

Original Research Article

Perfusion index monitoring and its correlation with outcome in neonates undergoing surgery

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ABSTRACT

Background: The perfusion index (PI) has been found to be a reliable indicator of peripheral perfusion and can be used to monitor perfusion in neonates undergoing surgical procedures. To study correlation of perfusion index with the need for post op mechanical ventilation, ICU care and inotropic support in neonates undergoing surgery.

Methods: Eighty neonates posted for surgery were enrolled after taking proper written informed consent from the parents. HR, BP and SPO₂ and PI were recorded at 3 minutes interval for the first 30 minutes of surgery, followed by every 5 minutes till the end of procedure. Neonates requiring admission in the Department of Pediatrics were shifted to the Neonatal ICU or ward. Post-operative vitals were monitored initially every 30 minutes for first 24 hours followed by 2 hourly.

Results: There was a statistically significant association between PI and need for post-op mechanical ventilation (MV). Duration of post-operative MV based on PI showed no significant difference. A lower PI was strongly correlated with an increased likelihood of requiring ICU-level care post-operatively, but not the duration of ICU stay. There was a potential association between PI and the requirement for inotropic support. Mortality rate was higher in patients with low PI, but not statistically significant.

Conclusions: Low PI in neonates is associated with poor outcome in terms of need for ICU stay, need of postoperative mechanical ventilation and inotropic support.

Keywords: Inotropic support, Pulse oximetry, Post operative mechanical ventilation

INTRODUCTION

Pulse oximetry is one of the most common and simple monitoring modalities currently in use in anesthesiology and critical care settings. Pulse oximetry is sometimes referred to as the fifth vital sign; it is a quick and non-invasive monitoring technique that measures the oxygen saturation in the blood. The perfusion index (PI) (derived from a pulse oximeter) is an indicator of the relative

strength of the pulsatile signal from pulse oximetry and has been found to be a reliable indicator of peripheral perfusion.¹⁻³ Hemodynamic monitoring of neonates is crucial because neonates are easily and acutely susceptible to hemodynamic disturbances. As such, non-invasive monitoring of hemodynamics is preferable. It has been postulated that non-invasive pulse oximetry determines the perfusion index and pulse variability

index and provides accurate measurements to predict hemodynamic changes in preterm or term infants.⁴

Equally, numerous studies have investigated the efficacy of perfusion index and pulse variability indices in monitoring neonatal hemodynamics.^{5,6} Because a pulse oximeter is almost universally available in the operating room and intensive care unit, this ratio can be used to monitor perfusion in neonates undergoing surgical procedures. With this background, this study was undertaken to find out the correlation between perfusion index and the outcome in neonates undergoing surgery, in the Department of Anesthesiology and Critical Care, at a tertiary care institute in North India, Srinagar.

Aims and objectives of the study are to study monitoring of peri-operative, PI and its correlation with the outcome in neonates. Another objective was to study correlation of PI with hemodynamic parameters in neonates requiring ICU admissions.

METHODS

This study titled “Perfusion index monitoring and its correlation with the outcome in neonates undergoing surgery.” was undertaken in the Department of Anesthesiology and Critical Care at Sher-i-Kashmir Institute of Medical Sciences (SKIMS), Soura, Srinagar from February 2022 to February 2024 after taking the institutional ethical committee clearance. The study was conducted in a prospective observational fashion.

A total of eighty neonates posted for surgery in Paediatric Surgery department of SKIMS were enrolled after taking proper written informed consent from the parents for the procedure and participation in the study.

Inclusion criteria

Inclusion criteria included all newborn babies admitted in Neonatal ICU or Paediatrics department requiring any elective surgical procedure.

Exclusion criteria

Exclusion criteria included refusal to participate in the study, patients requiring emergency surgical interventions and intraoperative mortality.

After taking written informed consent from the parents of 80 neonates, a detailed history was taken including prenatal, antenatal and postnatal history. A detailed preoperative physical examination was done including vitals (HR, NIBP, SPO2) detailed systemic examination and anthropometry, during the pre-anaesthetic visit.

All baseline investigations done preoperatively were documented in a predesigned format including a complete blood count and other investigations like liver

functions, renal functions, Chest X Ray, C Reactive Protein, Serum Calcium and Electrolytes as per need.

Before shifting the neonate to the OT, the OT was warmed to an ambient temperature of 26 to 28° Celsius. Bair-Hugger and forced-air warming blankets were kept ready. The patient was shifted to the OT and an automated NIBP cuff of the appropriate size, Electrocardiographic leads and reusable pediatric probes with disposable wraps were secured on the palm or the ventral aspect of right wrist of the patient for measurement of the baseline records of Pulse, Blood Pressure, SPO2 and PI. A 24 G IV cannula was secured and the patient was given general anesthesia using induction agents as per hospital protocol.

Patient was covered with a forced-air warming blanket and temperature monitoring was done. After induction and intubation, continuous monitoring of vitals (HR, BP and SPO2) and PI was done and recorded at 3 minutes interval for the first 30 minutes of surgery, followed by every 5 minutes till the end of procedure.

