

# Cardiovascular reserve ability and exercise capacity on bicycle ergometer exercise stress test in children with ventricular premature beat

Zheng-Hai Qu, Zi-Pu Li

Qingdao, China

**Background:** This study was undertaken to evaluate the cardiovascular reserve ability and exercise capacity on bicycle ergometer exercise stress test to determine the effect of anti-arrhythmic therapy in children with ventricular premature beat (VPB).

**Methods:** Ruled out those with organic cardiac disease by physical examination, echocardiography and myocardial enzyme analysis, 123 children with VPB (aged 2-17 years) were included in this study. Fifty patients were treated with anti-arrhythmic drugs (treatment group), and 73 patients were not treated with any anti-arrhythmic drugs (non-treatment group). Their heart rate, systolic pressure, diastolic pressure and total work capacity were determined by bicycle ergometer stress test.

**Results:** VPB disappeared in 22 patients (44%) of the treatment group and 31 patients (42.5%) of the non-treatment group. Seventeen patients in the treatment group and 22 patients in the non-treatment group underwent the bicycle ergometer exercise stress test. Compared with normal children, these patients showed no significant difference in heart rate, systolic pressure, diastolic pressure, and reserve indexes ( $F=3.18-4.98$ ,  $P>0.05$ ). The total work capacity was of no significant difference among the subgroups ( $F=3.16$ ,  $P>0.05$ ).

**Conclusions:** There is no relationship between anti-arrhythmic therapy and natural disappearance of VPB. VPB without organic cardiac abnormality does not influence children's heart function and exercise capacity. Exercise test is essential to patients with VPB.

*World J Pediatr* 2007;3(2):125-128

**Key words:** ventricular premature beat;

cardiovascular reserve;  
heart rate;  
blood pressure;  
exercise test;  
work capacity

## Introduction

Ventricular premature beat (VPB) is one of the most common patterns of arrhythmia, though it is generally agreed that VPB occurring in the absence of structural heart disease reflects a benign nature. There are many debates on whether pediatric patients with VPB should be given anti-arrhythmic therapy and take exercise as normal children in view of sudden death and clinical deterioration.<sup>[1]</sup> There are few long-term follow-up studies<sup>[2]</sup> on exercise in children with VPB, and no data are available on the relationship between anti-arrhythmic therapy and exercise test. In this group of children, we evaluated the cardiovascular reserve ability and work capacity on exercise stress test and the benefits of anti-arrhythmic therapy in children with VPB.

## Methods

This study was approved by the Ethics Committee of Qingdao University, and informed consent was obtained from the parents of the children before the study. A series of 123 patients with VPB aged 8.1 years on average (range 2 to 17 years) underwent resting 12-lead electrocardiography (ECG). None of them had cardiovascular diseases. Fifty-two patients had symptoms including palpitation (47 patients), dizziness (31) and/or syncope (12), which were not associated with exercise. Physical examination and routine laboratory test including test of myocardial enzyme, and echocardiography showed nothing abnormal. The patients were followed up periodically for 12 months to 84 months (mean 57 months). Of the 123 patients, 50 received anti-arrhythmic agents including propafenone

**Author Affiliations:** Department of Pediatrics, Affiliated Hospital of Qingdao Medical College, Qingdao University, Qingdao, China (Qu ZH, Li ZP)

**Corresponding Author:** Zheng-Hai Qu, MD, Department of Pediatrics, Affiliated Hospital of Qingdao Medical College, Qingdao University, Qingdao, China (Tel: 86-532-82923010; Email: quzhenghai@163.com)

©2007, World J Pediatr. All rights reserved.

(5-8 mg, tid or qid) or metoprolol (0.5 mg, bid) either on initial examination or during the follow-up period (the treatment group). The duration of treatment was 6 to 72 months (mean 38 months). The other 73 patients were not treated with any anti-arrhythmic drugs (the non-treatment group).

Thirty-one healthy children served as the control group. These children were recruited from a local primary school and a junior high school.

### Exercise test

The maximal symptoms-limited exercise test was performed using an electrical bicycle ergometer. Exercise test was performed in 40 randomly selected patients, of whom 17 were from the treatment group and 23 from the non-treatment group. They were instructed to put on proper clothing and to have non-oily meal including low-fat milk and two or three pieces of bread two hours before testing. The exercise test lasted from 8:00 AM to 10:00 AM at the room temperature of 20°C-22°C and a humidity of 40%-45%.

