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Umbilical cord arterial blood pH an indicator of rise in cesarean section rate due to false-positive indications by CTG

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ABSTRACT

Background: Cesarean section rate is rising globally, now accounting for more than 1 in 5 (21%) of all childbirths. This number is set to continue increasing over the coming decade unless the factors which increase the rate of cesarean section are kept in check. Intrapartum cardiotocography (CTG) has shown a false-positive rate of cesarean section. This has been correlated with neonatal umbilical cord blood pH analysis. **Aims and Objectives:** (1) Correlation of non-reassuring CTG, resulting in cesarean section with umbilical cord arterial blood pH. (2) To find the false-positive indications of cesarean section due to CTG. **Materials and Methods:** This observational study was conducted in the Department of Obstetrics and Gynecology of SKIMS, Soura, from September 2020 to July 2022 over a period of 22 months. Women with a gestational age of more than 34 weeks with singleton pregnancy were included in the study. Those with CTG-documented fetal distress were subjected to umbilical cord arterial blood pH monitoring. **Results:** A total of 85 patients underwent cesarean sections in view of fetal distress documented by CTG, but only 45 neonates had actual distress as documented by umbilical cord blood sampling. **Conclusion:** Social and non-medical factors no doubt have caused an alarming rise in cesarean sections, but at the same time, there are some iatrogenic causes, namely CTG, which lead to the rise in the cesarean section rate due to false-positive indications. This has been further supported by the fact that the pH of the umbilical cord blood of neonates with intrapartum non-reassuring CTG does not correspond to fetal acidemia in all cases. Hence, a significant number of cesarean sections is being done for false-positive indications.

Key words: Umbilical cord blood; pH; Cesarean section; Neonatal outcome; Cardiotocography

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INTRODUCTION

A cesarean section (CS) is a surgical procedure performed in situations where normal vaginal delivery (VD) can pose risks to either mother, baby, or both.[1,2] These situations include prolonged or obstructed labor, fetal distress, elevated blood pressure or glucose, multiple pregnancies, or abnormal presentation or position of the baby, among others.[1,3] CS reduces both maternal and neonatal morbidity and mortality significantly when it is done under proper indications, while at the same time, it can be harmful to the mother and the child when performed contrary.[4,5]

Over the years, global CS rates have significantly increased from around 7% in 1990 to 21% today, surpassing the ideal acceptable CS rate, which is around 10–15%, according to the WHO.[1,6] Various factors are responsible for this rise; these include maternal requests due to fear of VD, a low threshold for patients as well as doctors for VD, and the time- and energy-consuming process of vaginal deliveries. In addition to these social and non-medical reasons for the rise of cesarean sections, there are also some medical reasons, which add to this rise. Cardiotocography had been introduced to assess fetal well-being in the antenatal and intrapartum periods. However, it has a higher false-

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positive rate due to inter- and intra-observer variability. It leads to unnecessary obstetric interventions, namely cesarean sections and instrumental deliveries for fetal distress. This iatrogenic rise of the cesarean section can be checked using supplementary diagnostic tools like fetal scalp blood gas analysis. There are various methods by which we can evaluate the false-positive indications of cesarean section by cardiotocography (CTG). One of the means of ascertaining the indicated cesarean sections is monitoring the umbilical cord blood pH at the time of delivery. Non-acidotic babies with no post-cesarean section hospitalization are evidence of false-positive indications of fetal distress by CTG. Hence, the umbilical cord blood pH analysis helps to rule out the cesarean sections which were truly done for fetal distress retrospectively.

Umbilical cord blood gas analysis

Maternal and fetal acid-base balance is important to assess the adequacy of fetal oxygenation and fetal well-being *in utero*. It is important to recognize neonatal academia, as these neonates are at risk of an unfavorable outcome after delivery.[7] Henderson-Hasselbalch equation is the base to understand the acid-base balance of mother and fetus. CO_2 produced by oxidative metabolism is dissociated into H+ and HCO_3 – ions. With a normal pH of 7.4, the HCO3 concentration is 20 times the CO_2 concentration. In hypoxia, HCO_3 concentrations decrease, resulting in a reduction in pH and causing metabolic acidosis. Metabolic acidosis is thus a measurable outcome in the newborn and is commonly defined as a low umbilical pH or a high umbilical base deficit, which is expressed as a negative base excess. The normal range of umbilical cord pH is 7.40±0.2039. The cut-off for low umbilical pH (metabolic acidosis) varies from 7.2 to 7.040 and a base deficit of ≥12.0 mmol/L.[8]

Aims and objectives

(1) Correlation of non-reassuring CTG, resulting in cesarean section with umbilical cord arterial blood pH.
(2) To find the false-positive indications of cesarean section due to CTG.