Hypotension was treated with IV fluids and vasopressors as required. Inotropic support was started if required. Bradycardia was treated with Inj. ATROPINE 0.02 mg/kg.

At the end of the surgery, neonates requiring admission in the Department of Pediatrics were shifted to the Neonatal ICU or ward. In the NICU or ward, regular monitoring of hemodynamic parameters i.e., HR, NIBP, SPO2 and PI was done. The recordings were done initially every 30 minutes for the first 24 hours followed by 2 hourly till the outcome of the patient.

Monitoring of the parameters was done by the Resident posted in the respective units. The outcome parameters that were monitored after the procedure included the need and duration for postoperative mechanical ventilation, inotropic support, duration of ICU stay and mortality.

The variation in PI during the peri-operative periods and during NICU stay was correlated with the outcome and the variation in hemodynamic parameters.

Statistical analysis

Statistical analysis was done by using SPSS software v24. All the categorical variables were shown in the form of frequency and percentage. All the continuous variables were analyzed by using proper statistical test. All values discussed at 5% level of significance. ($p < 0.05$).

RESULTS

The data in Table 1 presents the median and interquartile range (IQR) for various parameters in a paediatric cohort.

Among those with a low perfusion index, 30 patients required post-op MV, while only 15 patients with a high perfusion index needed post-op MV. Conversely, 18 patients with a low perfusion index did not require post-op MV, compared to 17 patients with a high perfusion index.

The p value of 0.008 suggests that there is a statistically significant association between the perfusion index and the need for post-op MV, with a higher perfusion index being associated with a lower likelihood of requiring post-op MV (Table 2). The analysis of the duration of post-operative mechanical ventilation (MV) based on

perfusion index categories shows no significant difference between the groups. Patients with a low perfusion index had varying durations of MV ranging from 3 to 240 hours, while those with a high perfusion index had MV durations primarily clustered around 3 hours (Table 3).

Comparison of the need for ICU stay between patients categorized by perfusion index reveals a significant association (Table 4) indicating that a lower perfusion index is strongly correlated with an increased likelihood of requiring ICU-level care post-operatively.

Table 1: Distribution of various outcome measures in a paediatric cohort.

Parameter	Median (IQR)
Age (in years)	3 (2.75, 9.25)
Weight (Kg)	2.9 (2.53, 3.28)
Gestational age (Weeks)	37 (36, 38)
Duration of post-op MV (hours)	48 (6, 120)
Days of ICU stay (days)	5 (3, 12)

Table 2: Association of need of mechanical ventilation with perfusion index in a paediatric cohort.

Need of postop MV	Low perfusion index	High perfusion index	P value
Yes	30	15	0.008
No	18	17	

Table 3: Association of post-operative mechanical ventilation with perfusion index in a paediatric cohort.

Duration of postop MV (in hours)	Low perfusion index	High perfusion index	P value
3	3	15	0.345
6	5	0	
8	4	0	
48	5	0	
72	3	0	
96	3	0	
120	4	0	
192	3	0	
240	2	0	

Table 4: Association of need of ICU stay with perfusion index in a paediatric cohort.

Need of ICU stay	Low perfusion index	High perfusion index	P value
Yes	30	15	0.008*
No	18	17	

*,highly significant

Patients with a low perfusion index had varying lengths of ICU stay ranging from 1 to 18 days, while those with a high perfusion index predominantly had shorter stays, primarily limited to 1 day. The calculated p value of 0.845 indicates that these differences in ICU stay duration are not statistically significant, suggesting that the perfusion index alone may not be a decisive factor in determining the length of ICU care needed post-operatively (Table 5).

Among patients with a low perfusion index, 26 required inotropic support while 30 did not, indicating a significant need for cardiovascular support in this subgroup.

Conversely, none of the patients with a high perfusion index required inotropic support. The calculated p value of 0.082 suggests a borderline significance, indicating a

potential association between perfusion index and the requirement for inotropic support (Table 6).

Table 5: Association of ICU stays with perfusion index in a paediatric cohort.

Days of ICU stay	Low perfusion index	High perfusion index	P value
1	5	15	0.845
2	3	0	
3	8	0	
4	5	0	
5	8	0	
7	7	0	
10	7	0	
12	3	0	
14	4	0	
16	3	0	
18	3	0	

Table 6: Association of inotropic support with perfusion index in a paediatric cohort.

Need of inotropic support	Low perfusion index	High perfusion index	P value
Yes	26	0	0.082
None	30	24	

Table 7: Association of outcome measures with perfusion index in a paediatric cohort.

Outcome	Low perfusion index	High perfusion index	P value
Death	14	0	0.464
Discharge	35	31	

Among patients with a low perfusion index, 14 patients died and 35 were discharged, while none of those with a high perfusion index died and 31 were discharged. The calculated p-value of 0.464 indicates that these differences in outcomes are not statistically significant (Table 7).

