DOPPLER-DERIVED RIGHT VENTRICULAR MYOCARDIAL PERFORMANCE INDEX IN NEONATES: NORMAL VALUES

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Abstract- *Doppler-derived myocardial performance index (MPI), defined as the sum of isovolumetric contraction and relaxation durations divided by ejection time, is an easily measured and reproducible index that shows both systolic and diastolic myocardial function. The goal of this study was to define normal values of right ventricular (RV) MPI in neonates in the first 48 to 72 hours of life. Fifty-one quiet or asleep healthy and term neonates underwent complete M-mode, two-dimensional color-Doppler echocardiographic examination and RV MPI was calculated in them. Statistical analysis was performed, using a SPSS software. P value less than 0.05 was considered as significant. RV MPI was 0.23±0.14 in healthy neonates. There was no correlation between RV MPI and either age or weight of the newborn infants. RV MPI in healthy neonates was 0.23+0.14 in our study. While this closely resembles the results of some researchers, is lower than those previously reported by the other investigators in healthy children. The lower value of RV MPI in neonates may be possibly explained by its relation to the higher pulmonary arterial pressure of the lower ventricular mass in the first few days of life in neonates. Further study to evaluate the effect of pulmonary arterial pressure and right ventricular mass on RV MPI is recommended.*
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Key Words: *RV MPI, neonates, normal values*

INTRODUCTION

Traditionally assessment of ventricular systolic function by two-dimensional echocardiography has been based on the geometric models of ventricular shape. However this kind of assessment of ventricular ejection fraction and volumes may be difficult to obtain because of poorly defined ventricular endocardial borders and complex ventricular geometry in congenital heart diseases (1,2). On the other hand, Doppler analysis of the tricuspid and mitral inflow pattern may be limited because of fusion of the early and late inflow waves during tachycardia, and a normal inflow pattern may be difficult to separate from pseudonormalization (3,4). Furthermore these traditional parameters of systolic and diastolic myocardial function are influenced by several factors, including preload, afterload and heart rate (5-11). Myocardial performance index (MPI) or Tei index (12), a recently proposed Doppler-derived time interval index, combines both systolic and diastolic time intervals to generate a combined index of global ventricular function, that is independent of geometric assumptions. This study was designed to define normal values of RV MPI in healthy neonates.

MATERIALS AND METHODS

Fifty-one neonates including 26 female and 25 male were enrolled in the study. During a three-month period, all neonates born at Beheshti general hospital were examined on saturdays every week. Only those babies with a completely normal physical examination including a thorough cardiovascular evaluation were included. Data including prenatal history, mode of delivery (normal vaginal Vs. cesarean section), gestational age, postnatal age (as hours), sex, weight and the state of infant alertness (asleep or awake but quiet) were recorded. The preterm neonates were excluded. Also, the crying infants were either soothed in some way or otherwise excluded from the study. Then all the neonates who fulfilled the criteria, underwent a complete two-dimensional and color-Doppler echocardiographic study within 48 to 72 hours after birth, using a Hewlett-Packard sonos 1000 ultrasound system and a 5 MHz transducer. After routine echocardiographic examination, the tricuspid inflow waves were recorded from the apical four-chamber view with the pulsed-wave Doppler sample volume positioned at the tips of tricuspid leaflets in diastole; Doppler signals were displayed at a paper speed of 100 mm/second. Right ventricular (RV) ejection time was measured from the parasternal short-axis scan plane

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with a pulse-wave Doppler signal placed at the pulmonary valve annulus in the RV outflow tract. Calculation of isovolumic contraction time (ICT), isovolumic relaxation time (IRT) intervals and RV MPI are demonstrated in figure (1). To account for slight variations in R-R cycle length, each time interval was measured on k^5 consecutive beats and then averaged.

Statistical analysis

Data are expressed as mean±SD or percentages where appropriate. A Mann-Whitney rank-sum test was used to compare ages, weights and MPI in two sexes; linear regression analysis was used to assess the relation of the MPI to age, sex and weight. Statistical significance was defined as $P < 0.05$.

RESULTS

Fifty-one neonates were studied. Findings are shown as mean±MSD in table (1). MPI values did not show statistically significant difference between two sexes (P= 0.22). There was no correlation between MPI and variables of age and weight (Table 2, fig. 2 and 3).

