https://doi.org/10.33472/AFJBS.6.6.2024.1085-1093

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Anthropometric characteristics and exercise electrocardiogram in patients with sinus bradycardia undergoing electrocardiographic exercise testing

Linh Tran Pham,[1] Duy Xuan Nguyen[2], Si Dung Chu[1,3,4]

[1]Vietnam National Heart Institute, BachMai Hospital, Vietnam

[2]Military Hospital 105, Hanoi, Vietnam

[3]Training and Director of Healthcare Activities Centrer, BachMai Hospital, Vietnam

[4]Hospital of Vietnam National University, VNU, Hanoi, Vietnam

Correspondence: Si Dung Chu – ORCID: 0000-0001-7723-5893

Hospital of Vietnam National University, VNU, Hanoi, Vietnam

Article Info

Volume 6, Issue 6, May 2024

Received: 28 March 2024

Accepted: 30 April 2024

doi: 10.33472/AFJBS.6.6.2024.1085-1093

ABSTRACT

Objective: The study was conducted by the authors. "Anthropometric characteristics and exercise electrocardiogram in patients with sinus bradycardia undergoing electrocardiographic exercise testing".

Method: Cross-sectional descriptive study. Study on 60 patients with selection criteria being patients with sinus bradycardia less than 50 beats/minute on resting 12-lead electrocardiogram, with or without symptoms of bradycardia at two units, Vietnam National Heart Institute and Hanoi Heart Hospital during the period from January 2020 to September 2021.

Results: *Anthropometric characteristics:* The ratio of men and women is similar, the average age was 55.12 ± 13.89 years old, the majority were over 50 years age (6,6,7%), The majority of patients had a BMI below 23 (63.3%) and higher 23 (36.7%) with no statistically significant difference, the most common comorbidities are hypertension (38.3%). *Characteristics of exercise electrocardiography:* The average exertion time was 10.53% ± 0.46 minutes. Most patients stopped exercising at stages 3 and 5, the maximum exercise capacity achieved has a slightly low average value of 7.78 ± 3.56 METs, the Hrmax was 129.90 ± 29.22 beats/minute, the mean value of maximum exercise SBP is 155.23 ± 20.59 mmHg, the variation in SBP is 4.84 ± 2.72 mmHg/MET, the average value of maximum exercise DBP was 88.10 ± 9.11 mmHg, DBP variation was 2.40 ± 1.75 mmHg/MET. The average decrease in heart rate in the first 1 minute is 27,87 ± 16,82 beats/minute.

Conclude: The increased rate of sinus bradycardia with age also coincides with an increased risk of other cardiovascular diseases. The average age was 55.12 ± 13.89 years old, the ratio of men and female is similar, the majority of patients had a BMI below 23 and higher 23 with no statistically.

Keywords: Anthropometric characteristics, exercise electrocardiogram, sinus bradycardia, electrocardiographic exercise testing

INTRODUCTION

Sinus bradycardia is defined as sinus rhythm with a rate <50 beats/minute at rest. [1] The rate of bradycardia in the world is about 2.6%. [2] Sinus bradycardia can occur in completely healthy people, but it can also be a pathological disorder of the pacemaker system or the automatic conduction system in the heart. There have been many studies demonstrating that pathological bradycardia causes symptoms that reduce the quality of life and give patients a worse prognosis, which requires proper diagnosis as well as appropriate measures. suitable treatment. [3-6]

Electrocardiographic exercise testing in patients with sinus bradycardia in assessing exercise capacity is a simple, easy-to-perform method and has been proven to be effective in

providing an individual's prognosis. [7.8]; In addition, some other indicators of the ECG exercise test can evaluate the loss of the ability to modulate heart rate in sinus node dysfunction, thereby helping doctors to make indications for implantation. permanent pacemaker tailored to each specific patient. [1.9]

ACC/AHA/HRS consensus [1] in 2018 and European Society of Cardiology (ESC) consensus [9] in 2021 also recommended the role of electrocardiographic stress testing in diagnosing and guiding treatment of disorders. Sinus node dysfunction and conduction disorders. Although there have been many studies around the world about the effectiveness of this method on different subjects. [7,10-12] , but studies on anthropometric characteristics as well as exercise capacity in electrocardiographic exercise testing have not yet received adequate attention; Up to now in Vietnam, there has been no survey on exercise electrocardiography related to this issue in patients with sinus bradycardia. Therefore, the research team conducted the study: *"Anthropometric characteristics and exercise electrocardiogram in patients with sinus bradycardia undergoing electrocardiographic exercise testing"*

2. RESEARCH SUBJECTS AND METHODS

2.1. research design

Cross-sectional descriptive study.

