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Comparison of Cardiac Function by 2 Methods of Echocardiography: Conventional and MPI (Tei Index)

[1]Fariba Rashidi Ghader and [2]Atieh Makhlough
[1]Department of Pediatric Cardiology, [2]Department of Nephrology,
Mazandaran University of Medical Sciences, Sari, Iran

Abstract: CHD including LV volume overload may cause alteration in cardiac functions. Echocardiography could detect systolic and diastolic dysfunction using several echo indices. We performed a comparison between 2 different methods (standard and MPI) in echocardiography to detect cardiac dysfunction in abovementioned diseases. This study was of descriptive and analytic type. We studied 35 patients with left to right shunt such as VSD and PDA and valvular insufficiency such as MR and AI. We consider other 20 healthy people as control group to find normal range of MPI. Echo was performed in case group using standard method (systolic: Cardiac Index, mVCF, LVEF by simpson method and diastolic: E, A, E/A, EF slope), MPI and shunt flow by a pediatric cardiologist. In control group only MPI was measured. The data were analyzed by SPSS 13, descriptive statistic, t test, pearson correlation and chisquare. Thirty five patients at an age limit of 1mo to 9yr and sex of 13 female and 22 male were studied. Non of them had systolic and diastolic dysfunction using echocardiographic standard method. MPI was 0. 27±0. 08 in case group which was slightly higher than 0. 27±0. 06 in control group (NS). MPI had slightly positive correlation to shunt flow , male sex , age andweight which was also nonsignificant. MPI (tei index) is of high value in estimation of systolic and diastolic function. It can be used to diagnose cardiac dysfunction a little earlier than standard method.

Key words: Myocardial performance index, tei index, systolic function, diastolic function, LV volume overload

INTRODUCTION

Congenital Heart Disease with ventricular volume overload can cause persistent RV or LV abnormalities even after repair. Taking this into account, it seems to be a necessity to ascertain the determinants of ventricular function in patients with CHD (Sevket *et al*., 2005). At present cardiac function is evaluated using conventional echo indices including LVEF, for systolic function and E wave, A wave, for diastolic function. Recently new methods such as Myocardial Performance Index (MPI), Doppler Tissue Velocity (DTV), Cardiac Magnetic Resonance (CMR), have been used to detect earlier subclinical ventricular dysfunction (Eidem *et al*., 2001; Ling *et al*., 2001; Bahler *et al*., 2005; Salehian *et al*., 2004). MPI by Tei index is a useful, simple, noninvasive, nongeometric and Doppler-derived myocardial performance tool which can be used to assess both aspects of systolic and diastolic function (Friedman *et al*., 2003; Gonzalez *et al*., 1998; Broberg *et al*., 2003). MPI has been shown to have important clinical utility as a predictor of mortality in adult patients with dilated cardiomiopathy , primary pulmonary hypertention , acute myocardial infarction andamyloidosis. In pediatric patients with CHD, increasing values of the MPI correlated with increasing degrees of ventricular dysfunction (Eidem *et al*., 2001). MPI and DTV were abnormal in some patients with Duchennes Muscular Dystrophy with normal ventricular function determined by conventional echo method (Bahler *et al*., 2005). This result shows presence of early cardiac dysfunction which is undetectable by routine conventional echo indices. It is probable that the presence of a relation between magnitude of left to right shunt and MPI may help early detection of cardiac dysfunction so that we could interfere in the prevention of it, however it has been shown to have no significant relation between those two in a study on patients with ASD (Sevket *et al*., 2005).

Due to scarcity of relevant studies in this subject, we decided to perform present study so that we could find out wheather there is difference between Tei index and conventional method to diagnose cardiac dysfunction, or as much larger left to right shunt, there is earlier cardiac dysfunction and if there is a relation between cardiac

Corresponding Author: Dr. Fariba Rashidi Ghader, MD, Boo-Ali Sina Hospital, Pasdaran Boulevard, Sari, Iran

dysfunction and some factors such as age, sex, kind of disease. The purpose of this study, is to determine LV function by MPI and conventional method in a group of patients with VSD and PDA and to compare those data to a similar age-match children of normal control for MPI. This study was done on patients referring to pediatric cardiologic clinics in Sari, Iran.

MATERIALS AND METHODS

This prospective descriptive analytic study consisted of 35 patients with VSD and PDA (age range 1mo-9yr) who underwent routine 2D and Doppler echocardiography. Exclusion criteria included patients with fever, asthma and pneumonia. All patients became calm using breast feeding or similar maneurs except for hypnotic drugs. A group of normal ageandsex matched children served as control population. This study had no ethical difficulties because there was no intervention. Echo was done by echocardiograghic device named Vingmed 800 manufactured in Belgium. All echo indices were determined by a pediatric cardiologist. At first MPI with Tei index was measured by determining specific time intervals shown in Fig. 1. To obtain the sum of isovolemic contraction and relaxation time, the Ejection Time (ET = interval b) is substracted from the interval from mitral valve closure to opening (interval a) for LV. The difference is then divided by the ET. Alternatively if MR is present, the duration of regurgitation signal can be substituted for interval a (Fig. 1). To account for slight variations in heart rate, each time interval was measured in 5 consecutive beats and then averaged. After finishing caculation of MPI, conventional standard examination was performed according to CI, mVCFc, LVEF (using simpsons method) for systolic function and EF slope, E wave, A wave and E/A ratio for diastolic function. In patients group, magnitude of left to right shunt was determined by calculating Qp/Qs using the formula 1.