Table 1. Normal values of RV MPI in neonates

Variable	Female (n= 26)	Male (n= 25)	Total (n= 51)
Age (hours)	34.2±14.5	25.0±11.6	29.74±13.8
Weight (grams)	3028.1±527.2	3296±610.8	3158.7±575.9
MPI	0.21±0.118	0.27±0.15	0.23±0.14

Table 2. Correlation coefficient between RV MPI and age and weight

	Correlation coefficient	P value
MPI* Age	0.227	0.11
MPI* weight	0.021	0.45

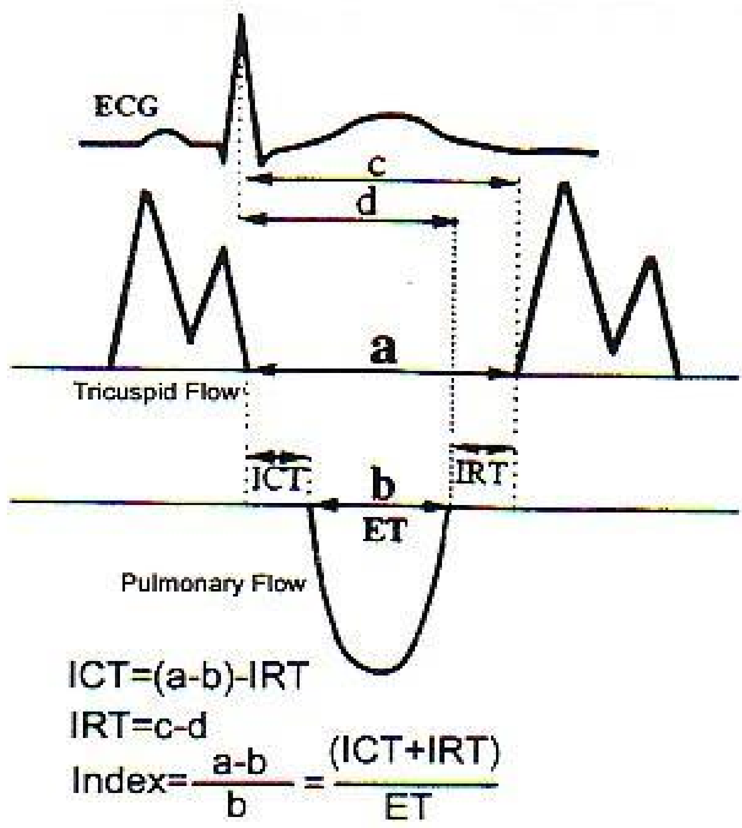

Fig. 1. Schema for measurement of Doppler intervals. The myocardial performance index is defined as a-b/b, where a is the interval between cessation and onset of the tricuspid inflow, and b is the ejection time (ET) of the right ventricular outflow tract. Isovolumetric relaxation time (IRT) is measured by subtracting the interval c between the R wave and the onset of tricuspid inflow. Isovolumetric contraction time (ICT) is obtained by subtracting IRT from a-b. ECG, Electrocardiogram.

DISCUSSION

Our study demonstrated that normal range of RV MPI in neonates is 0.23±0.14. To date, there are few studies on normal values of RV MPI in neonates. As to our knowledge, on the basis of searching in the Pubmed, the first study was by Tsutsumi and coworkers (13) and co workers in Japan and the second one by Eidem and coworkers (14). It should be cited that there is slight discrepancy in the reported values of the above researches. Eidem and coworkers reported a normal value of 0.35±0.05 for R MPI in neonates and concluded that advancing gestational age causes no significant change in the fetal RV MPI. On the other hand Tsutsumi and coworkers reported that Tei index undergoes gradual decrease with increasing gestational age. RV MPI has also been calculated in healthy children. Again, values of 0.24±0.04 by Ishii (10) and 0.32± 0.03 by Eidem, reflect the existing discrepancy in this regard. While our result shows a lower RV MPI in neonates in comparison with those reported by Eidem for healthy children and neonates it closely resembles the values obtained by Ishii in healthy children. Looking back to the formula of RV MPI, we expect that our lower values could either be due to a shorter interval between tricuspid inflow waves i.e. an overall more rapid heart rate in neonates or a more prolonged pulmonary ejection time. However, previous studies have shown that correlation between MPI and heart rate is weak (16). The higher pulmonary arterial pressure within the initial 48 to 72 hours of life, may be partly responsible for our findings. To date, the relationship between pulmonary arterial pressure and RV MPI has not been directly delineated. However, Casio and coworkers studied the association between myocardial right ventricular relaxation time and pulmonary arterial pressure in chronic obstructive lung disease and concluded that myocardial relaxation time was positively related to pulmonary systolic pressure (17). Lack of correlation between RV MPI and age or weight of the neonates in our study is well explained by the homogenous nature of our studied group of neonates. Overall, RV MPI is an easily measured index of ventricular myocardial performance, applicable in a wide variety of heart diseases either congenital or acquired (18-23).

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