Sample size: Apply sample size calculation formula to determine a proportion estimate, 95% confidence level, allowable error is d = 0.05, choose p = 2.6% (Rate of sinus bradycardia) according to Paul N .Jensen et al. (2014) [2], calculated the minimum sample size n = 45.

2.2. Research subjects

Study on 60 patients with selection criteria being patients with sinus bradycardia less than 50 beats/minute on resting 12-lead electrocardiogram, with or without symptoms of bradycardia.

Conducting research at two units, Vietnam National Heart Institute - Bach Mai Hospital and Hanoi Heart Hospital during the period from January 2020 to September 2021.

Exclude patients with myocardial infarction that occurred less than 48 hours ago. Unstable angina with new resting pain. Severe uncontrolled arrhythmia. Aortic valve stenosis. Uncontrolled heart failure. Pulmonary artery occlusion. Myocarditis, pericarditis, progressive endocarditis. Left ventricular thrombosis after infarction. High-grade atrioventricular block or third-degree atrioventricular block. Patients with characteristics that cannot perform NPGS such as Pregnant patients. Patients with damage to the motor system that makes movement difficult: lower limb amputation, lower limb disability...

Diagnostic criteria on 24-hour diabetes Holter Apply according to the definition of sinus node dysfunction and conduction disorders of the 2018 ACC/AHA/HRS recommendations. [1]

Standards for evaluating the results of diabetes mellitus: Apply according to ACC/AHA 2013 guidelines on diabetes mellitus. [8]

2.3. Data processing

Using SPSS 20.0 statistical analysis software. Descriptive statistics and analysis. Qualitative results are expressed as percentages, quantitative results are expressed as mean ± standard deviation or median and interquartile range depending on distribution characteristics, K difference is considered is statistically significant when $p < 0.05$.

2.4. Ethics in research

This research can only be conducted after the research outline is approved by the Scientific Council, approved for implementation and approved by the leaders of the Vietnam National Heart Institute - Bach Mai Hospital, the leaders of the Hanoi Heart Hospital.

3. RESEARCH RESULTS

3.1. Anthropometric characteristics

In a study of 60 patients with sinus bradycardia, there were 60 male patients (accounting for 60 %) higher than the number of female patients (accounting for 40 %), however this difference was not statistically significant . statistics ($p < 0.05$) .

Chart 1 . Distribution according to age of research subjects

The average age of patients with sinus bradycardia is 5.12 ± 13.89 years old. The age distribution of research subjects is uneven between age groups. The group over 50 years old accounts for the majority, 6.6.7%. Of which , the age group from 50 to 59 years old accounts for the highest proportion, accounting for 28.3% . The group under 30 years old has the lowest number and rate, with only 2 patients accounting for 1.7 %.

Table 1 . Characteristics of body mass index of research subjects

	Group	Quantity	Ratio (%)
Body mass index (BMI)	BMI < 23	38	63,3
	BMI ≥ 23	22	36,7

In the study, the group of patients with BMI < 23 had a rate of 63.3% more than the group of patients with BMI ≥ 23 with a rate of 36.7 %.

Table 2 . Characteristics of comorbidities in patients with sinus bradycardia

Pathological	Quantity (n=60)	Ratio (%)
Hypertension	23	38,3
Type 2 diabetes	6	10,0
Metabolic lipid disorders	8	13,3
Ischemic heart disease	2	3,3
Moderate and severe heart valve disease	2	3,3
Atrial septal defect has occluded the parachute	1	1,7
There are no comorbidities	26	43,3

The most common comorbidities in the study were hypertension accounting for 38.3%, lipid metabolism disorders accounting for 13.3%, type 2 diabetes accounting for 10.0%. Other less common diseases include: Ischemic heart disease accounts for 2 cases (3.3%), of which 01 case has 80-90% RCA stenosis and 01 case has had a coronary artery stent placed. Moderate to severe valvular heart disease (excluding tight aortic valve stenosis) accounted for 2 cases (3.3%) and 01 case (1.7%) after atrial septal defect occlusion. Among these patients, 11 patients had multiple comorbidities (3 patients had 3 comorbidities, 8 patients had 2 comorbidities). There were 26 patients without comorbidities, accounting for 43.3%.