MATERIALS AND METHODS

The present observational study was conducted in the Department of Obstetrics and Gynecology, SKIMS, Srinagar, Jammu and Kashmir, on patients with >34-week gestation with a single live fetus in cephalic presentation. The study was initiated after obtaining ethical clearance from the Institutional Ethical Committee, and patients were enrolled after getting proper informed consent in the local language. The study was conducted over a period of 22 months. Patients' were selected after fulfilling the selection criteria. Inclusion criteria: gestational age >34 weeks singleton cephalic presentation and exclusion criteria: elective lower segment cesarean section (LSCS) breech anomalous babies multifetal gestational age <34 weeks.

Sample size estimation

The sample size for the study was calculated as: n=Z2×(p)×(1−p)/2, where "n" is the sample size, Z is the confidence interval, i.e., 1.96 for 95%, and p is the confidence level, i.e., 0.05 for +5%. P=prevalence taking the incidence of fetal acidosis in term singleton pregnancies as described in the literature (19.4%), the sample size for the present study was calculated to be: n=(1.96)2×(0.194)×(1−0.194)/(0.05)2=240.

Methodology

After taking informed consent, all patients were subjected to a history, general physical examination, abdominal and vaginal examination, followed by ultrasonography. Ultrasonography detected placental position, assessment of the amount of liquor, fetal weight, and confirmation of maturity. Then, CTG was done in all patients in the active phase of labor before delivery and assessed objectively using the Krebs scoring system.

Blood collection

After taking informed consent, blood collection was performed following delivery by a pediatrician, from an immediately isolated segment (10–20 cm) of the cord and was subjected to blood gas analysis.

Statistical methods

The recorded data were compiled and entered in a spreadsheet (Microsoft Excel) and then exported to the data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as mean±standard deviation, and categorical variables were summarized as frequencies and percentages. Graphically, the data were presented by bar and pie diagrams. A Chi-square test was employed.

RESULTS

Table 1 shows that 240 patients were enrolled in the study, aged between 20 and 39 years, with a mean age of 29.3+4.01 years. The majority of patients, i.e., 101 (42.1%), were between the age group of 30 and 34 years, followed by 80 (33.3%) patients who were between the ages of 25 and 29 years. 32 (13.3%) patients were between 20 and 24 years of age group while 27 (11.3%) patients were 35–39 years of age.

Table 2 shows that 174 (72.5%) women were primigravidae and 66 (27.5%) were multigravida.

Table 3 shows that the mean gestational age was 37.8±1.3 weeks. The majority of the patients, i.e., 192 (80%), have a gestational age of >37. The gestational age of the patients ranged between 35 and 40 weeks.

Table 1: Age distribution of study patients

Age (years)	Number	Percentage
20–24	32	13.3
25–29	80	33.3
30–34	101	42.1
35–39	27	11.3
Total	240	100

Mean±Standard deviation (Range)=29.3±4.01 (20–39)

Table 2: Parity distribution of study patients

Parity	Number	Percentage
Primi	174	72.5
Multi	66	27.5
Total	240	100

Table 3: Gestational age (weeks) of study patients

Gestational age (weeks)	Number	Percentage
<37 weeks	48	20.0
≥37 weeks	192	80.0
Total	240	100

Mean±Standard deviation (Range)=37.8±1.31 (35–40)

Table 4 shows associated risk factors that were found in 78 patients, including GDM in 42 (17.5%) patients, GHT in 13 (5.4%), IHCOP in 9 (3.8%) patients, anemia in 5 (2.1%) patients, IUGR in 4 (1.7%) patients, T2DM in 3 (1.3%) patients, and APLA in 2 (0.8%) patients.

Table 5 shows that out of 240 patients, in 189 (78.8%) patients, artificial rupture of the membranes (ARM) was done; in 29 (12.1%) patients, there was spontaneous rupture of membranes (SROM); and in 22 (9.2%), there was premature rupture of membranes (PROM).

Table 6 shows that out of 240 patients, the majority, i.e., 117 (48.8%), had a clear liquor, 76 (31.7%) patients had a grade I meconium-stained liquor, 19 (7.9%) patients had a grade II meconium-stained liquor, and 28 (11.7%) had a grade III meconium-stained liquor.

