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STUDY OF ROLE OF PERFUSION INDEX IN EARLY IDENTIFICATION OF NEONATAL CIRCULATORY SHOCK

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Abstract

Background: Given that the perfusion index displayed by a pulse oximeter is an objective parameter providing an indirect measure of peripheral perfusion. Present study was aimed to study role of perfusion index in early identification of neonatal circulatory shock so that we could employ it as an objective parameter for predicting shock. **Material and Methods:** Present study was single-center, prospective, observational study, conducted neonates admitted to Neonatology department who is under hemodynamic monitoring in conditions like shock, hypoglycemia, Perinatal asphyxia, respiratory distress, seizure and sepsis. Perfusion Index measured using pulse oximetry in right upper limb. **Results:** In the present study, 100 neonates were study. 66% were above 34 weeks of gestational age and 34% were below 34 weeks of gestational age. Mean gestational age was 35.88 ± 2.23 weeks. 54% were males and 46% were females. 47% were normal deliveries and 53% were LSCS. 28% had birth weight less than 1.75 kg. Mean birth weight was 2.01 ± 0.86 kg. In presents study, common neonatal complications observed were respiratory distress syndrome (35 %), hyperbilirubinemia (32 %), meconium aspiration syndrome (25 %), sepsis (12 %) & birth asphyxia (10 %). The majority of the neonates who had shock has perfusion index less than 0.9. The association is statistically significant. ($P<0.05$). The majority of the neonates who had serum lactate more than 6 has perfusion index less than 0.9. The association is statistically significant. ($P<0.05$). **Conclusion:** Clinical shock in neonates can be reasonably predicted when perfusion index is less than 0.91. Perfusion index less than 0.91 has high sensitivity and low false positivity in predicting clinical shock.

Keywords: Clinical Shock, Neonates, Perfusion Index, Serum Lactate.

INTRODUCTION

Shock is a clinical state that's characterised by an acute breakdown of the circulatory system's ability to keep adequate perfusion levels in the tissues. [1] This results in dysfunction within the cells due to a lack of oxygen, which ultimately results in the death of the cells. Accidents involving the umbilical cord, placental abnormalities, fetal and neonatal hemorrhage, maternal anaesthesia and hypotension, intrauterine and/or intrapartum asphyxia, neonatal sepsis, pulmonary air leak syndromes, lung over distension while receiving positive pressure ventilation, and cardiac arrhythmias are all potential causes of shock. [1]

There are three stages of shock, which correspond to different degrees of shock: the compensated phase, the decompensated phase, and the irreversible stage. In compensated shock, despite the presence of a normal blood pressure, an abnormally rapid heart rate is observed.[2]A peripheral perfusion index (PI) can be determined by calculating the ratio of the pulsatile to the non-pulsatile light that reaches the detector

of the pulse oximeter. [3] It is expressed as a percentage. The Perfusion index value ranges from 0.02% (very weak pulse) to 20% (very strong pulse) [3]

Given that the perfusion index displayed by a pulse oximeter is an objective parameter providing an indirect measure of peripheral perfusion. Present study was aimed to study role of perfusion index in early identification of neonatal circulatory shock so that we could employ it as an objective parameter for predicting shock.

MATERIAL AND METHODS

Present study was single-center, prospective, observational study, conducted in department of Neonatology, Saveetha medical college, Chennai, Tamilnadu., India. Study duration was of 2 years (January 2020 to December 2019). Study approval was obtained from institutional ethical committee.

Inclusion Criteria

- All Neonates admitted to Neonatology department who is under hemodynamic monitoring in conditions like shock, hypoglycemia, Perinatal asphyxia, respiratory distress, seizure and sepsis, parents willing to participate in present study

Exclusion Criteria

- Major congenital anomaly
- Life threatening illness diagnosed in the antenatal period.

