8% and proportion of cases among exposed being 26% and odds ratio of 4.81 at 95% confidence level and 80% power we arrived at a sample size of 44 each among cases and controls.

2.5 Inclusion Criteria

Women with live singleton, Term pregnancy Cephalic presentation.

2.6 Exclusion Criteria

- Malpresentation
- Congenital anomalies
- Rupture of membranes > 12hrs
- Preterm.
- Multiple gestation.

- IUGR.

The study randomly included 88 full term pregnant women who were admitted to the labor room. During this study period patient who had Meconium-stained amniotic fluid on spontaneous or artificial rupture of membranes comprised the study group and those with clear liquor comprised the control group.

All patients who delivered either vaginally or by cesarean section, umbilical cord was clamped immediately after delivery and arterial blood sample was collected in a pre-heparinized syringe and was sent for ABG analysis. The gas analysis was done within 30 minutes. Other relevant information such as baby weight, APGAR scores at birth, mode of delivery and admission to NICU was noted.

Table 2: Metabolic acidosis in umbilical cord arterial blood

pH <7.00	Severe acidemia
pH 7.00 to 7.10	Moderate acidemia
pH 7.10 to 7.25	Mild acidemia
pH >7.40+/-0.20	Normal pH

APGAR score of the baby at birth was also assessed. Baby was followed up until discharge.

Fetal outcomes such as

- APGAR < 7 at 5 minutes,
- Neonates requiring NICU admission,
- Neonatal mortality in first 24 hours.

3. Statistical analysis

All characteristics were summarized descriptively. For continuous variables, the summary statistics of mean± standard deviation (SD) were used. For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation. Chi-square (χ^2) test was used for association between two categorical variables.

The formula for the chi-square statistic used in the chi square test is:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

The subscript “c” are the degrees of freedom. “O” is observed value and E is expected value.

The difference of the means of analysis variables between two independent groups was tested by unpaired t test. The t statistic to test whether the means are different can be calculated as follows:

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

where \bar{x}_1 = mean of sample 1

\bar{x}_2 = mean of sample 2

n_1 = number of subjects in sample 1

n_2 = number of subjects in sample 2

$$s_1^2 = \text{variance of sample 1} = \frac{\sum(x_1 - \bar{x}_1)^2}{n_1}$$

$$s_2^2 = \text{variance of sample 2} = \frac{\sum(x_2 - \bar{x}_2)^2}{n_2}$$

If the p-value was < 0.05, then the results were considered to be statistically significant otherwise it was considered as not statistically significant. Data were analyzed using SPSS software v.23.0. and Microsoft office 2007.

4. Results

In the present study total number of subjects were 88 out of which 45.5% subjects belong to 38-39 weeks period of gestation, and 54.5% of them were > 39weeks of gestation. Age group distribution – Mean of 26yrs & Range b/w 19-37years, SD 3.6. In present study out of 44 cases with Meconium-stained liquor, 25% (11) were with Grade I MSL, 38.6% (17) of the cases were Grade 2 MSL and the rest 36.4%(16) cases had grade 3 MSL.

Table 3: Comparison of cord blood pH between controls and cases

Cord blood pH	MSL								p value
	Clear		Grade I		Grade II		Grade III		
	N	%	N	%	N	%	N	%	
≤7.2(acidemia)	13	29.5%	3	27.3%	14	82.4%	16	100.0%	<0.001*
>7.2 (normal)	31	70.5%	8	72.7%	3	17.6%	0	0.0%	
Total	44	100.0%	11	100.0%	17	100.0%	16	100.0%	

Among the subjects in the control group, 70.5% of their umbilical artery cord blood pH were in the non-acidotic range of >7.2 whereas 29.5% were of acidotic PH.

Amongst the cases group with MSAF, 75% of the cases had acidotic pH <7.2 and only 25% had pH >7.2 (non-acidotic pH).

Table 5: Correlation between cervical dilatation, duration from detection to delivery, cord blood pH in Meconium-stained Liquor and NICU admission

Cervical Dilatation	Duration from detection to delivery	Cord blood pH	MSL	NICU Admission			Total
				28 HRS	48 HRS	72 HRS	
0-4cms	<1hr	≤7.2	Grade I	1	0	0	1
		>7.2	Grade II	4	0	0	4
	1-2hr	≤7.2	Grade III	1	0	0	1
		>7.2	Grade II	2	0	0	2
5-8cms	<1hr	≤7.2	Grade III	0	1	0	1
		>7.2	Grade II	2	0	2	4
	1-2hr	≤7.2	Grade III	1	0	0	1
		>7.2	Grade III	2	2	2	6
8cms-full dilation	<1hr	≤7.2	Grade II	0	1	0	1
		>7.2	Grade III	0	1	0	1
	1-2hr	≤7.2	Grade II	0	1	0	1
		>7.2	Grade III	0	1	1	2

Table 5 shows Correlation between cervical dilatation, duration from detection to delivery, cord blood pH in MSL and NICU admission. 6 babies were admitted in NICU with Grade 3 MSL detected at cervical dilatation of 5-8cms, duration taken to deliver 1-2hours has an acidotic pH <7.2 Thereby it shows cases with Grade 3 MSL when the duration from detection of meconium to delivery interval was more cord blood pH was towards the acidotic range <7.2.