The test started with an initial workload of 15 W, which increased every 3 minutes by 15 W for children with body surface area  $\leq 1.2 \text{ m}^2$  and 25 W for children with body surface area  $> 1.2 \text{ m}^2$ . A 12-lead ECG was performed every minute throughout the exercise and every 5 minutes after the exercise. Leads II, AVF, V6 were monitored continuously throughout the exercise.<sup>[3-5]</sup>

The heart rate, blood pressure, and total work capacity were determined at rest before the exercise and/or at the peak of the exercise. The test was terminated<sup>[1,6]</sup> when one of the following end-points was reached: target heart rate, severe fatigue, maximal systolic blood pressure during the exercise, severe dyspnea, nausea, vomiting, dizziness, weakness, new arrhythmias or ST-T changes. All children were given considerable verbal encouragement to continue the exercise as long as possible.

### Statistical analysis

The data were expressed as mean  $\pm$  SD. Demographic and exercise testing variables were compared between the treatment, non-treatment, and control groups using variance analysis and Student's *t* test. A value of  $P < 0.05$  was considered statistically significant.

The heart rate and blood pressure of the patients measured at rest and at peak exercise; peak workload was expressed in watts.

## Results

The characteristics of resting 12-lead ECGs are shown in Table 1. No significant difference was observed in ECG results between the treatment and non-treatment groups. VPB disappeared in 22 patients (44%) in the treatment group and 31 (42.5%) in the non-treatment group during the period of follow-up.

The data of exercise test of the three groups are summarized in Tables 2 and 3. The resting heart rate and blood pressure were similar in the three groups. An increase in systolic blood pressure and heart rate was observed after intensified exercise in all the groups. No significant difference was found in heart rate, systolic and diastolic pressure at rest and at peak exercise. The total workload was  $187 \pm 79 \text{ W}$  (treatment group),  $199 \pm 86 \text{ W}$  (non-treatment group), and  $207 \pm 56 \text{ W}$  (control group) ( $F = 3.25$ ,  $P > 0.05$ ). There was no significant difference among the three groups, though the treatment group was the lowest in the three groups.

VPB increased during exercise in 5 patients of the treatment group and in 12 patients of the non-treatment

**Table 1.** Results of resting 12-lead ECG at the first and last examinations

	Treatment group (50)		Non-treatment group (73)	
	First (%)	Last (%)	First (%)	Last (%)
Isolated	20 (40)	13 (46)	36 (49)	20 (48)
Couplets	23 (46)	12 (43)	30 (41)	17 (40)
Non-sustained				
Ventricular tachycardia	2 (4)	1 (3.5)	4 (5.4)	2 (4.8)
Polymorphic	5 (10)	2 (7)	3 (4)	3 (7.1)
Total	50 (100)	28 (100)	73 (100)	42 (100)

**Table 2.** Heart rate in the three groups (beats/min)

Group	First exercise	Peak exercise	Heart rate reserve
Treatment	84 $\pm$ 7	168 $\pm$ 14	78 $\pm$ 16
Non-treatment	84 $\pm$ 12	178 $\pm$ 20	89 $\pm$ 12
Control	80 $\pm$ 10	175 $\pm$ 19	84 $\pm$ 20
<i>F</i>	4.98	3.38	3.22
<i>P</i>	>0.05	>0.05	>0.05

**Table 3.** Blood pressure in the three groups

Group	Systemic blood pressure			Diastolic blood pressure		
	At rest	At peak exercise	Reserve	At rest	At peak exercise	Reserve
Treatment	106 $\pm$ 7	130 $\pm$ 16.5	27 $\pm$ 19	63 $\pm$ 6	70 $\pm$ 17	9 $\pm$ 11
Non-treatment	108 $\pm$ 7	143 $\pm$ 15.0	38 $\pm$ 17	63 $\pm$ 7	72 $\pm$ 12	11 $\pm$ 8
Control	110 $\pm$ 8	143 $\pm$ 14.5	35 $\pm$ 21	64 $\pm$ 5	75 $\pm$ 18	12 $\pm$ 11
<i>F</i>	4.74	3.87	3.18	9.56	4.34	3.93
<i>P</i>	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05

group. Four patients had ST-T segment changes, and 2 patients showed polymorphic VPB. There was no significant difference between the treatment and non-treatment groups.

## Discussion

Exercise test in children is considered a technique by which the results are reproducible within narrow limits if several variables are controlled.<sup>[2]</sup> The variables include the ambient room temperature, time of testing, height of bicycle seat, and time of last meal, etc.<sup>[3,4,7,8]</sup> In the present study, these variables were carefully controlled. The heart rate, blood pressure, and total work capacity are the best noninvasive testing indexes. They are useful in detecting cardiac abnormalities that are silent at rest and manifested with physiological stress. The exercise test is also a good indicator for success or failure of therapeutic interventions. Exercise responses in patients with VPB are the focus of studies.<sup>[9,10]</sup>

There are two types of exercise inducers, i.e., tread-mill and cycle ergometer. Each has advantages and disadvantages. The bicycle ergometer is more feasible because of little noise during the operation and small artifacts of ECG and blood pressure recording. In our study, we reduced the initial workload and stepwise increment according to body surface area. The time of exercise from 10 to 15 minutes was fit for children.<sup>[1,8]</sup>

In the 123 patients, 70 were found to have persistent VPB after a mean follow-up of 57 months. The disappearance of VPB in the treatment and non-treatment groups was of no significant difference. No clinical deterioration were found in the patients. These findings agree with those reported elsewhere.