Neonates admitted to NICU who needs hemodynamic monitoring were enrolled into the study after getting consent from parents. Hemodynamic monitoring was done for the recruited neonates from the time of enrollment for 48 hours in stable neonates and for 72 hours in sick neonates. For all recruited babies every 8th hourly from the time of recruitment to 48 hours. In shock babies every twenty minutes till perfusion is normal and thereafter as scheduled till 72 hours. Treatment of the primary condition, shock and choice of inotropes as per unit policy.

Clinical criteria to define Shock / Poor perfusion;

- Weak & fast pulse (Heart Rate >180/min)
- Capillary Refill Time >3 Sec
- Extremities cold to touch
- With or without the following signs: Lethargy, not arousable on stimulation, very pale

The monitoring included the following parameters;

- Heart rate measurement was done by using stethoscopes when the baby is not agitated.
- Blood pressure was measured in supine position with an appropriate size cuff in a quiet environment, in the right upper limb, when the baby was not agitated. The width of the cuff was 60 to 70% of the arm length.
- Lactate levels were taken from arterial blood gas analysis (normally done for all babies admitted in NICU who needs hemodynamic monitoring)
- Perfusion Index measured using pulse oximetry in right upper limb.

$$\text{Perfusion index} = \frac{\text{Pulsatile signals of infrared}}{\text{Non pulsatile signals of infrared}} \times 100$$

Data was collected and consolidated using Microsoft Excel software and analyzed using IBM SPSS software. To characterize the data, descriptive statistics of frequency analysis and percentage analysis were used for categorical variables, while mean and standard deviation was used for continuous variables. The correlation between perfusion index and other parameters of shock will be calculated by using area under the ROC curve.

RESULTS

In the present study, 100 neonates were study. 66% were above 34 weeks of gestational age and 34% were below 34 weeks of gestational age. Mean gestational age was 35.88 ± 2.23 weeks. 54% were males and 46% were females. 47% were normal deliveries and 53% were LSCS. 28% had birth weight less than 1.75 kg. Mean birth weight was 2.01 ± 0.86 kg. Gestational diabetes mellites (32 %) & pregnancy induced hypertension (26 %) were common maternal risk factors observed.

Table 1: General Characteristics

	No. of patients	Percentage
Gestational age in weeks		
≤34	34	34
>34	66	66
Mean Gestational age (mean ± SD)	35.88±2.23	
Gender		
Male	54	54
Female	46	46
Mode of delivery		
NVD	47	47
LSCS	53	53
Birth weight (kgs)		
≤1.75	28	28
>1.75	72	72
Mean **Birth weight (kgs)**	2.01±0.86	
Maternal Risk factors		
Nil	42	42
Gestational Diabetes Mellites	32	32
Pregnancy induced Hypertension	26	26

In presents study, common neonatal complications observed were respiratory distress syndrome (35 %), hyperbilirubinemia (32 %), meconium aspiration syndrome (25 %), sepsis (12 %) & birth asphyxia (10 %).

Table 2: Neonatal Complications

Risk factors	Frequency	Percentage
Respiratory Distress Syndrome	35	35
Hyperbilirubinemia	32	32
Meconium aspiration syndrome	25	25
Sepsis	12	12
Birth asphyxia	10	10
Apnea	5	5
Ventilation requirement	4	4
Retinopathy of prematurity	4	4
Intra Ventricular Hemorrhage	3	3

Among study participants, Systolic blood pressure was significantly less in neonates with shock as compared to those without shock, difference was statistically significant. Diastolic blood pressure, mean arterial pressure & heart rate were comparable among neonates with & without shock.