Table 6: Comparison of perinatal outcome in cases and control

Outcome	MSL								P value
	Clear		Grade I		Grade II		Grade III		
	N	%	N	%	N	%	N	%	
Good	44	100.0%	11	100.0%	16	94.1%	7	43.8%	<0.001*
Poor	0	0.0%	0	0.0%	0	0.0%	5	31.3%	
Mas	0	0.0%	0	0.0%	1	5.9%	3	18.8%	
Death	0	0.0%	0	0.0%	0	0.0%	1	6.3%	
Total	44	100.0%	11	100.0%	17	100.0%	16	100.0%	

Note: * significant at 5% level of significance (p<0.05)

In grade 3 MSL 100% cases had acidotic pH, In grade 2 MSL 82.4% and in grade 1 MSL only 27.3% had acidotic pH P value of <0.001% which is statistically significant.

In this study, in control group 56.8% cases delivered vaginally and 38.7% cases delivered by LSCS and 4.5% cases had instrumental delivery. Among MSL cases with Grade 1 MSL 63.3% delivered vaginally. In Grade 2 MSL 52.9% cases delivered by LSCS, 41.2% cases delivered vaginally and 5.9% cases had instrumental delivery. In Grade 3 MSL cases 50% underwent LSCS, 31.2% delivered vaginally and 18.8% cases had instrumental delivery.

Table 4: Comparison of NICU Admissions In Cases And Control

NICU Admission	MSL								p value
	Clear		Grade I		Grade II		Grade III		
	N	%	N	%	N	%	N	%	
24hrs	1	2.3%	1	9.1%	7	41.2%	6	37.5%	<0.001*
48hrs	0	0.0%	0	0.0%	2	11.8%	4	25.0%	0.005*
72hrs	0	0.0%	0	0.0%	0	0.0%	5	31.3%	<0.001*

Note: * significant at 5% level of significance (p<0.05)

Table 4, In control group with clear liquor 2.3% babies were admitted in NICU for 24hrs. Amongst Cases with grade 1 MSL only 9.1% babies were admitted in NICU for 24hrs. In grade 2 MSL 41.2% babies were admitted in NICU for 24 hrs, 11.8% babies were admitted in NICU for 48hrs. In Grade 3 MSL 37.5% babies were admitted in NICU for 24hrs, and 31.3% babies were admitted for 72hrs.

Among 44 cases with Grade 3 MSL 4 babies were grossly asphyxiated with APGAR score 3 at 1 minute and 7 babies had APGAR score of 4-6.

In our study 100% of the control subjects with clear liquor had good perinatal outcome. It was observed that in Grade 1 MSL 100% babies had good perinatal outcome, In Grade 2 MSL 94.1% babies had good perinatal outcome whereas 1 baby (5.9%) had Meconium Aspiration syndrome.

In Grade 3 MSL 43.8% babies had good perinatal outcome, 31.3% babies had poor outcome and 18.8% babies had MAS, 1 perinatal death accounting to 6.3%.

Table 7: Pearson correlation between cord blood ph & APGAR (5min) for meconium stained LIQUOR.

Pearson Correlation	r value	p value
Cord blood Ph & APGAR (5min)	0.237	0.122

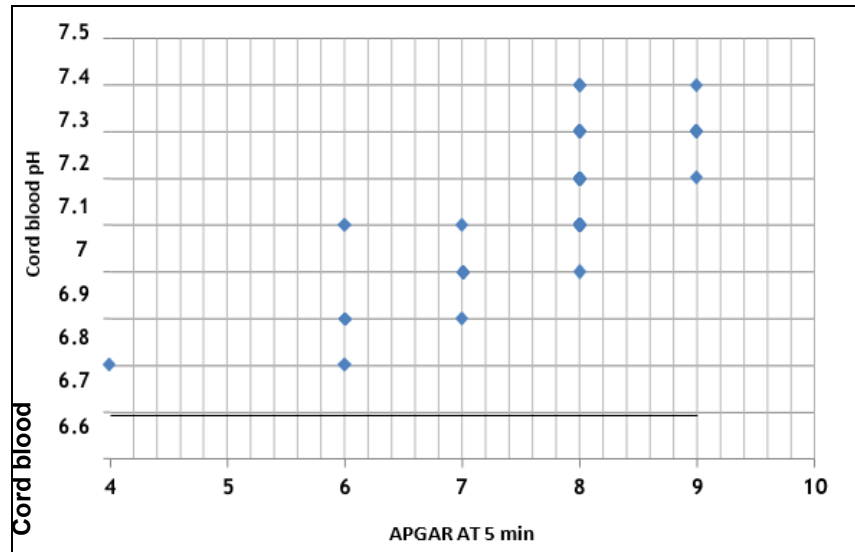


Fig 1: Pearson correlation between cord blood ph & APGAR (5min) for meconium stained LIQOUR

The correlation between cord blood pH and APGAR at 5min for MSL was positive. In grade 1 and grade 2 MSL as APGAR scores were good even at 5 min. Hence positive correlation between these two in MSL was not statistically significant.

