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The Relationship between Heart Rate Recovery and Rate Pressure Product on Coronary Lesion Severity Using Syntax Score in Stable Angina Pectoris Patients at Haji Adam Malik Hospital Medan

Faisal Adam[1], Cut Aryfa Andra[2], Hilfan Ade Putra Lubis[2]

[1] *Resident Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Sumatera Utara*
[2] *Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Sumatera Utara*

***Corresponding Author**: Faisal Adam, E-mail: adamfaisal113@gmail.com

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ABSTRACT

Introduction: RPP is used as a marker of cardiac function. RPP reflects the function of the heart in fulfilling oxygen demand stably and continuously during activity. Slow decline of HRR is associated with risk factors for atherosclerosis, similar to hypertension and dyslipidaemia There has not been much research on HRR and RPP in coronary heart disease. The aim of this study is to examine the relationship between RPP and syntax score in stable coronary heart disease.

Methods: This study is an observational analytic study with a cross sectional design to determine the relationship between HRR and RPP to the severity of coronary lesions using the syntax score in stable angina pectoris patients. Sampling was carried out at the Haji Adam Malik Hospital Medan from February. HRR and RPP scores were obtained from cardiac exercise testing and syntax scores were obtained from coronary angiography after validation by an interventionist. EF data were taken from echocardiography results validated by consultant echocardiographers. Statistical data analysis using computer statistical tools, p value <0.05 was considered statistically significant.

Results: From angiographic data in samples with syntax score ⩾ 23, there were 23 (100%) LAD, 21 (91.3%) LCx, and 22 (95.7%) RCA involvement. In samples with Syntax score < 23, there were single vessel lesions as many as 11 (40.07%), two vessels as many as 12 (44.4%), and three vessels as many as 4 (14.8%). From the test results, there was a significant relationship between HRR and RPP and SYNTAX score with a p value <0.05 (<0.001) in both variables.

Conclusion: There was a significant association in HRR scores and RPP scores between groups with SYNTAX scores ⩾ 23 and SYNTAX scores < 23.

Keywords

Heart Rate Recovery, Rate Pressure Product, Syntax Score, Stable Angina Pectoris

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INTRODUCTION

Coronary heart disease is the leading cause of death from cardiovascular disorders. As many as 41.3% of deaths from cardiovascular disease in the US are caused by coronary heart disease.[1,2] In Europe there are 1194 deaths per 1 million population due to coronary heart disease. In Indonesia, 14.4% of deaths in Indonesia are caused by coronary heart disease.[1]

One part of coronary heart disease is stable angina pectoris. Stable angina pectoris comprises all situations in the spectrum of coronary artery disease other than acute coronary syndromes. Diagnosis and risk stratification in patients with stable coronary artery disease is important for the prevention of acute coronary syndrome. Cardiac exercise testing is one of the diagnostic modalities of stable angina pectoris. Cardiac exercise testing is a simple and widely available modality. Treadmill and bicycle exercise testing, using a 12-

lead ECG monitor, is still a useful option to perform in patients with stable angina pectoris and with moderate PTP (15-85%). Data on heart rate response, blood pressure, symptoms and activity load can also be obtained from these exercise tests. These are useful for diagnostic and prognostic information. To obtain maximum diagnostic information, the ECG training test procedure can be performed with the limitation of clinical symptoms and signs, without the influence of anti-ischemia drugs.[3,4]

Heart Rate Recovery (HRR) measurement after cardiac exercise testing is a simple and useful modality for autonomic nerve assessment, especially parasympathetic nerve activity. During exercise, an increase in sympathetic activity and a decrease in parasympathetic activity leads to an increase in heart rate. As soon as exercise is stopped there is parasympathetic reactivation and withdrawal of sympathetic activity, causing a decrease in heart rate. An abnormal decrease in heart rate after a decrease in exercise is a predictor of cardiovascular events and a cause of mortality in both healthy and sick individuals. In addition, a slow decrease in HRR is associated with risk factors for atherosclerosis, just like hypertension and dyslipidaemia.[5]