DISCUSSION

As a part of minimal mandatory monitoring pulse oximetry is a valuable asset in the field of anesthesiology and critical care. The perfusion index (PI) (derived from a pulse oximeter) is an indicator of the relative strength of the pulsatile signal from pulse oximetry and has been found to be a reliable indicator of peripheral perfusion.

PI has been used to determine proper management of pain especially in patients unable to communicate their discomfort to the clinician.⁷ Various studies have shown that PI provides information about illness severity, early neonatal respiratory outcome, low superior venacaval flow, hemodynamically significant patent ductus arteriosus and subclinical chorioamnionitis.⁸⁻¹¹

PI is being increasingly recognized as an effective parameter to increase the sensitivity for the detection of

important neonatal complications. The present study was undertaken to find out the correlation between perfusion index and the outcome in neonates undergoing surgery. The results of the study are discussed as under.

The median age of the children was 3 days, with an IQR from 2.75 to 9.25 days, indicating most neonates fall within this age range. The median weight was 2.9 kg, with an IQR from 2.53 to 3.28 kg, suggesting a relatively small size likely due to the inclusion of neonates or infants. The median gestational week at birth was 37 weeks, with an IQR from 36 to 38 weeks, indicating that the majority of the children were born at term (Table 1).

A statistically significant association between the perfusion index and the need for post-op MV, with a higher perfusion index being associated with a lower likelihood of requiring post-op mechanical ventilation. However, the analysis of the duration of post-operative mechanical ventilation (MV) based on perfusion index categories shows no significant difference between the groups. This implies that other factors may be more critical in determining the duration of MV needed postoperatively.

In the present study, lower perfusion index was strongly correlated with an increased likelihood of requiring ICU-level care post-operatively. This suggests that monitoring and interventions to improve perfusion indices may potentially mitigate the need for intensive care following surgical procedures.

In the present study, patients with a low perfusion index had varying lengths of ICU stay ranging from 1 to 18 days, while those with a high perfusion index predominantly had shorter stays, primarily limited to 1 day. The difference was however not significant statistically. Although higher inotropic requirement was seen in the group with low perfusion index, the p value of 0.082 suggests a borderline significance, indicating a potential association between perfusion index and the requirement for inotropic support, though it does not reach conventional levels for statistical significance. Mortality rate was higher in patients with low perfusion index, however the difference was not statistically significant, suggesting that perfusion index alone may not be a determining factor in predicting mortality or discharge status post-operatively.

Several studies have studied relation between perfusion index and outcome in surgical patients. Cresi et al, recorded perfusion index in preterm infants and concluded that neonatologists should use the perfusion index in measuring neonatal hemodynamics given its ability to detect hemodynamic status in newborns in the first week of life.¹¹ Xing She et al, observed that perfusion index predicted the length of ICU stay in surgical patients better than lactate levels.¹²

Alderliesten et al, investigated the value of the perfusion index in monitoring neonatal hemodynamics in preterm infants in the first three days of life. The study established that the perfusion index has the potential to monitor neonatal dynamics as well as provide guidance for medical interventions.¹³

Islam Rasmy et al, evaluated the ability of perfusion index (PI) to predict vasopressor requirement during early resuscitation in patients with severe sepsis and concluded that perfusion index (PI) is a good predictors of vasopressor requirement during early resuscitation.¹⁴

In 2005 C De Felice et al, did a study to assess the value of the pulse oximetry perfusion index (PI) in the early prediction of subclinical HCA (Histological chorionamnitis) in term newborns. The findings of the study indicate that HCA positive term infants with subclinical disease show lower perfusion index (PI) values from the first minutes of life than control neonates and have worse short-term outcomes. In addition, earlier HCA detection was associated with a reduction in neonatal illness severity. These findings, as well as confirming the importance of perfusion index (PI) monitoring in the high-risk newborn, provide, for the first time, an easily applicable and non-invasive diagnostic

tool for the early screening of perinatal inflammatory disease, suggesting its use in newborn monitoring right from the delivery room.¹⁰

Vinod Kumar Mandala, et al, conducted a systematic review that indicated that perfusion and pulse variability indices are effective measurements that can enable neonatologists to monitor hemodynamic changes occurring in newborn infants.¹⁵

CONCLUSION

From the present study, it can be concluded that perfusion index is an indicator of cutaneous perfusion and any change in perfusion index can reflect a change in global perfusion. Low perfusion index is associated with poor outcome in terms of need for ICU stay, need of postoperative mechanical ventilation and inotropic support. Any intervention aimed at normalizing the perfusion index can improve the outcome in neonates undergoing surgery.

Perfusion index is quite sensitive to patient movement. Applying pressure to the sensor causes blood flow changes in the cutaneous microcirculation giving false results. Also, neonatal surgical conditions are mostly emergent in nature and it is not feasible to rule out any associated congenital heart disease that can have an effect on the perfusion index.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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