Table 7 shows the majority of women, i.e., 167 (69.6%) delivered by LSCS, while 73 (30.4%) patients delivered by normal VD. Furthermore, 85 patients underwent a cesarean section due to non-reactive CTG. Among them, 10 were done under general anesthesia (GA) in view of severely abnormal CTG, while 85 were done under spinal anesthesia (SA).

Table 8 shows that the umbilical arterial cord blood pH of <7.15 was observed in 45 (18.8%) neonates, while as normal pH (>7.15) was seen in 195 (81.3%) neonates. The mean pH levels observed were 7.23+0.113, with a range of 6.7–7.34.

Table 4: Associated risk factors among study patients

Risk factor	Number	Percentage
GDM	42	17.5
GHT	13	5.4
IHCOP	9	3.8
Anemia	5	2.1
IUGR	4	1.7
T2DM	3	1.3
APLA	2	0.8
Total	78	32.6

IUGRL: Intrauterine growth restriction, APLA: Antiphospholipid antibodies, T2DM: Type 2 diabetes mellitus, IHCOP: Intrahepatic cholestasis of pregnancy, GDM: Gestational diabetes mellitus

Table 5: Rupture of membranes among study patients

Rupture of membranes	Number	Percentage
ARM	189	78.8
SROM	29	12.1
PROM	22	9.2
Total	240	100

ARM: Artificial rupture of the membrane, SROM: Spontaneous rupture of membrane, PROM: Premature rupture of membrane

Table 6: Color of liquor among study patients

Color of liquor	Number	Percentage
Clear	117	48.8
Grade I MSL	76	31.7
Grade II MSL	19	7.9
Grade III MSL	28	11.7
Total	240	100

MSL: Moisture sensitivity level

Table 7: Mode of delivery anesthesia among study patients

Mode of delivery	Number	Percentage
NVD (Local infiltration)	73	30.4
Total LSCS	167	69.6
LSCS due to non-reactive CTG	85	35.41
SA GA	75	44.90
GA	10	5.90
Total	240	100

NVD: Normal vaginal delivery, LSCS: Lower segment cesarean section, SA: Spinal anesthesia, GA: General anesthesia, CTG: Cardiotocography

Table 9 shows that the Apgar score at 1 min was <7 in 45 (18.75%) neonates and >7 in 195 (81.25). Apgar score at 5 min was <7 in 26 (10.83%) neonates and >7 in 214 (89.16%) neonates.

DISCUSSION

A total of 240 patients were enrolled in the study, aged between 20 and 39 years, with a mean age of

Table 8: Umbilical cord arterial blood pH of study neonates

pH	Number	Percentage
<7.15 all born by LSCS	45	18.8
≥7.15	195	81.3
Total	240	100

Mean±standard deviation (range)=7.23±0.113 (6.7–7.34)

Table 9: 1 min and 5 min Apgar score of study neonates

Apgar score	1 min, n (%)	5 min, n (%)
<7	45 (18.75)	26 (10.83)
≥7	195 (81.25)	214 (89.16)
Total	240 (100)	

29.3+4.01 years. The majority of patients, i.e., 101 (42.1%), belonged to the age group of 30–34 years, followed by 80 (33.3%) patients who were between 25 and 29 years of age. 32 (13.3%) patients were aged between 20 and 24 years, while 27 (11.3%) patients were 35–39 years of age. The mean age of patients in a study done by Sahu and Pathak (2019)[9] was 24.07 years, with a range of 18–36 years.

The majority of women were primigravidae (72.5%) and 27.5% were multigravidae in the present study. The mean gestational age was 37.8±1.31 weeks in our study patients, with the majority, i.e., 192 (80%), having a gestational age of >37. The gestational age of the patients ranged between 35 and 40 weeks.

In the present study, associated risk factors were observed in 78 patients, including GDM in 42 (17.5%) patients, GHT in 13 (5.4%), IHCOP in 9 (3.8%) patients, anemia in 5 (2.1%) patients, IUGR in 4 (1.7%) patients, T2DM in 3 (1.3%) patients, and APLA in 2 (0.8%) patients.

In our study, artificial rupture of membranes was done in women with a non-reassuring fetal heart rate for augmentation of labor. Of the 240 patients studied in the present study, in 189 (78.8%) patients, ARM was done; in 29 (12.1%) patients, SROM occurred; and in 22 (9.2%), PROM occurred.