The Syntax score (SYNergy between percutaneous coronary intervention with TAXus and cardiac surgery) is a modality for determining the complexity of coronary heart disease. The prognostic value of the SYNTAX score in predicting cardiovascular events, mortality, and morbidity in coronary heart disease has been previously demonstrated and shows several benefits over other scoring systems. RPP is used as a marker of cardiac function. RPP reflects the function of the heart in fulfilling oxygen demand stably and continuously during activity.[6,7] There has not been much research on HRR and RPP in coronary heart disease. This study also aims to examine the relationship between RPP and syntax score in stable coronary heart disease.[7]

METHODS

This study was an observational analytic study with a cross sectional design to determine the relationship between HRR and RPP to the severity of coronary lesions using the syntax score in APS patients at Haji Adam Malik Hospital. Sampling was conducted in February 2024, with the target population being adult patients suspected or known to have SAP and undergoing treadmill examination and coronary angiography.

All samples of this study were patients with stable coronary heart disease and underwent treadmil examination and coronary angiography at Haji Adam Malik Hospital Medan who met the inclusion and exclusion criteria. The diagnosis of stable coronary heart disease was determined based on ESC guidelines. The sample collection used the quota method (consecutive) in which every subject who met the inclusion criteria was sampled until the total minimum sample size was 40 patients.

Subjects who became research samples were patients with stable coronary heart disease and underwent treadmil examination and coronary angiography at Haji Adam Malik Hospital Medan, which then before the action had informed consent to patients who met the inclusion criteria. Baseline data, subject identity (age, gender, family history, previous history of heart disease, physical activity, and smoking), physical examination (pulse, blood pressure), and 12-lead ECG examination.

HRR and RPP scores were obtained from cardiac exercise test examination results and syntax scores were obtained from coronary angiography after being validated by the interventionist. EF data were taken from echocardiography results that had been validated by an echocardiography consultant. All data obtained will be subjected to data processing, analysis, and hypothesis testing, which have been determined using SPSS ver 19.

For bivariate analysis on categorical variables, the chi square test and Fisher exact test were used. Bivariate analysis on numeric variables used the Independent T-test or Mann Whitney U-test if the data were not normally distributed. For samples that were found to be significant in the bivariate analysis test, they were entered into the multivariate test to identify the most dominant variable. Statistical data analysis using computer statistical tools, p value <0.05 was considered statistically significant.

RESULTS

A total of 50 samples that met the criteria were included in this study. The average age was 56 years. In this study, most patients were male with 28 people (56%), did not smoke 28 people (56%), suffered from

hypertension 42 people (85%), did not suffer from DM 34 people (68%), did not suffer from CKD 41 people (82%), and did not suffer from dyslipidemia 34 people (68%). The total sample with Syntax score ≥ 23 was 23 people.

Table 1. Basic Characteristics

Variable	SYNTAX Score		P value
	≥ 23	< 23	
Age (Years)			0.599
• < 45	3	3	
• ≥ 45	20	24	
Type Sex			0.945
• Man	13 (56.5)	15 (55.6)	
• Woman	10 (43.5)	12 (44.4)	
BMI (Mean ± SD)	25.26 ± 4.38	25.93 ± 4.03	0.660
Smoke			0.283
• Yes	12 (52.2)	10 (37)	
• No	11 (47.8)	17 (63)	
Hypertension			0.193
• Yes	21 (91.3)	21 (77.8)	
• No	2 (8.7)	6 (22.2)	
Diabetes mellitus			0.318
• Yes	9 (39.1)	7 (25.9)	
• No	14 (60.9)	20 (74.1)	
CKD			0.062
• Yes	7 (30.4)	2 (7.4)	
• No	16 (69.6)	25 (92.6)	
Dyslipidemia			0.827
• Yes	7 (30.4)	9 (33.3)	
• No	16 (69.6)	18 (66.7)	
E.F			0.009
≥ 50%	4	13	
< 50%	19	14	
Total	23	27	