Formula 1:

$V\,PA \times D\,PA^2 / V\,AO \times D\,AO^2$

V PA = Velocity of Pulmonary flow
D PA = Diameter of Pulmonary Artery
V AO = Velocity of Aortic flow
D AO = Diameter of Aortic artery

All data were analized using student t test, descriptive statistics, pearsons correlation coefficient and chi-square.

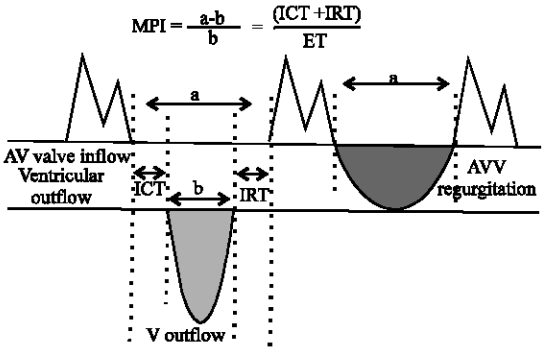

Fig. 1: Myocardial Performance Index (MPI). Interval "a" repersent the duration (msec) from atrioventricular valve closure to opening for either the tricuspid or mitral valve. Tricuspid or mitral regurgitation interval, if available, can be subsituated for closure to opening interval "b" repersents ventricular ejection time (msec) for either right or left ventricular outflow duration. MPI is calculated for either ventricular as flow: (biterval "a" -Interval "b")/(Interval "b")

Practical word definition:

LVEF (%): Left Ventricular Ejection Fraction . A fraction of LV blood ejecting from it during systole. It is an important index to real estimate cardiac systolic dysfunction. Simpsons method is more accurate than M Mode.

mVCFc: The mean velocity of circumferential fiber shortening over the entire LV ejection period. It can be calculated as: mVCFc = (EDD-ESD)/ EDD × ET × R-R interval. This is known as Bazett formula.

CI (L/Min/M²): It equals cardiac output corrected by surface area.

E wave (m s^{-1}): Amplitude of E wave. It is an index of diastolic function.

A wave (m s^{-1}): Amplitude of A wave. It is an index of diastolic function.

E/A: E/A ratio, It is an index of diastolic function.

EF slope (m s^{-2}): It is an index of diastolic function.

MPI: Myocardial Performance Index, an index of global systolicanddiastolic function.

Qp/Qs: Pulmonary cardiac output / aortic cardiac output, this ratio equals magnitude of left to right shunt.

RESULTS AND DISCUSSION

This study consisted of 35 patients with ages ranging from 1month to 9 year and sex including 13 female and 22 male. Age, sex, wt for patients and control group and kind of disease for patints are presented in Table 1. Echocardiographic quantitatively variables are also listed in Table 2.

Conventional echo measurements of systolic and diastolic ventricular function in patients were measured which were all within normal limit. MPI is also shown in Table 2. MPI in normal controls was 0. 27±0. 06 and in patients group was 0. 27±0. 08 which are not significantly different between 2 groups. This is also shown in Fig. 2, however, if we suppose that normal value of MPI is less than 0. 4 according to studies (Sebbag *et al*., 2001; Frommelt, 2005; McMahon *et al*., 2004), there were 2 (6%) abnormal persons in patients group but none were abnormal in normal controls. This was also analyzed by t-test (p = 0. 16) which was nonsignificant. Relation of Tei index with some variables was evaluated. The result is presented in Table 3. As shown, no significant relation is present between magnitude of left to right shunt and MPI, though MPI increases a little with volume of shunt.

This study showed assessment of systolic and diastolic LV function using conventional echo indices which was nomal in all of the patients in comparison with MPI (tei index) which was normal in 94% of patints (100% in normal controls), however, this was statistically nonsignificant shown in Fig. 3.

