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Original Research Article

ASSESSMENT OF CARDIAC SYMPATHO-VAGAL BALANCE IN HEALTHY NEONATES USING HEART RATE VARIABILITY (HRV).

[1]Dr. Prabakar.S, [2]Dr. Vikram.R , [3]Dr. Jaganathan.R.

[1]Assistant Professor, Department of Paediatrics, Madha Medical College and Research Institute, Chennai.

[2]Associate Professor, Department of Paediatrics, Madha Medical College and Research Institute, Chennai.

[3]Professor, Department of Paediatrics, Madha Medical College and Research Institute, Chennai.

Corresponding Author: Dr. Prabakar. S

Abstract

Introduction: Cardiac autonomic tone or sympatho-vagal balance is beat to beat fluctuation in heart rate. Heart rate variability (HRV) is a noninvasive method for assessment of cardiac autonomic tone. There is paucity of data on normal values of HRV in newborn infants. This study was an initiative to assess the feasibility of measurement and analysis of short term HRV in healthy term neonates.

Materials & Methods: The present study was conducted in the Department of Paediatrics, Madha Medical College and Research Institute, Chennai, India (Jan 2022- July 2022).20 healthy term neonates who met the inclusion criteria of gestational age > 37 weeks & APGAR score >= 8 at 5minutes were included in the study. HRV (short term) was assessed by 5 minutes continuous recording of ECG using a lead II electrocardiogram (ECG).

Results: The average RR interval was between 487.5ms - 546.5ms, the average heart rate was between 110.2-123.7 bpm lying well within physiological limits of the newborns. The HRV parameters included in this study were time domain, frequency domain and non- linear analysis. Time Domain values were expressed in first quartile and third quartile of SDSD were between 10.78ms - 36.43ms, RMSSD were 10.82ms - 36.4ms and pNN50 were 0.39 - 16.82. Frequency domain values expressed in first quartile and third quartile of LF were 56.04NU - 72.97NU, HF were 26.76NU - 41.58NU. Value of the LF/ HF ratio was 1.33 -

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2.72. Nonlinear values expressed in first quartile and third quartile of SD1 were between 7.62ms - 25.76ms & SD2 were 25.50ms - 46.03ms.

Conclusion: Heart rate variability measurement in neonates is feasible. However, at present, lack of standard criteria for the analysis of heart rate variability, prevents precise comparisons among the various studies. Further extensive research is needed to compare the prognostic and diagnostic values of the various HRV indices in neonates before an ideal index can be introduced for clinical intervention purposes.

Keywords: Heart rate variability, neonates, Cardiac Sympatho-Vagal balance, ANS.

Introduction

Clinically, normal or average baseline variability is considered as a valid indicator of fetal well being[1] .With increasing knowledge of dealing with measurement and physiological interpretation, HRV is rapidly gaining importance for its clinical application but its role to neonates is still not yet well established. Normal values of HRV in newborn infants are not widely available. This problem may be partially attributed to the lack of standardization of different methods. This study was just an initiative to see the utility and feasibility to establish short term HRV measurement in healthy term neonates and to record and analyze the normal HRV data of newborn. It's just a small initiative to further explore the potential of this noninvasive tool of cardiac autonomic tone detection for greater roles like early detection of sepsis, neuro- developmental outcomes in hypoxic ischemic encephalopathy patients. Cardiac autonomic tone commonly known as Heart rate variability (HRV) is beat to beat fluctuation in heart rate (i.e., in R-R intervals) within physiological limit under resting conditions. These beat-to-beat variations occur due to continuous changes in the cardiac autonomic sympathetic and parasympathetic outflow to the heart. Heart rate variability is now one of the most frequently used non invasive method in scientific study for assessment of sympatho-vagal balance (Cardiac autonomic tone) in health and disease condition[2].Till two decade ago heart's rhythm fluctuations were ignored in practical cardiology and it was believed that irregularity of cardiac function is a pathological phenomenon. Thus, an observation that an absolutely regular sinus rhythm can also be a negative prognostic factor came as a surprise to many clinicians and cardiologists. The beat-to-beat variation having intrinsic oscillations reflects a complex interplay between the ionic membrane current responsible for SA node automaticity and the regulatory influences of autonomic nervous system. In absence of autonomic innervations to heart (as occurs in transplanted heart), there is absolute regularity of heart rate with minimal variations.[3,4,5]

Materials & Methods:

The present study was conducted in the Department of Paediatrics, Madha Medical College and Research Institute, Chennai, India from Jan 2022 to July 2022.20 healthy term neonates who met the inclusion criteria of gestational age > 37 weeks & APGAR score >= 8 at 5minutes were included in the study and patients with major congenital anomalies, obvious cardiac anomalies & illness requiring admission in neonatal intensive care unit were excluded from the study. Written informed consent was obtained from parents after explaining the

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detailed protocols to them. Relevant basic information was obtained from medical records and baseline parameters were recorded. Cardiac autonomic modulation was assessed by short term heart rate variability by 5 minutes continuous recording of ECG using a lead II electrocardiogram (ECG). The ECG signal was continuously amplified, digitized and stored in the computer for offline analysis. Processing of acquired ECG signal i.e., detection of R wave (R wave detection and RR intervals) was done by software.

