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Original Research Article

Perfusion Index Cut-Off to Diagnose Sick Preterm Newborn

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Abstract

Perfusion index is a non-invasive method to assess the peripheral perfusion at a specific monitoring site measured by masimo pulse oximeter using signal extraction technology. Perfusion Index is an important measure to diagnose peripheral perfusion noninvasively. Present study is planned to find out the cut-off value of perfusion index for preterm neonates. 633 preterm neonates of 28-36wks was followed simultaneously for perfusion index and capillary refill time. Capillary refill time more than 3 is a sign of poor peripheral circulation. Using the statistics of diagnostic tests, the perfusion index cut-off for sick preterm is 1.3sec by plotting in receiver operator characteristics curve. Capillary refill time more than 3 is taken as gold standard. The sensitivity of perfusion index is 88%. Perfusion index is a very important non-invasive measure to diagnose sick preterm.

Keywords: Perfusion index (PI), Capillary refill time (CRT), Cut-off value, preterm, newborn, Receiver operator characteristics curve (ROC).

INTRODUCTION

Perfusion index is a non-invasive method to assess the peripheral perfusion at a specific monitoring site (hand, finger, foot) expressed as ratio of pulsatile and nonpulsatile strength of photoplethysmograph signal depending on the amount of infrared (940nm) light absorbed in a masimo pulse oximeter using signal extraction technology [1]. Capillary refilling time (CRT) has been used as a widely accepted method to assess cardiac output and peripheral circulation especially in neonates. Measurement of blood pressure is difficult in newborns due to lack of easy availability of adequate sized cuff & electronic multichannel monitor. Invasive blood pressure monitoring again, is cumbersome in neonates. Under such circumstances, capillary refilling time (CRT) has been broadly used as an accepted method to assess cardiac output and peripheral circulation. There is paucity of literature describing normal values of perfusion index range. The value of CRT is affected by age, ambient or skin temperature and site of measurement [2], duration as well as amount of blanching pressure and inter observer variation [3]. CRT is also being affected by nursery equipments like warmer and phototherapy [4]. Singh *et al*., reported CRT in healthy neonates of 35-42weeks as 2.22, 2.21, 2.23, and 2.21 seconds on day1, day3, day 5, and day 7 of life [5]. Strozik *et al*., seen that the upper limit of normal for neonatal CRT was 3 seconds, values are consistent on the midpoint of the sternum and forehead [6]. Present study is planned to find out the cut-off value of perfusion index as an early guide to detect sick preterm newborn in comparison to capillary refill time.

METHOD

Present study was planned to prepare a cut off of perfusion index value of preterm newborn which corresponds with capillary refill time 3seconds. It is a prospective observational cohort study done over 1yr period from January to Dec 2018 at Calcutta National Medical College Hospital which is a tertiary care hospital with approximately 1200 delivery per month. Outborn neonates are also admitted in NICU in this hospital. Neonates of 28-36wks 6 days were included in the study. Neonates temperature was kept in thermoneutral range and appropriate fluid and feeding was given as per NICU protocol. Preterm neonates who became sick during the hospital stay and there was prolonged capillary refill time were included in the study. The inclusion criteria were clinically and hemodynamically stable conditions at birth, gestational age between 28 and 36 weeks 6days, Apgar score at 1 minute 7 to 10, no need for mechanical ventilation or other invasive procedures at birth. Neonates were followed prospectively during their course of stay and vital signs were checked twice a day. Masimo pulse oximeter probe was attached to the right hand of the neonates showing perfusion index. The neonates who

have capillary refill time 3 seconds were noted for perfusion index value. Capillary refill time was recorded on the middle part of the sternum by the same observer. 630 observations were noted over a period of 1yr (January 2018 to December 2018).

RESULTS

Collected data were analysed by SPSS version 16 software. Perfusion index value cut off which corresponds to capillary refill time 3 was detected by using the statistics of diagnostic test. Sample size was calculated from the previous pilot study to have power of study80%. Total 633 cases were taken 279 was male, 354 was female. 102 cases was born by caesarean section.531 cases was born by normal delivery. Mean gestational age was 33wks. Mean birth weight was 1604 gm (Table-1). Using the statistics of diagnostic test sensitivity of perfusion index to diagnose CRT 3 was 88% and specificity was 56% (Table-2) negative predictive value of 97%. Receiver operator characteristics (ROC) curve was prepared to find out the cut off of perfusion index value for CRT3. Perfusion index cut off for CRT 3 was 1.3 (Figure-1).