In a study in patients with D-TGA, systolic and diastolic function using MPI with Tei index compared with Cardiac Magnetic Resonance (CMR) as a good standard method which showed high sentivity of MPI to estimate global cardiac function (Salehian *et al*., 2004). Taken into account that CMR is not only too expensive and unavailable in many centers and but also necessitates skillful technicians to interpret the results, it is obvious that MPI is of high vaue in real estimation of ventricular function. In a search about Anorexia Nervosa, LV MPI increased while conventional echo indices remained within normal limit (Eidem *et al*., 2001). In another study in patients with PPH, RV function which assessed by MPI was significantly depressed before therapy and improved after therapy, particularly in patients with clinical improvement (Sebbag *et al*., 2001). Cardiac function is determined in Duchenne Muscular Dystrophy by DTV

Table 1: Demographic Data of patients and normal control

	Mean ± SD	
Group/data	Patients	Normal control
Age (mo)	54. 5±53. 5	56±53
Sex (M/F)	1. 69 (22m, 13f)	1.5 (12m, 8f)
Weight (kg)	10. 5±8	12±7
Kind of disease		
VSD+MR+AI	12 (34%)	
VSD+MR+AI+PDA	15 (42%)	
PDA +MR+AI	7 (20%)	
VSD+MR	1 (2%)	

Table 2: Quantitatively data of systolic and diastolic function

	Mean±SD	
Group/data	Patients	Control
LVEF (%)	70. 57±2. 62	
mVCFc	1. 46±0. 15	
CI (L/min/M^2)	3. 30±0. 22	
E wave (m/s)	1. 00±0. 15	
A wave (m/s)	0. 60±0. 07	
E/A	1. 66±0. 19	
EF slope (m/s^2)	8. 04±0. 44	
Qp/Qs	2. 67±0. 82	
MPI	27±0. 08	27±0. 06

Table 3: Correlation of some variables with MPI

Correlation/variables	Correlation coefficient = r	p value
Qp/Qs (shunt volume)	0. 029	0. 86
Age	0. 178	0. 20
Sex		0. 33
Weight	0. 151	0. 38
Kind of disease		0. 37

(Doppler Tissue Velocity) and MPI by Tei index compared with conventional echo method which revealed that the later was normal in most patients but DTV and MPI were abnormal in 86 and 79%, respectively (Bahler *et al*., 2005). This study and similar ones suggest earlier detection of cardiac dysfunction using these newer methods (Norozi *et al*., 2005; Sebbag *et al*., 2001; Prakash *et al*., 2004; Kato *et al*., 2005; Moyssakis *et al*., 2005). These are in the same direction as our study results, however, DTV is more sensitive than MPI in most studies. Given nonavailability of special digital echocardiographic device required for calculation of DTV in most centers, importance of MPI as a very useful, simple, reproducible and nongeomeric method of quantitative functional assessment of both systolic anddiastolic ventricular performance would be apparent (Eidem *et al*., 2001; Broberg *et al*., 2003).

Present study also revealed no signifigant relation between MPI and left to right shunt volume, though MPI increased a little with magnitude of shunt. This finding was not in the same direction with a relevant study in patients with ASD, however, this was also nonsignificant (Sevket *et al*., 2005). A possible reason for this difference may be concurrent secondary mitral and aortic insufficiency in some of our patients, also it may be due

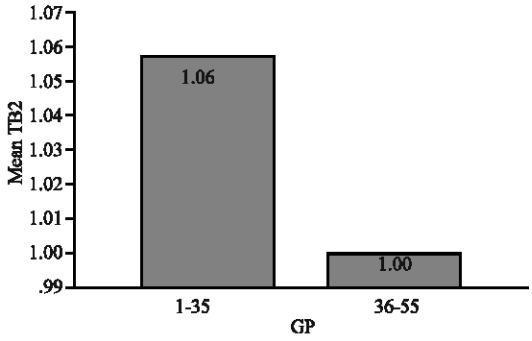

Fig. 2: MPI (Tei index) as qualitative (normal = 1, abnormal = 2) in patients group (1-35) and normal control (36-55)

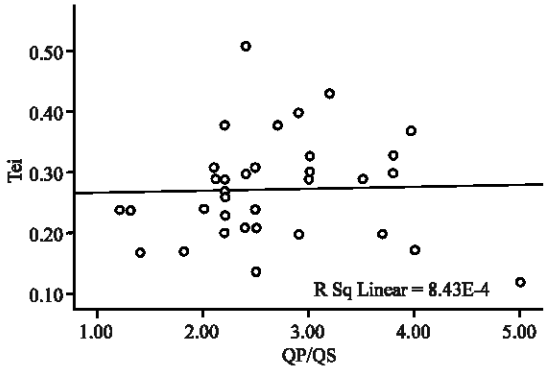

Fig. 3: Linear correlation of MPI (Tie index) quantitatively with left to right shunt volume

to some differences between RV (Sevket *et al*., 2005) and LV (in our study) configuration or lower age range in our patients.

Study limitations: The relatively small sample size in this study limits the scope of conclusion. Furthermore serial changes in of MPI in individual patients at various stages of medical therapy for heart failure could not be addressed in this study.

CONCLUSION

MPI is an easily obtained, reproducible and quantitatively measure of systolic and diastolic performance. This study suggests the potential clinical utility of this index in the early identification of subclinical left ventricular dysfunction in patients with PDA and VSD, so it is not adequate to calculate only conventional echo indices for real assessment of ventricular function. Further studies of the myocardial performance index in patients with VSD and PDA are warranted.

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