3.2. Characteristics of exercise electrocardiography.

Table 3 . Characteristics of outcome indicators when performing ECG

Index	Medium ($\bar{X}$ ± SD)	Smallest value	Greatest value

Maximum exertional heart rate (Beat/minute)		129,90 ± 29,22	80	168
Heart rate modulation index		0,64 ± 0,25	0,16	1,03
Maximum exercise capacity (METs)		7,78 ± 3,59	3,2	16
Heart rate decreased during the first 1 minute of recovery phase (beats/minute)		27,87 ± 16,82	8	45
Systolic blood pressure (SBP) (mmHg)	Before strenuous standing posture	122.10 ± 2.23	100	140
	During maximum exertion	155,23 ± 20,59	110	180
	Variability Systolic blood pressure per METs	4,84 ± 2,72		
Diastolic blood pressure (DBP) (mmHg)	Before strenuous standing posture	72.50 ± 1.02	60	90
	During maximum exertion	88,10 ± 9,11	70	110
	DBP variability per METs	2,4 ± 1,75		

Evaluating the resulting indicators when performing physical exertion, found: Maximum exercise capacity achieved 7.78 ± 3.59 METs. The average maximum exercise heart rate was 129.90 ± 29.22 (beats/minute), heart rate modulation index (CI) was 0.64 ± 0.25.

At the time before exertion, in standing position: Average SBP was 122.10 ± 2.23 (mmHg); Average DBP was 122.10 ± 2.23 (mmHg). At maximum exertion: Average SBP is 155,23 ± 20,59 (mmHg), Average DBP is 88,10 ± 9,11 (mmHg), SBP variability per 1 METs was 4.84 ± 2.72, SBP variability per 1 METs was 2.4 ± 1.75.

The decrease in heart rate in the first 1 minute of the recovery period was 27.87 ± 16.82 (beats/minute) .

Table 4. Percentage of patients not achieving target indicators when performing electrocardiographic stress testing

Index	**Quantity (n=60)**	**Ratio (%)**
Maximum heart rate < 85% of predicted maximum heart rate	27	45
Heart rate modulation index < 0.8	32	53,3
Not reaching 85% of predicted maximum exercise capacity	32	53,3
Heart rate decreased in the first 1 minute to <12 beats/minute	7	11,6

In the patient group studied, the proportion of patients not achieving the target indicators was quite high. The proportion of patients reaching 85% of predicted maximum heart rate is 45 % (predicted HRmax = 220 - age). The proportion of patients with heart rate modulation index < 0.8 is 53.3%. The proportion of patients not achieving 85% of predicted maximal exercise capacity was 53.3%. However, the proportion of patients whose heart rate recovered in the first 1 minute was less than 12 beats/minute was low (11.6 %) .

4. DISCUSSION

4.1. Anthropometric characteristics

* *Gender characteristics:* In our study (Table 1), males accounted for 60.0%, females accounted for 40.0%. Although the rate of men is higher than that of women, there is no difference ($p > 0.05$). This result is also consistent with the research of Michael Semelka (2013) [14] out of 600 patient with sinus pradycardia and Chu Dung Si et al (2016) [15] out of 52 patients showing that the proportion of male and female patients with sinus bradycardia is similar equivalent.

* *Age characteristics:* The average age of the study subjects was 55.12 ± 13.89 years old. The majority of subjects are 50 years old or older, accounting for 6.6,7%, of which mainly the age group 50-59 years old accounts for (Table 1), also consistent with Chu Dung Si's research (58.54 ± 17,74). [14] The study results are still lower than the research of some other authors such as Michael Semelka (2013) [14] which noted that the risk of sinus bradycardia occurs at all ages but is more common in [16] study of 122,043 patients showed that sinus bradycardia is mostly seen in people aged 20-24 years old. The epidemiological characteristics of sinus bradycardia occurring mainly in these 2 age groups are explained by the fact that in healthy young people, especially athletes, sinus bradycardia occurs due to sympathetic hyperactivity. In elderly patients, sinus bradycardia occurs due to a number of diseases such as degenerative sinus node dysfunction, ischemic heart disease, or the patients with over 65 year olds (Study of Hiss RG, Lamb LE).[16]

* *Characteristics of body mass index* : In the study (Table 1), the majority of patients had a BMI of less than 23, accounting for 63.3%, the proportion with BMI of 23 or more accounted for 36.7%. BMI is often lower than studies by some authors around the world such as Jensen PN (2014) [2] and Al-Mallah MH (2014). [11] This can be explained by the different racial characteristics and lifestyles of Vietnamese people compared to Western people.