Table 2. Training Test Characteristics Heart

Variable	SYNTAX Score		P value
	≥ 23 (N: 23, 46%)	< 23 (N: 27, 54%)	
Pressure blood systolic (mmHg)			
• Peak (Median (min-max))	200(173 – 220)	195(183 – 220)	0.028
• Resting (Mean ± SD)	157.78 ± 13.06	133.22 ± 10.46	<0.001
Pressure blood diastolic (mmHg)			
• Peak (Median (min-max))	130(110 – 172)	100 (90 -112)	<0.001
• Resting (Median (min-max))	95 (89 – 120)	82 (70 – 85)	<0.001
PHR (Median (min-max))	115 (80 – 126)	159 (140 -170)	<0.001
RHR (Median (min-max)	109 (72 – 120)	142 (120 -153)	<0.001
METs (Median (min-max))	9 (9-11)	10 (9-12)	0.022 [a]
Duke Score (Median (min-max))	-10 (-12 – 4)	-5 (-8 – (-3))	<0.001
HRR (Median (min-max))	8 (5 – 13)	17 (12 – 25)	<0.001
RPP (Median (min-max))	23,246 (16,000 – 26,082)	31,110 (30,210 – 32,600)	<0.001

In this study, the mean and median resting and peak systolic and diastolic blood pressure were higher in the group with SYNTAX score ≥ 23 at 157.78 ± 13.06 mmHg, 200 (173 - 220) mmHg, 95 (89 - 120) mmHg, 130 (110 - 172) mmHg respectively. In the group with SYNTAX score < 23, the median RHR, PHR, HRR and RPP were higher with values of 142 (120 -153), 159 (140 -170), 17 (12 - 25) and 31,110 (30,210 - 32,600).

Table 2 shows that there were significant differences in resting systolic blood pressure, peak blood pressure, RHR, PHR, HRR and RPP between groups with SYNTAX score ≥ 23 and SYNTAX score < 23.

Table 3. Characteristics Angiography Coroner

Variable	SYNTAX Score		P value
	≥ 23 (N: 23, 46%)	< 23 (N: 27, 54%)	
LM involvement	8 (34.8)	1 (3.7)	0.007
LAD involvement	23 (100)	20 (74.1)	0.011
LCx involvement	21 (91.3)	16 (59.3)	0.012
RCA involvement	22 (95.7)	10 (37)	<0.001
Single vessel involvement	0 (0)	11 (40.7)	0.001
Two vessels involvement	1 (4.3)	12 (44.4)	0.001
Three vessels involvement	22 (95.7)	4 (14.8)	<0.001

Samples with positive ischaemic response results on cardiac exercise test were followed by coronary angiography. From the angiographic data in samples with syntax score ≥ 23, there were 23 (100%) LAD, 21 (91.3%) LCx, and 22 (95.7%) RCA involvement. In samples with Syntax score < 23, there were 11 (40.07%) single vessel lesions, 12 (44.4%) two vessels, and 4 (14.8%) three vessels.

Table 4. Connection between HRR and RPP towards SYNTAX score

		SYNTAX Score (n(%))		P value*
		≥ 23 (N: 23, 46%)	< 23 (N: 27, 54%)	
HRR	Tall	1 (2)	27 (54)	<0.001
	Low	22 (44)	0 (0)	
Lesson plan	Tall	0 (0)	27 (54)	<0.001
	Low	23 (46)	0 (0)	
Total		23 (46)	27 (54)	

DISCUSSION

In this study, it was found that the majority of patients had a SYNTAX score < 23 with a total of 27 people (54%). This study is in line with Emren et al who found the majority of respondents had a SYNTAX score < 23 with 234 people (58%). But it is different from Iskandar in 2022 who found that the majority of respondents had a SYNTAX score ≥ 23, totalling 218 people. The SYNTAX score is a tool for assessing the complexity of coronary artery disease based on the number of lesions, lesion location, and functional importance.[8,9] The SYNTAX score is a validated tool for assessing the complexity and severity of CAD.22 It serves as a prognostic indicator of cardiovascular morbidity and mortality.[23] A retrospective analysis showed that CAD severity based on SYNTAX scoring can assist in selecting revascularisation strategies and, thus, improve treatment decisions.[10,11]

