

Correlation between mitral regurgitation grading and left ventricular systolic function in children with rheumatic fever

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Abstract

Background: Rheumatic fever (RF) and its valvular complications often occur in children 5-15 years old. Mitral regurgitation (MR) is a frequent valvular complication and can lead to decreased left ventricular (LV) systolic function.

Objectives: To observe the correlation between MR grading and LV systolic function in children with RF.

Method: A cross-sectional study was conducted by obtaining medical record data at Dr Soetomo General Academic Hospital from January 2015 to March 2019. Subjects were children aged 5 to 18 years with diagnosed RF. MR was found on echocardiography along with data regarding LV systolic function (ejection fraction, shortening fraction and LV end systolic diameter). Data were processed to derive frequency distribution then normality test with Shapiro Wilk and correlation with Spearman test; $p < 0.05$ was considered significant.

Results: A total of 40 children met the criteria, the percentage of males being more than females. Mean age was 11.32 years. Of the 40 children 37.5% had mild MR, 42.5% moderate MR, and 20% severe MR. The grading of MR had a significant positive correlation with LV end systolic diameter ($r = 0.63$; $p = 0.001$), and significant negative correlation with ejection fraction ($r = -0.62$; $p = 0.001$) and shortening fraction ($r = -0.60$; $p = 0.001$).

Conclusions: In children with RF, grading of MR had a significant positive correlation with LV end

systolic diameter and significant negative correlation with ejection fraction and shortening fraction.

(Key words: Rheumatic fever, Children, Mitral regurgitation, Left ventricular systolic function)

Introduction

Rheumatic fever (RF) is an inflammatory disease caused by an immunological response to Group A beta haemolytic Streptococcus and occurs mainly in children 5-15 years old. Major manifestations are carditis, polyarthritis, Sydenham chorea, erythema marginatum and subcutaneous nodules. The diagnosis is based on revised Jones criteria 2015¹. The most common cardiac complication of RF is mitral regurgitation (MR). MR is graded as mild, moderate and severe and could affect left ventricular (LV) systolic function².

Echocardiography is used to assess valve and heart function. LV function could be seen as ejection fraction, shortening fraction and end-systolic LV diameter. LV ejection fraction is the best index of LV function and can be estimated by measuring the LV end-diastolic volume and the LV end-systolic volume from the apical four-chamber view. The normal LV ejection fraction in children ranges from 56-78%. The shortening fraction is an index of LV systolic function that measures LV diameter, with a normal range of 26-45%. The LV end systolic diameter is a picture of the dimensions of the heart chamber at the end of systole which can be known through echocardiography modalities, with a normal range of 20-40 mm. Parameters to assess grading of MR are colour flow jet area, contract vein diameter, regurgitation fraction or area and pressure gradient. Management is given appropriately based on grading of MR and condition of the heart function so that hopefully there is no permanent valve damage and heart failure²⁻⁴.

Studies that examined the grading or severity of mitral valve disorder associated with LV systolic function have been reported in several countries. The results showed that RF is common in children of school age and the most common heart disorder was MR. Severe MR could cause decreasing LV function⁵⁻⁶. A study showed that the severity of MR correlated with LV systolic function, namely a decrease in ejection fraction and an increase in LV

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end-systolic diameter in RF patients⁷. The LV systolic function shows the severity of MR grading. This study uses parameter pressure gradient to grade MR. Therefore, this study was conducted so as not to delay the management to avoid the permanent valve damage for RF in Dr. Soetomo General Hospital, Surabaya, Indonesia.

Objectives

To observe the correlation between MR grading and LV systolic function in children with RF.

Method

A retrospective cross-sectional study was carried out by looking at medical record data at the Paediatric Department of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia from January 2015 to March 2019. Subjects were 5-18-year-old children diagnosed to have RF based on revised Jones criteria 2015¹. Echocardiography was done in all subjects to evaluate grading of MR, ejection fraction, fraction shortening, and LV systolic function. Total sampling was used in this study. There were 55 children in the Paediatric Department of Dr Soetomo General Academic Hospital, Surabaya from January 2015 to March 2019 diagnosed with RF who had undergone echocardiography. We excluded 15 children with congenital heart disease, endocarditis, leukaemic children on anthracycline chemotherapy and other heart valve diseases.

