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TRENDS OF PREDUCTAL AND POSTDUCTAL OXYGEN SATURATIONS IN PRETERM INFANTS IMMEDIATELY AFTER BIRTH

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ABSTRACT

Studies on healthy term newborns have shown that during transition from fetal to neonatal circulation, the oxygen saturation (SpO_2) values are initially low and gradually increase to normal. The postductal SpO_2 is consistently lower than the preductal SpO_2 but their difference gradually decreases after birth. The present study aims to find out the trend of preductal-postductal SpO_2 gradient in preterm infants.[1] In preterm infants, the ductus arteriosus remains patent for longer, and due to the relatively increased pulmonary vascular resistance, the right to left shunt occurs for a longer period. Hence the preductal-postductal SpO_2 gradient may persist longer. This study shows that the preductal-postductal SpO_2 gradient is significant in the first 20 minutes of life in preterm infants. So, it can be concluded that there is a preductal-postductal SpO_2 gradient in preterm infants in the first 20 minutes of life which gradually decreases from 1 to 20 minutes.

KEYWORDS: **preterm, oxygen saturation, SpO_2 gradient**

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INTRODUCTION

Physiological studies of postnatal transition in healthy term and near term infants have shown that oxygen saturation (SpO_2) in the first few minutes after birth can be as low as 60 to 70% and it would take more than 5 minutes to reach a stable SpO_2.[2,3,4] Studies on preductal and postductal SpO_2 in healthy term neonates show that postductal SpO_2 is consistently 7 to 10% less than preductal SpO_2 in such newborns immediately after birth.[4,5] There are only a few studies on oxygen saturation trends in preterm infants (these studies have been done mainly in late preterm infants). Hence, the purpose of this study is to study the normal preductal-postductal SpO_2 gradient in preterm infants (including both early and late preterm infants). Data has shown that the difference in preductal and postductal arterial SpO_2 in preterm infants with congenital heart diseases is more than 25%.[6] If we can show a normal trend in preductal-postductal SpO_2 gradient in preterm infants immediately after birth, the detection of an abnormal gradient may be followed up to see the incidence of organic heart disease in such cases. In such cases, further studies i.e. early screening for congenital heart diseases may be done. The aim in this study is to look for the usual gradient in preductal and postductal SpO_2 values in preterm infants, so that this study can be of help in future studies for determination of standard gradient in preductal and postductal SpO_2 trends in the first few minutes of life in preterm infants.

MATERIALS AND METHODS

This observational cross-sectional study has been conducted over a period of 1 year (1/9/2013-31/8/2014) in the labor room and operation theatre of the Department of Gynecology and Obstetrics, & the Neonatology division of the Department of Pediatric Medicine, KPC Medical College and Hospital, Kolkata. The study population includes 80 preterm infants immediately after birth. The inclusion criteria is preterm infants who did not need oxygen or resuscitation (with or without oxygen) at birth. The exclusion criteria are the preterm infants with central cyanosis, perinatal asphyxia, requiring oxygen therapy just after birth, requiring resuscitation by ventilation, history of multiple gestations, congenital anomalies, emergency caesarean delivery and maternal medical or obstetric complications. Approval from the institutional ethics committee (Approval no. KPC/2013/102) & informed consent from parents has been taken before conducting the study. Clinical data collection has been done according to predesigned proforma which includes variables like gestational age, mode of delivery, maternal medications (anaesthesia, analgesia) etc. Assessment of gestational age at birth has been done using the New Ballard scoring system.[7] The pulse oximeter used is PM 7000 of Shenzhen Mindray Bio-Medical Electronics Co. Ltd. Two such pulse oximeters were set at their highest sensitivity. One sensor was connected to the right hand of the baby (for preductal SpO_2) and another to the left foot (for postductal SpO_2), and both were secured with adhesive tapes. The sensors (Mindray SpO_2 sensors) were then connected to the two pulse oximeters which continuously recorded SpO_2. . The time taken to do this and to wipe the baby dry and place it under a radiant warmer was around 1 minute. The SpO_2 was recorded from 1 minute after birth at intervals of 1 minute until a SpO_2 value of ≥ 90% was achieved (preductal). The pulse oximetry measurements were carried out for the first 20 minutes after birth. The SpO_2 data was transferred to a Microsoft Excel spreadsheet for further analysis by the SPSS data analysis software. Data have been represented in terms of mean and standard deviation or as median and interquartile range. The data represented as mean and standard deviation have been analysed using independent (unpaired) t test.[8] Everywhere, the 95% confidence interval has been used and p value < 0.05 has been taken to be significant.

RESULTS

The mean gestational age of infants included was 32.88 weeks and their mean body weight was 1665.56 grams. Of these 36 (45%) were male and 44 (55%) were female. The study comprises of 56 (70%) early preterm infants (gestational age < 34 weeks) and 24 (30%) late preterm infants (gestational age 34–36 weeks). Of all the subjects 44 (55%) were born by spontaneous vaginal delivery and 36 (45%) were born by elective caesarean section. The median 1 and 5 minute Apgar score (along with interquartile range) for all subjects included in the study were 8 (IQR 1) and 10 (IQR 0.00) respectively.