In this study, there were significant differences in HRR and RPP values between groups with SYNTAX scores ≥ 23 and SYNTAX scores < 23. The group with SYNTAX scores < 23 had higher HRR and RPP with values of 17 (12 - 25) and 31.110 (30.210 - 32.600). This study is consistent with Emren et al who found that the mean HRR was higher in patients with low SYNTAX score compared to patients with high SYNTAX score (21.3 ± 9vs. (9.8 ± 4.5, p < 0.001). Cole et al showed that the decrease in heart rate after a cardiac exercise test in the first minute was dominated by vagal activation. This is also confirmed based on another study conducted by Laurino. They found a decrease in heart rate after the first minute of exercise which was thought to be a decrease in vagal activity in patients with stable coronary arteries.[12]

HRR is a measure of autonomic nervous system function. A decreased HRR has been associated with an increased risk of cardiovascular events and all-cause mortality. A slower HRR is associated with risk factors for atherosclerosis. Although research protocols and cut-off points for HRR differ between studies, most show an increased risk of cardiovascular events in patients with abnormal HRR. Indeed, even small changes in HRR can affect cardiovascular outcomes.16 Based on the ROC curves in Iskandar's study, it shows that the first

minute heart rate recovery (HRR1) and second minute heart rate recovery (HRR2) have good diagnostic value, as the curves are far from the 50% line and close to 100%. The AUC values for HRR1 and HRR2 obtained from the ROC method were 90.8% (95% CI: 87.3%-94.2%, p=0.000) and 70% (95% CI: 64.4%-76.7%, p=0.000), respectively. Statistically, AUC values above 80% are considered significant, so HRR1 has significant value for predicting SYNTAX scores in patients with stable coronary artery disease, while HRR2 has moderate value for predicting SYNTAX scores.[10]

In this study there was a significant relationship between SYNTAX, HRR, and RPP scores with a p value <0.05. This study is in line with Iskandar 2022. HRRI and HRR2 showed a significant association with high SYNTAX scores (8.39 ± 3.83 p=0.00, 19.58 ± 5.57 p=0.00, respectively) and there was also a significant association with low SYNTAX scores (16.96 ± 4.93 p=0.00, 31.69 ± 8.13 p=0.00). Multivariate logistic regression analysis in the study found that HRR1 and HRR2 were negatively associated with SYNTAX scores. This is also in line with Emren et al. In the multivariate logistic regression analysis, a decrease in HRR (OR: 0.780; 95% CI: 0.674-0.902; p = 0.001), peak systolic blood pressure (OR: 1.054; 95% CI: 1.023-1.087; p = 0.001), and peak HR (OR: 0.950; 95% CI: 0.923-0.977; p < 0.001) were found to be independent predictors of SYNTAX score. However, there was a negative correlation between HRR and SYNTAX score (r: -0.580, p < 0.001). Heart rate recovery (HRR) is a function of vagal reactivation, and its decrease is an independent prognostic indicator for cardiovascular events and all-cause mortality. HRR is calculated by subtracting the heart rate at the 1st, 2nd, and 3rd minutes after test termination from the patient's heart rate at the end of exercise. Many studies have shown that HRR in the first and second minutes is highly predictive of prognosis in coronary artery patients and reported that those with impaired HRR have a significantly higher risk of death.[13]

CONCLUSION

There was a significant association in HRR scores and RPP scores between groups with SYNTAX scores ⩾ 23 and SYNTAX scores < 23.

DECLARATIONS

None

CONSENT FOR PUBLICATION

The Authors agree to publication in Journal of Society Medicine.

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COMPETING INTERESTS

The authors declare that there is no conflict of interest in this report.

AUTHORS' CONTRIBUTIONS

All authors are responsible for conceptualization, manuscript preparation, manuscript editing, and manuscript assurance.

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