Statistical analysis:

Data was analysed using SPSS software. All the parameter data were reported as mean ± SD, median, and first quartile and third quartile showing frequency distribution of data.

Results

The mean birth weight of neonates in the study was found to be 2.78+/- 0.36 kg while the mean age was 3 postnatal days (72 hours). No gross deviation was observed in head circumference and length measurements from the normal range described for neonates. The temperature and respiratory rate of the neonates in the study lied within the normal range described for neonates. (Table 1). The average RR interval was between 487.5ms -546.5ms, the average heart rate was between 110.2-123.7 bpm lying well within physiological limits of the newborns. The HRV parameters included in this study were time domain, frequency domain and non- linear analysis. Time Domain values were expressed in first quartile and third quartile of SDSD [Standard deviation of differences between adjacent RR intervals] were between 10.78ms - 36.43ms, RMSSD [Root square of the mean of the sum of the squares of differences between adjacent RR intervals] were 10.82ms - 36.4ms and pNN50[Percentage of NN50 (NN50 Number of R-R interval differences > 50ms).] were 0.39 -16.82 (Table2) .Frequency domain values expressed in first quartile and third quartile of LF [Low frequency power- (0.040 to 0.15) Hz] were 56.04NU - 72.97NU [Normalized Units], HF [High frequency power- (0.15 to 0.4) Hz] were 26.76NU - 41.58NU. Value of the LF/ HF ratio was 1.33- 2.72. Nonlinear values expressed in first quartile and third quartile of SD1 were between 7.62ms - 25.76ms & SD2 were 25.50ms - 46.03ms. (Table 3).

Table 1: Baseline Parameters

Parameters	Mean	SD	Median	1st quartile	3rd quartile
Birth weight (kg)	2.78	0.36	2.75	2.5	3.175
Hours of Life (Hours)	72	36.35	71	48	95
APGAR at 1 min	7.88	0.67	8	7	9
APGAR at 5 min	9	0	9		
Temperature (Celsius)	36.89	0.29	36.8	36.65	37.2
Respiratory Rate	49.22	7.51	48	44	55
Head circumference (cm)	32.96	0.78	33.2	32.45	33.5
Length (cm)	47.33	3.06	47.2	45.35	49

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Table 2: Time Domain Measures

Parameter	Mean	SD	Median	1st quartile	3rd quartile
Average RR (ms)	507.88	54.13	504.05	487.5	546.5
Average Rate (BPM)	120.07	14.63	119.5	110.2	123.7
SDSD (ms)	23.84	16.60	18.91	10.78	36.43
RMSSD (ms)	23.83	16.60	18.89	10.82	36.4
pNN50 (%)	7.57	10.43	1.59	0.39	16.82

Table 3: Frequency Domain and Non-Linear measure

Parameters	Mean	SD	Median	1st quartile	3rd quartile
LF (NU)	64.98	12.47	69.60	56.04	72.97
HF (NU)	33.23	10.08	29.68	26.76	41.58
LF/HF	2.19	0.86	2.33	1.33	2.72
SD1 (ms)	16.85	11.74	13.37	7.62	25.76
SD2 (ms)	39.44	17.02	40.94	25.5	46.03

Discussion:

Heart rate variability is one of the most frequently utilized tool to assess cardiac autonomic modulations by analyzing the spontaneous variability of continuous series of R-R interval (in an ECG) recorded under resting conditions. HRV reflects the response of ANS to intrinsic and extrinsic stimuli. Continuous changes in sympathetic and parasympathetic neural impulses leads to alterations in the heart rate and causes oscillations around the mean value, which is called as HRV. Heart rate variability studies provides an opportunity to understand the dynamic nature of heart functions and ANS functionality.[6,7] Earlier literature mentioned that the ratio of the power in the low frequency band to that in the high frequency band seems to decrease with gestational age and thus correlates with autonomic nervous system maturation in infancy.[8] HRV can be of special importance especially in preterm neonates as it can help in understanding the developmental changes in cardiac autonomic tone. Thus, it can be used as important tool for assessing maturation of autonomic nervous system in preterm neonates at birth and with increasing postnatal age. Extracting the clinically significant features of HRV under various conditions, might help us understand the pathophysiology of derangement of autonomic function. HRV is a well-established noninvasive measure of cardiac autonomic control that has been shown to be related to hypertension [9,10] and to predict future adverse cardiovascular events in adults [11]and has been suggested for putative prognostic use in children [12]. Alterations of HRV in adults, however, may not necessarily represent a prenatal initiated event according to the concept of fetal programming considering the close interaction with other neuroendocrine systems such as the hypothalamus- pituitary-adrenal (HPA) axis [13] .HRV analysis may be used as an early warning system for detecting brain injury in neonates in rural areas where an electroencephalogram is not readily available[14,15] .Further extensive research is needed to compare the prognostic and diagnostic

values of the various HRV indices in neonates before an ideal index can be introduced for clinical intervention purposes. Heart rate variability (HRV), by far remains a promising noninvasive tool for the assessment of cardiac sympatho-vagal tone in health and disease condition of neonates.

Conclusion

Heart rate variability (HRV) measurement in neonates is feasible. However, at present, lack of standard criteria for the analysis of heart rate variability, prevents precise comparisons among the various studies. Until recommendations for standardized analytical methods are made, clinical application of heart rate variability in neonatal and infant prognosis and therapy would remain premature.

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