* *Characteristics of diseases in patients with sinus bradycardia.*

The most common comorbidities in the study were hypertension accounting for 38.3%, lipid metabolism disorders accounting for 13.3%, type 2 diabetes accounting for 10.0%. Other less common diseases include: Ischemic heart disease accounts for 2 cases (3.3%), of which 01 case has 80-90% RCA stenosis and 01 case has had a coronary artery stent placed. Moderate to severe valvular heart disease (excluding tight aortic valve stenosis) accounted for 2 cases (3.3%) and 01 case (1.7%) after atrial septal defect occlusion. Among these patients, 11 patients had multiple comorbidities (3 patients had 3 comorbidities, 8 patients had 2 comorbidities) (Table 2). The rate of this comorbidity is also quite similar to the study of Paul N. Jensen (2014): hypertension accounts for 27-76%, diabetes accounts for 9-26%, ischemic heart disease accounts for 5- 19% and other diseases from 2-26%. [2] Thus, the increased rate of sinus bradycardia with age also coincides with an increased risk of other cardiovascular diseases. It is also necessary to pay more attention when assessing whether a patient's symptoms are caused by bradycardia or are symptoms of comorbid diseases.

4.2. Characteristics of exercise electrocardiography.

* *Maximum exercise capacity*

In our study (Table 3): Average exertion time was 10.53% ± 0.46 minutes. The majority of patients stopped exercising in stages 3 and 5 (16 patients, accounting for 26.7% for each stage), stopping exercise in stage 4 was 11 cases, accounting for 18.3%; Stopping at stage 6 is 8 cases, accounting for 13.3%, stopping at stage 2 is 7 cases, accounting for 11.7%, and stopping at stage 7 with the least number of patients, only 2 cases, accounting for 3.3%, no patient reached maximum exertion at stage 8 (exertion level equivalent to an athlete) and no one stopped exertion at stage 1 (worst exertion level).

The maximal capacity achieved in our study had an average value of 7.78 ± 3.56 METs. This result is lower than the results of other studies. Research by Ahmed HM [11] on 31,090 patients

(mean age 55 ± 10 years, 49% female) had an average maximum capacity value of 9 ± 3 METs. The study by Al-Mallah MH et al [17] was conducted on 69,885 patients, average age was 54 ± 10 years, 54% were men, average maximum exercise capacity was 10 ± 3 METs. Research by Nguyen TVK and colleagues (2020) [18] on Koreans and Vietnamese people shows that maximum exercise capacity of healthy Vietnamese people at 19 – 35 years old is 10.9 ± 1.7 METs. Maximum exercise capacity is only about 2/3 of the exertion value at 10 – 39 years old (8 METs). [19]

The mean maximal exercise capacity in our study was low equivalent to the number of patients who did not reach 85% of the predicted maximum exercise capacity (32 cases, accounting for 53.5%). This can be explained by the fact that in our study the number of patients not reaching the target heart rate (85% of the predicted maximum heart rate) was high (27 cases, accounting for 45%), and at the same time the number of patients was high. Patients with heart rate modulation index (CI) < 0.8 are also high (32 cases, accounting for 53.5%) (table 3). The mechanism causing this similarity is explained by the fact that VO_2 max is proportional to the patient's achieved HRmax, patients with low HRmax will also have low VO_2 max.

* *Maximum exercise heart rate*

In this study (Table 3), the average HRmax was 129.90 ± 29.22 beats/minute. Some research results around the world: Research by Gulati M and colleagues [20] shows that group CI ≥ 0.8 has HRmax of 162 ± 13 beats/minute and group CI < 0.8 has HRmax of 135 ± 12 beats/minute /min, the study by Al-Mallah MH et al. [17] had an average HRmax of 151 ± 28 beats/min and the study by Ahmed MH [11] with an average maximum heart rate of 154 ± 15 beats/min, the study of gave the following results of Nóra Sydó et al (2014): [21] HRmax in men is 166 ± 17 beats/minute, in women is 163 ± 14 beats/minute.