Table 8: Pearson correlation between cord blood ph & APGAR (5min) for clear LIQOUR

Pearson Correlation	r value	p value
Cord blood Ph & APGAR (5min)	0.78	<0.001*

Note: * significant at 5% level of significance (p<0.05)

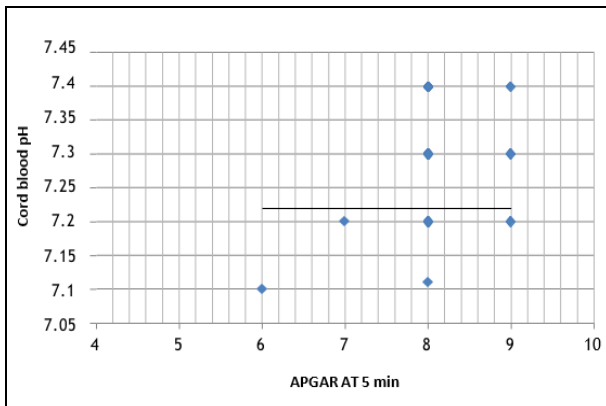


Fig 2: Pearson correlation between cord blood ph & APGAR (5min) for clear LIQOUR

There is a strong positive correlation between the cord blood pH and APGAR at 5min for clear liquor. This correlation was also found statistically at 5% level of significance.

5. Discussion

Umbilical cord blood pH is the best predictor of perinatal outcome. When we compared the correlation between cord blood pH in cases and controls, we found that 70.5% clear liquor babies had non acidotic pH >7.2.

Whereas amongst meconium-stained babies 100% of Grade 3 MSL, 82.4% of grade 2 MSL had acidotic pH. Comparable with the study conducted by Perveen F *et al.* (2015) [14] where 53.3% controls (clear liquor) and 49.1% cases (MSL) had non acidotic umbilical cord blood pH >7.2 whereas 38.2%controls (clear

liquor) and 61.5%cases (MSL) had umbilical cord blood pH <7.2 (p value =0.054).

Mode of delivery was significantly influenced by the presence of meconium-stained amniotic fluid. In the control group 56.8% delivered vaginally 38.6% delivered by LSCS 4.5% instrumentally delivered comparable with the study conducted by Khatun HA *et al.* [15] (2009) out of 80 cases in the control group 51.3% delivered vaginally and 48.7% by LSCS.

Cesarean deliveries were more with grade 2 meconium comparable with Chishty AL *et al.* [16] observed 62% of cesarean section rate, even in places where other facilities of intrapartum monitoring like fetal blood sampling and cardiotocography are available, the rate of caesarean delivery were found to be increased.

While we compared the APGAR score between cases and controls, we found that in Grade 3MSL, 4 babies were grossly asphyxiated with APGAR score 3 at 1 minute and 7 babies had APGAR score of 4-6, compared to study conducted by Vaghela HP *et al.* [17] (2014) APGAR score in 1minute was 3 in 3 babies and 2 babies had an APGAR score of 4-6 with grade 3 MSL. Sedaghatian *et al.* [18] found similar result in their study.

Majority of poor perinatal outcome such as MAS, birth asphyxia, NICU admission >48- 72hrs and perinatal death were seen in Grade 3 MSL comparable with study conducted by Vaghela HP *et al.* [17] (2014) where Perinatal mortality was 5%.

6. Conclusion

The present study reveals that grade 1 and grade 2 MSL were associated with very few babies with fetal acidosis and poor neonatal outcome. Only cases with grade 3 meconium had severely acidotic pH resulting in fetal acidosis and increased neonatal morbidity and mortality.

Majority of C-sections which were done in cases of grade 1 and 2 MSL had mildly acidotic to normal umbilical cord blood pH and very good perinatal outcome. Thereby concluding unnecessary C-sections in such cases can be avoided/reduced and as grade 3 MSL had very poor perinatal outcome, early intervention will improve perinatal outcome in these babies.

Babies with umbilical cord blood pH 6.8 to 7.0 showed signs of severe birth asphyxia and poor APGAR scores with perinatal morbidity and mortality. Hence umbilical cord blood pH can be taken as the best and most sensitive parameter to assess neonatal

outcome and thereby to reduce poor perinatal outcome.

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