Table 3: Haemodynamic Parameters

Haemodynamic Parameters	Shock present	Shock absent	P value
Systolic blood pressure	65.21 ± 8.7	69.12 ± 2.2	0.04
Diastolic blood pressure	40.16 ± 5.6	48.12 ± 4.5	0.05
Mean arterial pressure	47.69 ± 6.4	49.16 ± 2.26	0.76
Heart rate	150.18 ± 14.16	148.12 ± 2.21	0.42

The majority of the neonates who had shock has perfusion index less than 0.9. The association is statistically significant. (P<0.05)

Sensitivity=90.90%

Specificity=94.87%

Positive predictive value=83.33%

Negative predictive value =97.36%

Table 4: Association between Perfusion Index and Shock

PI	Shock present	Absent	P value
≤0.9	20	4	<0.01
>0.9	2	74	
Total	22	78	

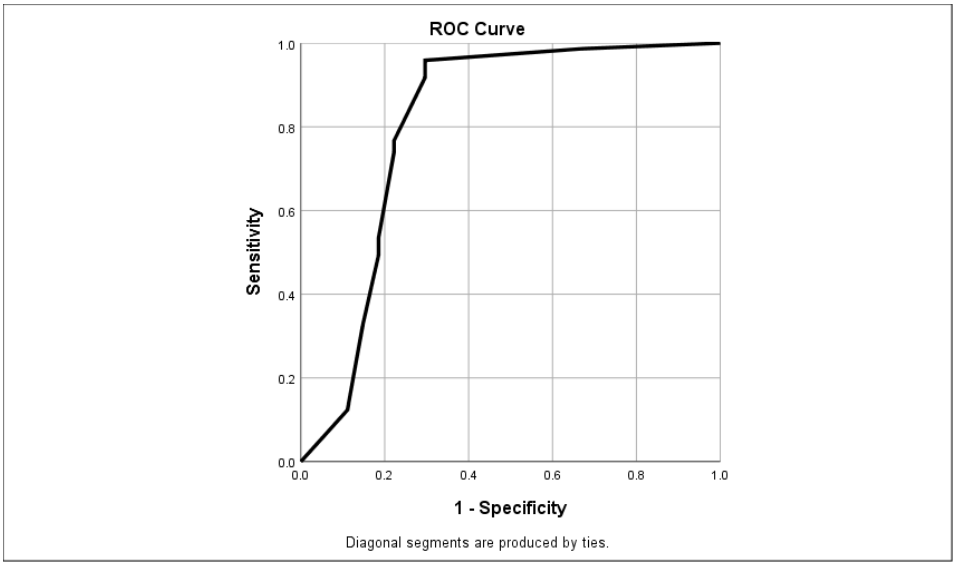

Table 5: Area under the Curve

Area Under the Curve				
Test Result Variable(s): perfusion index				
Area	Std. Error	P value	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.808	.064	.000	.683	.932

The majority of the neonates who had serum lactate more than 6 has perfusion index less than 0.9. The association is statistically significant. (P<0.05)

Table 6: Association between Perfusion ndex and Serum Lactate

PI	Serum Lactate ≥ 6	Serum Lactate ≤2	P value
≤0.9	21	3	<0.01
>0.9	3	73	
Total	24	76	

DISCUSSION

Shock is a complex clinical syndrome characterized by acute failure of the circulatory system to maintain adequate tissue and organ perfusion. This leads to inadequate oxygen and nutrient substrate delivery to body tissues. The hemodynamic status of newborns is usually estimated by the interpretation of indirect parameters of systemic blood flow, like blood pressure, heart rate, capillary refill time and urine output.

Perfusion index (PI) is an indicator of vasoconstriction. So, a decrease in perfusion index indicates increase in sympathetic tones which occur in many conditions like pain, stress and in shock. In our study, we constructed ROC curve to predict future shock by percentage of change in perfusion index (PI). This result should be interpreted cautiously because pain, stress and hypothermia also decrease the PI.

In present study, majority of the neonates who had shock has perfusion index less than 0.9. The association is statistically significant. (P<0.05). The majority of the neonates who had serum lactate more than 6 has perfusion index less than 0.9. The association is statistically significant. (P<0.05)

A prospective study done by Lima et al., [4] found that PI had skewed distribution which varies from 0.30 to 10.0 with median value of 1.4 and concluded that PI can be used to monitor peripheral perfusion in critically ill patients.