Comparison shows that the maximum exercise heart rate obtained in our study is similar to the group with CI < 0.8 in other studies and lower than the studies on healthy patients or the group with CI < 0.8. 0.8. This result is explained by the high number of patients not reaching our target heart rate (27 cases, accounting for 45%), and the average CI in our study was only 0.64 ± 0.25 (Table 3.7).

* *Maximum exercise blood pressure*

The mean value of maximal exercise SBP was 155.23 ± 20.59 mmHg, significantly lower than the study with men (184) [21], research by M. Ahmed et al: group CI ≥ 0.8 is 180 ± 25mmHg and group CI < 0.8 is 174 ± 33 mmHg. Regarding variation in systolic blood pressure during maximum exercise: the average increase was 4.84 ± 2.72 mmHg/MET, lower than the literature (10 mmHg/MET). [19] This can be explained Nóra Sydó for man (184 ± 24 mmHg), women (168 ± 24 mmHg) because in our study, the proportion of patients who did not reach the target heart rate and had a CI lower than 0.8 was high (45%; 53,3%).

The average value of maximum exercise DBP is 88.10 ± 9.11 mmHg, quite consistent with the studies of Ahmed M [11] with the average value of maximum exercise DBP in the group CI ≥ 0 .8 is 85 ± 11mmHg and CI < 0.8 group is 86 ± 16 mmHg. In the study of In the study of Nóra Sydó MD et al [19]: Maximum exercise diastolic blood pressure in men was 78 ± 16 mmHg and in women was 75 ± 16 mmHg. The diastolic blood pressure variation of 2,40 ± 1,75 mmHg/MET is consistent with the literature: during exercise, diastolic blood pressure often increases slightly or remains the same, or decreases due to peripheral vasodilation.

** Heart rate recovery phase*

Heart rate decrease in the first 1 minute in our study was 27,87 ± 16,82 beats/minute , the number of patients with heart rate decrease in the first 1 minute during the recovery period < 12 beats/minute was only 7 cases account for 11.6% (Table 4). The results of many other studies around the world agree that a decrease in heart rate in the first minute of the recovery period < 12 beats/minute is abnormal. [19,22,23] The increase in heart rate during exercise is mainly due to increased sympathetic nervous system tone. Recovery of heart rate after exercise involves reactivation of the parasympathetic system. Impaired parasympathetic activity is closely associated with increased overall mortality. In this study, we found that the majority of patients had abnormalities in increased heart rate during the exercise period. However, no abnormal decrease in heart rate was observed during the recovery period (abnormal activity of the parasympathetic system). This contrast can be explained by the fact that in the study, the proportion of patients without abnormalities of the parasympathetic nervous system. Sinus bradycardia is quite high (19 cases, accounting for 31.7%) causing abnormal changes in heart rate during exercise, mainly related to the mechanism of sinus node dysfuntion due to other causes.

CONCLUDE

Anthropometric characteristics:

Gender: The ratio of men and women is similar. The average age of the study subjects was 55.12 ± 13.89 years old, the majority were aged 50 years or older (6,6,7 %) . The majority of patients had a body mass index (BMI) below 23 (63.3%), with a BMI of 23 or higher accounting for 36.7%, with no statistically significant difference.

The most common comorbidities are hypertension (38.3%), lipid metabolism disorders (13.3%), and type 2 diabetes (10.0%). Thus, the increased rate of sinus bradycardia with age also coincides with an increased risk of other cardiovascular diseases.

Characteristics of exercise electrocardiography:

The average exertion time was 10.53% ± 0.46 minutes. Most patients stopped exercising at stages 3 and 5, with no cases at the lowest level of exertion.

The maximum exercise capacity achieved has a slightly low average value of 7.78 ± 3.56 METs , the number of cases not reaching 85% of maximum exercise capacity is high (53.5%).

The average maximum exercise heart rate (Hrmax) was 129.90 ± 29.22 beats/minute. Maximum exercise blood pressure The mean value of maximum exercise SBP is 155.23 ± 20.59 mmHg, the variation in systolic blood pressure is 4.84 ± 2.72 mmHg/MET . The average value of maximum exercise DBP was 88.10 ± 9.1 1 mmHg, diastolic blood pressure variation was 2.40 ± 1.75 mmHg/MET .

Heart rate in the recovery phase: The average decrease in heart rate in the first 1 minute is 27, 87 ± 16, 82 beats/minute , the heart rate decrease in the first 1 minute in the recovery phase is < 12 beats/minute, accounting for the proportion low (11.6%).

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