In the present study, the majority, i.e., 117 (48.8%), had a clear liquor, 76 (31.7%) patients had a grade I meconium-stained liquor, 19 (7.9%) patients had a grade II meconium-stained liquor, and 28 (11.7%) had a grade III meconium-stained liquor, which is similar to the findings conducted in our study. Acidotic pH was seen in 45 (18.8%) babies, although their CTG was also non-reactive. The total number of deliveries by cesarean section was 167 (63.9%), out of which 85 cesarean sections were done for non-reactive CTG, with the majority of cases done in SA (75) and few in GA (10). As mentioned above, 45 babies were acidotic; however, 42 out of 85 had no acidosis, though delivered by cesarean section due to non-reactive CTG. In our study, all babies born to mothers with an acidotic pH required hospital admission. Hospitalization with the need for a ventilator was observed in 14 babies. In the present study, the Apgar score at 1 min was <7 in 45 (18.75%) neonates and >7 in 195 (81.25). Apgar score at 5 min was <7 in 26 (10.83%) neonates and >7 in 214 (89.16%) neonates.

Hence, an inference was drawn that the cesarean sections done for fetal distress documented by CTG were not all truly indicated. There should have been supplementary tests as well to establish true fetal distress, which needs delivery by cesarean section.

Furthermore, an added advantage of umbilical cord blood sampling at the delivery of a baby is that it helps in the recognition of at-risk neonates who need intensive post-delivery care.[10]

Limitations of the study

There has been a rise in cesarean sections due to false positive CTG. This however could have been prevented by preoperative fetal scalp blood sampling. However it was difficult to obtain consent for the same from the parturient and her family members. They did not allow any such sampling.

CONCLUSION

It was seen that few cases with intrapartum CTG-documented fetal distress actually had any distress on umbilical cord arterial blood sampling. Thus, there is a need for supplementary diagnostic tests like intrapartum fetal blood gas sampling to cut down on falsely indicated cesarean sections by CTG. While a cesarean section can be an essential and lifesaving surgery, it can put women and babies at unnecessary risk of short- and long-term health problems if performed without any medical. In addition to the iatrogenic cause of the rise in cesarean sections, social and non-medical challenges also need to be tackled.

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REFERENCES

1. WHO. Caesarean Section Rates Continue to Rise, Amid Growing Inequalities in Access; 2021. Available from: https://www.who.

int/news/item/16-06-2021-caesarean-section-rates-continue-to-rise-amid-growing-inequalities-in-access [Last accessed 2023 Apr 27].

2. Rahman M, Khan N, Rahman A, Alam M and Khan A. Long-term effects of caesarean delivery on health and behavioural outcomes of the mother and child in Bangladesh. J Health Popul Nutr. 2022;41(1):45.
   https://doi.org/10.1186/s41043-022-00326-6
3. Keag OE, Norman JE and Stock SJ. Long-term risks and benefits associated with cesarean delivery for mother, baby, and subsequent pregnancies: Systematic review and meta-analysis. PLoS Med. 2018;15(1):e1002494.
   https://doi.org/10.1371/journal.pmed.1002494
4. Blustein J and Liu J. Time to consider the risks of caesarean delivery for long term child health. BMJ. 2015;350:h2410.
   https://doi.org/10.1136/bmj.h2410
5. Mylonas I, Friese K. Indications for and risks of elective cesarean section. Dtsch Arztebl Int. 2015;112(29-30):489-495.
   https://doi.org/10.3238/arztebl.2015.0489
6. WHO. WHO Statement on Caesarean Section Rates; 2015. Available from: https://www.who.int/publications/i/item/WHO-RHR-15.02
7. Sanyaolu A, Okorie C, Qi X, Locke J and Rehman S. Childhood and adolescent obesity in the United States: A public health concern. Glob Pediatr Health. 2019;6:2333794X19891305.
   https://doi.org/10.1177/2333794X19891305.
8. Kumar N, Suman A and Sawant K. Relationship between immediate postpartum umbilical cord blood, pH and fetal distress. Int J Contemp Pediatr. 2016;3(1):113-119.
   https://doi.org/10.18203/2349-3291.ijcp20160141
9. Sahu D and Pathak V. Study to evaluate correlation between immediate fetal outcome, cord blood pH and causes of fetal distress in low risk patients undergoing emergency caesarean section. Indian J ObstetGynecol Res 2019;6(3):337-341.
   https://doi.org/10.18231/j.ijogr.2019.073
10. American Academy of Pediatrics. Neonatal encephalopathy and neurologic outcome, second edition: Report of the American college of obstetricians and gynecologists' Task force on neonatal encephalopathy. Pediatrics. 2014;133:e1482-e1488.

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