Ethical issues: Ethical clearance was issued by the Health Research Ethics Committee of Dr Soetomo General Hospital, Surabaya, Indonesia (1035/KEPK/III/2019). As it was a retrospective study no informed consent could be obtained.

Statistical analysis: Data processing used the Statistical Package for the Social Sciences (SPSS) program. The data were processed to derive frequency distribution then normality test with

Shapiro Wilk and correlation with Spearman test; p value <0.05 was considered significant.

Results

A total of 40 children diagnosed with RF were included in the study. The basic characteristics of the children are presented in Table 1.

Table 1
Basic characteristics of research subjects (n=40)

Characteristic	Total
<i>Gender</i>	
Male - n (%)	23 (57.5)
Female - n (%)	17 (42.5)
<i>Age (years)</i>	
Mean (SD)	11.32 (2.60)
<i>Nutritional status</i>	
Good nutritional - n (%)	29 (72.5)
Malnutrition - n (%)	11 (27.5)
<i>Carditis</i>	
Clinical n (%)	31 (77.5)
Subclinical n (%)	09 (22.5)
<i>Mitral regurgitation grading</i>	
Mild n (%)	15 (37.5)
Moderate n (%)	17 (42.5)
Severe n (%)	08 (20.0)

Subjects were evaluated for LV systolic function (Table 2).

Table 2: Left ventricular (LV) systolic function

Variable	Minimum-maximum value
Ejection fraction	52.00-78.41%
Shortening fraction	32.20-55.46 %
End systolic LV diameter	17.50-37.50 mm

Analysis of correlation between grading of MR and LV systolic function using Spearman test is presented in Table 3.

Table 3: Correlation between grading of mitral regurgitation (MR) and left ventricular systolic function

Variable	Mild MR	Moderate MR	Severe MR	r	p
Mean ejection fraction (%)	74.1	66.8	55.7	-0.62	0.001
Mean shortening fraction (%)	48.6	38.9	34.8	-0.60	0.001
End systolic left ventricle diameter (mm)	22.4	25.5	32.1	0.63	0.001

r: correlation coefficient; p<0.05 significant

There was significant correlation between grading of MR and LV systolic function. Correlation coefficient between grading of MR and end systolic LV diameter was positive, but in the opposite direction to ejection and shortening fraction.

Discussion

In this study severe MR was less than mild and moderate MR. There were three levels of grading MR with pressure gradient parameter, 20-40% for

mild, 40-60% for moderate and >60% for severe MR⁴. Research in other countries found that patients with RF have valve disorders, mostly MR. Severe MR was 8.2% less than mild MR which had an incidence of 30.7%. LV systolic function could be seen in several parameters such as ejection fraction, shortening fraction and end-systolic LV diameter^{5,8}.

In this study Spearman analysis showed that there was a significant correlation between MR grading

and LV systolic function. The grading of severity of MR had a negative correlation with the ejection fraction and the shortening fraction and a positive correlation with the end-systolic LV diameter. MR would have increased volume load and pressure load which are related to ejection fraction. MR causes backflow circulation into the left atrium so that the left ventricle pumps blood to meet the blood flow to the aorta to be circulated to the body which could overload left ventricle. This will increase muscle mass and affect end-systolic LV diameter. If the process persisted, it could cause LV hypertrophy⁹.

A previous study in Indonesia found that children with rheumatic heart disease had decreased ejection fraction when MR became more severe. There was a significant correlation with higher LV end-systolic diameter as MR becomes more severe¹⁰. Another study showed that 60.1% patients with RF experienced mild MR and 39.9% moderate to severe MR. There was a decrease in LV function in moderate to severe MR with a significant correlation for increased LV end-systolic diameter ($p < 0.001$)¹¹.

This study has several limitations. Echocardiography was done by several people so that the accuracy of the result was not always the same. This study did not monitor LV function in children with RF with MR serially so that it could not assess the progression of cardiac function.

Conclusions

In children with RF, grading of MR had a significant positive correlation with LV end systolic diameter and significant negative correlation with ejection fraction and shortening fraction.

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