Table-1: Patient Clinical and Demographic Characteristics

Clinical Parameter	Median	Range
Gestational age(wks)	33	28-36
Birth wt(gm)	1604	1100-2010
Systolic BP	51	45-95
Diastolic BP	32	22-49
Mean BP	38	28-65
Mean CRT(sec)	2.0	2.1-2.3
Mean Perfusion index	1.5	1.2-1.7

Table-2:

TEST RESULTS	SHOCK CRT ≥3	NO SHOCK CRT<3	TOTAL
POSITIVE PI≤1.3	True positive (a) **66**	False positive (b) **243**	Total positives (a+b)**309**
NEGATIVE PI>1.3	False negative(c) **9**	True negative(d) **315**	Total negatives (c+d)**324**
TOTAL	(a+c) **75**	(b+d) **558**	(a+b+c+d)**633**

Sensitivity = a/(a+c)
=66/75 = 0.88

Specificity = d/(b+d)
=315/558 = 0.56

1- Specificity = 0.44

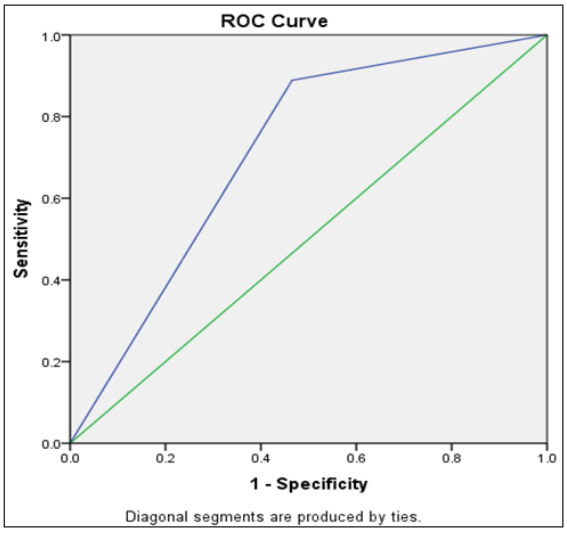

Fig-1:

DISCUSSION

When peripheries are hypoperfused or vasoconstricted, the proportion of light absorbed from the pulsatile component decreases, and so does the PI [7]. The PI may reflect early hemodynamic changes in patients in the intensive care unit setting [3]. In critically ill patients, a reduction in PI is associated with decrease in temperature and capillary refill time-known indicators of poor peripheral perfusion [7]. A number of studies have determined PI in well [8, 9] and unwell [10] term infants, as well as preterm [11, 12] infants. In well term infants, DeFelice found that the mean PI was 4.5 one minute after birth and 4.42 at 5 min (13). Granelli found that the mean PI was 1.68 in a group of 10 000 term infants between 1 and 310 h of life [10], and was lower in infants with a duct dependent circulation. Similarly, its use in preterm infants has been studied by Takahashi (14), who examined 30 very low birth weight infants born at 22–32 weeks gestational age and found that a cut-off value of PI < 0.44 was the best identifier of a low superior vena cava flow (<40 mL/kg/min. In the present study it is found that perfusion index is a good indicator of peripheral perfusion and comparable to capillary refill time. Mean perfusion index in the present study is 1.5 which can be taken as a normal value of perfusion index in a stable preterm infant. Kinoshita *et al*., has seen that mean value of perfusion index in very preterm infant is 0.7 ranging from 0.29 to 1.35 [15]. If capillary refill time more than 3 is taken as gold standard, then using the statistics of diagnostic test the sensitivity of perfusion index is 88% to detect sick preterm. J Mathew et al in his study of correlation of perfusion index to CRIB score found that perfusion index has direct negative correlation to CRIB score [16]. Receiver operative characteristics curve prepared by plotting sensitivity and 1-specificity to find out the best cut-off for perfusion index value (1.3). The area under the receiver operative characteristics curve is 71% which indicates significant positive outcome.

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