Table I

Table showing the mean and standard deviation of pre and postductal SpO_2 values of all preterm infants during first 20 minutes of life

Minutes after birth	Mean preductal SpO_2 (%)	SD	Mean postductal SpO_2 (%)	SD
1	56.06	8.62	46.89	8.32
2	62.09	7.83	53.56	7.65
3	69.56	7.81	59.35	7.40
4	72.90	7.31	62.54	7.09
5	78.80	6.37	72.49	6.03
6	80.19	5.98	74.05	5.84
7	81.61	5.70	75.71	5.51
8	83.03	5.49	77.23	5.39
9	84.3	5.30	78.83	5.35
10	85.99	5.23	80.15	5.19
11	87.00	4.21	82.15	4.35
12	87.99	3.41	84.21	3.39
13	89.26	2.66	86.20	2.65
14	90.29	2.45	88.04	2.20

15	91.54	2.24	89.72	2.14
16	91.91	2.06	90.08	1.78
17	92.48	1.81	90.60	1.83
18	92.95	1.75	91.30	1.77
19	93.65	1.44	92.25	1.57
20	94.39	0.94	94.04	0.99

Table I shows that both the preductal and postductal oxygen saturation values of preterm infants increase from 1 to 20 minutes after birth. The SpO_2 values at 1 minute after birth are as low as 50% and take almost 20 minutes to reach a stable $SpO_2$of around 95%.

Table II

Table showing the mean preductal-postductal oxygen saturation gradient at 1, 5, 10, 15 and 20 minutes of life

Minutes after birth	Preductal-postductal oxygen saturation gradient (%)
1	9.2
5	6.3
10	5.5
15	1.9
20	0.4

The gradient of preductal and postductal oxygen saturations in all preterm infants in the first 20 minutes of life is shown in Table II. For all preterm infants, at no point of time is the gradient more than 17%.

Table III

Table showing comparison of pre and postductal SpO_2 values of all preterm infants at 1, 5, 10, 15 & 20 minutes of life

	Mean (standard deviation) (%)	95% confidence interval	p value*
Preductal SpO_2 at 1 minute after birth	56.06 (8.62)	6.53 – 11.82	< 0.001
Postductal SpO_2 at 1 minute after birth	46.89 (8.32)		
Preductal SpO_2 at 5 minutes after birth	78.80 (6.37)	4.38 – 8.25	< 0.001
Postductal SpO_2 at 5 minutes after birth	72.49 (6.03)		
Preductal SpO_2 at 10 minutes after birth	85.99 (5.23)	4.21 – 7.46	< 0.001
Postductal SpO_2 at 10 minutes after birth	80.15 (5.19)		
Preductal SpO_2 at 15 minutes after birth	91.56 (2.23)	1.21 – 2.57	< 0.001
Postductal SpO_2 at 15 minutes after birth	89.68 (2.12)		
Preductal SpO_2 at 20 minutes after birth	94.39 (0.94)	0.25 - 0.63	0.034
Postductal SpO_2 at 20 minutes after birth	94.06 (0.99)		

****p derived by independent t test***

Table 3 shows the results of independent t tests done comparing the pre and postductal SpO_2 values of all preterm infants at 1, 5, 10, 15 and 20 minutes after birth. These t tests show that the difference between the pre and postductal SpO_2 values for all preterm infants during the first 15 minutes of life is significant ($p < 0.001$). The p value at 20 minutes is 0.034, which is also significant, but the significance of difference is less compared to the first 15 minutes.

DISCUSSION

In the present study, it has been found that the preductal SpO_2 values are significantly higher than the postductal SpO_2 values upto 20 minutes after birth. The significance of difference is much less at 20 minutes than at 15 minutes. This indicates that the difference will probably gradually become insignificant at some point of time beyond 20 minutes after birth, but no comment can be made on this as SpO_2 values have been recorded only for the first 20 minutes after birth. Existing studies show that the preductal SpO_2 values may be significantly higher than the postductal values upto 15 minutes after birth.[5] One study by Meier-Stauss P et al showed that SpO_2 values from hand were always higher than those from foot in term babies and there was no significant difference between the two after 17 minutes of life.[9] In Moller's textbook of Pediatric Cardiovascular Medicine, it has been mentioned that for healthy neonates, the difference between the pre and postductal SpO_2 gradually decreases and both reach a value of 95% at 60 minutes after birth.[10] The possible reasons for the difference in findings of the present study from those of existing studies are a small sample size, difficulty in fixing the probe due to presence of vernix (this may have influenced the first few oximeter readings), movement artefacts (minimized by proper fixation of probe), manual recording of data, data collection only upto 20 minutes after birth and no follow up of the subjects included in the study. Hence in future, studies may be conducted on the same issue with a larger sample size. Follow up studies of these preterm infants should be carried out. The preterm infants having a higher than usual preductal-postductal SpO_2 gradient may be followed up to study the chances of development of congenital heart disease.

CONCLUSION

From this study, it can be concluded that there is a preductal-postductal oxygen saturation gradient in preterm infants in the first 20 minutes of life which gradually decreases from 1 to 20 minutes. Further studies are required to comment that this gradient is normal and a gradient more than this will require early investigations for organic congenital heart disease.

CONFLICT OF INTEREST

None.

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