There was no difference in heart rate, systemic blood pressure, diastolic blood pressure and their reserves at peak exercise. The similarity of total work capacity and total exercise time in the three groups demonstrated that children with VPB whose heart is anatomically normal have the ability to perform normal exercise.

Several patients (12.2%) of our series presented with worsened conditions. Despite there was no significant difference between the treatment and non-treatment groups, exercise test for children with VPB should be carefully performed to determine whether the presence of arrhythmia during exercise is a transient condition or whether it continues to exist or is clinically deteriorative after a long-term follow-up?

The data on this issue are preponderance of evidence though it is related to small groups of patients. Lu et al<sup>[11]</sup> reported 136 children aged 5-11 years with

ventricular arrhythmia, who were subjected to 24-hour ECG and treadmill exercise testing. They found that there was no relationship between exercise capacity and ventricular arrhythmia. Hu et al<sup>[12]</sup> found that VPB at daytime is related to the increased sympathetic nerve tension and no medication is needed. We found that VPB in the absence of demonstrable cardiac disease may disappear naturally. Anti-arrhythmia treatment is useless to exercise capacity and cardiovascular function. We also noticed that the treatment group of patients had lower max heart rate, peak systemic blood pressure, total work capacity and total exercise time though there was no significant difference with the other two groups. It is suggested that long-term anti-arrhythmia treatment renders patients to think that they are ill, and they are afraid of exercise test psychologically.

**Funding:** None.

**Ethical approval:** This study was approved by the Ethics Committee of Qingdao University.

**Competing interest:** No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

**Contributors:** QZH proposed the study and wrote the first draft. LZP analyzed the data.

## References

- Zhou TF, Lu YY, Jin ZH, Luo ZQ, Zhang J, Tang W, et al. The use of bicycle ergometer exercise test in the evaluation of potentially cardiogenic symptoms, functional premature beats and convalescent myocarditis in children. *Chin J Pract Pediatr* 2002;2:96-98.
- Drory Y, Pines A, Fisman EZ, Kellermann JJ. Persistence of arrhythmia response to healthy young man. *Am J Cardiol* 1990;66:1092-1094.
- Sarubbi B, Pacileo G, Pisacane C, Ducceschi V, Iacono C, Russo MG, et al. Exercise capacity in young patients after total repair of Tetralogy of Fallot. *Pediatr Cardiol* 2000;21:211-215.
- Yetman AT, Lee KJ, Hamilton R, Morrow WR, McCrindle BW. Exercise capacity after repair of Tetralogy of Fallot in infancy. *Am J Cardiol* 2001;87:1022-1023.
- Washington RL, Bricker JT, Alpert BS, Daniels SR, Deckelbaum RJ, Fisher EA, et al. Guidelines for exercise testing in the pediatric age group. From the Committee on Atherosclerosis and Hypertension in Children, Council on Cardiovascular Disease in the Young, the American Heart Association. *Circulation* 1994;90:2166-2179.
- Gibbons RJ, Balady GJ, Beasley JW, Bricker JT, Duvernoy WF, Froelicher VF, et al. ACC/AHA Guidelines for Exercise Testing. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). *J Am Coll Cardiol* 1997;30:260-311.
- Steinberger J, Moller JH. Exercise testing in children with pulmonary valvar stenosis. *Pediatr Cardiol* 1999;20:27-31.

- 8 Guo Y, Zhou AQ, Gao W, Li F, Li Y, Yang JP, et al. Evaluation of physiological index on treadmill exercise testing of 294 healthy children in Shanghai area. *Chin J Pediatr* 2003;41:338-343.
- 9 Yabek SM. Ventricular arrhythmias in children with an apparently normal heart. *J Pediatr* 1991;119:1-11.
- 10 Tsuji A, Nagashima M, Hasegawa S, Nagai N, Nishibata K, Goto M, et al. Long term follow-up of idiopathic ventricular arrhythmias in otherwise normal children. *Jpn Circ J* 1995;59:654-662.
- 11 Lu GP, Liu YY, Sheng F. Assess of risk in moving in children with arrhythmias by treadmill test and dynamic cardiogram. *J Appl Clin Pediatr* 2002;17:619.
- 12 Hu R, Qian YR, Yang SX. Relationship between ventricular premature constraction and activity of autonomic nervous systems in children and its clinical significance. *J Appl Clin Pediatr* 1995;10:5-8.

*Received September 5, 2006*

*Accepted after revision March 27, 2007*