Van Genderen et al., [5] monitored stroke volume, heart rate, MAP and PI by pulse oximeter in adults. They found that PI would detect central hypovolemia and shock very early and well before the occurrence of cardiovascular deterioration.

Patrizia Zaramella et al.,[6] studied the relationship between foot perfusion index, obtained by pulse oximeter, and oxygen delivery, oxygen consumption, fractional oxygen extraction, and blood flow, measured indirectly by near-infrared spectroscopy (NIRS) on the calf of the neonate. There is a positive correlation between the foot perfusion index and oxygen delivery (r=0. 32, p=0. 03) and between perfusion index and calf blood flow (r=0. 32, p=0. 03). There is no correlation between the foot perfusion index and calf fractional oxygen extraction and between foot perfusion index and oxygen consumption. The foot perfusion index was 1.26±0.39.

In the study by De Felice C, et al [7] perfusion index of 0.86 ± 0.26 predicted high illness severity (SNAP score) in the neonate with high sensitivity. S, Takahashi et al [5]found a positive correlation between perfusion index and SVC flow and predicted low SVC flow in preterm neonates with the Perfusion index less than 0.44. In a study done by Lima AP, et al.,[4] in the adult population, the perfusion index of 1.4 indicated poor peripheral perfusion.

In a study by Dr Senthil Kumar et al,[9] perfusion index of 0.91 predicted shock with high sensitivity and low false positivity index in the patients. The results of this study are very similar to this study. Perfusion index displayed in newer pulse oximeters may be a useful added parameter for the assessment of peripheral perfusion. The best cutoff for the prediction of poor perfusion is less than 0.91 in neonates.

Limitations of the study were, small sample size, more studies of similar nature across multiple centers with varied population groups need to be correlated.

CONCLUSION

Clinical shock in neonates can be reasonably predicted when perfusion index is less than 0.91. Perfusion index less than 0.91 has high sensitivity and low false positivity in predicting clinical shock. Additionally, it has association with serum lactate which also helps in predicting shock

A larger study with larger sample size might be needed, to get more insight about the perfusion index and its prediction of impending illness.

Conflict of Interest: None to declare

Source of funding: Nil

References

1) Davendralingam Sinniah, Shock in the neonate. IeJSME 2013 7 (2):17-28

2) Nuntnarumit P, Yang W, Bada-Ellzey HS. Blood pressure measurements in the newborn. Clin Perinatol.1999; 26:981-996.

3) Pinto Lima A, Beelen P, Bakker J. Use of a peripheral perfusion index derived from the pulse oximetry signal as a noninvasive indicator of perfusion. Crit Care Med 2002; 30: 1210–3.

4) Lima AP et al, Use of a peripheral perfusion index derived from the pulse oximetry signal as a noninvasive indicator of perfusion,Crit Care Med2002Jun;30(6):1210-3

5) Van Genderen ME, Peripheral perfusion index as an early predictor for central hypovolemia in awake healthy volunteers. AnesthAnalg 2013 Feb; 116(2):351-6.

6) PatriziaZaramella et al, Foot Pulse Oximeter Perfusion Index Correlates with Calf Muscle Perfusion Measured by Near Infrared Spectroscopy in Healthy Neonates .Journal of Perinatology (2005) 25,417–422.

7) De Felice C et al, Early postnatal changes in the perfusion index in term newborns with subclinical chorioamnionitis ,Arch Dis Child Fetal Neonatal Ed2005;90:F411–F414.

8) S Takahashi et al, The perfusion index derived from a pulse oximeter for predicting low superior vena cava flow in very low birth weight infants, Journal of Perinatology (2010) 30,265–269

9) Gupta S, Donn SM. Assessment of neonatal perfusion. InSeminars in Fetal and Neonatal Medicine 2020 Oct 1 (Vol. 25, No. 5, p. 101144). WB Saunders.