Review Article

My Approach to Semi-Supine Bicycle Stress Echocardiography: Is It the Best Modality for Brazil?

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Introduction

Physical stress echocardiography is a firmly established method in the diagnosis and prognosis of coronary artery disease.[1-3] Compared to pharmacological stress echocardiography, it is physiological, does not depend on venoclysis, and is free of side effects. Physical exercise preserves the normal electromechanical response and provides valuable prognostic information about a patient's functional status. Therefore, physical stress is the test of choice for assessment of myocardial ischemia in patients who are capable of exercise.[4] The main differences between methods are displayed in Table 1.

The most frequently used tools for this method are treadmill and cycle ergometer (ergometric bicycle or semi-supine bicycle). Echocardiography performed during physical exertion on a bicycle offers an advantage in relation to a treadmill, because it is possible to obtain images in real time, rather than after exercise.[5] Continuous monitoring of myocardial contractility makes it possible to define the exact moment, that is, at which heart rate the change occurs in patients with a positive test. If this alteration occurs at low heart rates or low double product, the presence of severe coronary stenosis or multivessel disease is inferred, thus providing valuable prognostic information.[6] A semi-supine bicycle offers advantages in relation to a supine bicycle due to its structure, which consists of coupling a cycle ergometer system to a hospital bed, where the patient can lie or sit to pedal while the doctor acquires the images.

In addition to detecting myocardial ischemia and viability, bicycle stress echocardiography is also indicated for assessment of patients who complain of dyspnea, making it possible to study diastole,[7-9] detect and follow pulmonary hypertension,[4] and monitor hypertrophic cardiomyopathy.[10]

Contraindications to physical stress include unstable or complicated acute coronary syndrome, severe cardiac arrhythmias (ventricular tachycardia, complete atrioventricular block), and moderate to severe systemic arterial hypertension (resting systolic blood pressure above 180 mmHg).[4]

Keywords

Echocardiography; Coronary Artery Disease; Exercise

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My approach

To perform physical stress echocardiogram using a semi-supine bicycle accurately and safely, we follow a specific protocol. The nursing team responsible for the initial interview receives patients with the application of a questionnaire and preparation for the test. Patients are advised to consume their usual diet up to 2 hours before the exam or a light meal up to 1 hour before. During the interview, we consult the medical request and the reason for referral, personal and family cardiovascular history, presence of manifest atherosclerotic disease or its risk factors, comorbidities, and current or previous symptoms. A brief review of medical records is performed, and previous cardiovascular exams are made available to the examiner.

The physician responsible for the exam must fill out our institution's safety checklist, verifying absolute contraindications to the test. A free and informed consent form is applied. The patient is positioned on the semi-supine bicycle and monitored with 12-lead electrocardiogram, with appropriate skin preparation if necessary, non-invasive blood pressure, and pulse oximetry (Figure 1). We use a semi-supine bicycle made by the company Inbramed, which allows vertical inclination of up to 40 degrees and horizontal rotation of up to 30 degrees using an electronic control (Figure 2). It accommodates patients weighing up to 150 kg and allows the load to be increased by 1 watt up to a maximum level of 240 watts at 60 rotations per minute. The semi-supine bicycle has a panel so that rotations per minute can be viewed in real time. Patients are instructed to maintain 60 rotations per minute. Load control and electrocardiographic recording are done using a compatible TEB APEX ergometry system (Figure 3). A particular feature of our service is that we requested a safety belt adapted to the semi-supine bicycle in order to increase patients' perception of stability. Movements of longitudinal and transverse rotation allow for ideal adjustment of the patient's position to optimize both physical effort in the supine or semi-sitting position and image quality by allowing the patient to lean to the left (Video 1).

The echocardiography device should have all usual preset adjustments made, including the use of harmonics to better visualize the endocardial border. The examination then begins with a resting echocardiogram; at this moment, special attention must be paid to conditions that contraindicate physical stress or that may cancel the need to conduct the examination under stress.

After conducting a complete resting examination, images are captured during physical exertion using a specific protocol,

Table 1 – Different stress modalities and their respective characteristics

	Exercise (Bicycle/treadmill)	Inotropes/chronotropes (Dobutamine)	Vasodilator (Dipyridamole/adenosine)
Physiology	Preserves electromechanical response	Beta-1 adrenergic agonist with the effect of increased heart rate and/or contractility	Effect on A2A adenosine receptors; increased coronary blood flow
Test selection	Test of choice for patients who can perform adequate level of exercise Bicycle is preferrable for assessing diastolic function	Patients who are not able to perform physical exercise Preferrable for assessing myocardial viability	Test of choice for myocardial perfusion
Characteristics	Increases myocardial oxygen demand	Increases myocardial oxygen demand	Increases coronary blood flow
Hemodynamic response			
Heart rate	↑↑	↑↑	↑
Stroke volume	↑↑	↓ or no change	No significant change
SBP	↑↑ (50%)	↑	↓
Contractility	↑	↑	No change
Myocardial blood flow	↑	↑	↑
Contraindications	Unstable or complicated ACS Severe cardiac arrhythmias (VT, complete AVB) Resting SBP > 180 mmHg	Hemodynamically significant LV outflow tract obstruction Unstable or complicated ACS Severe cardiac arrhythmias (VT, complete AVB) Resting SBP > 180 mmHg	Bronchospasm Significant hypotension Unstable or complicated ACS Severe cardiac arrhythmias (VT, complete AVB)

AVB: atrioventricular block; ACS: acute coronary syndrome; LV: left ventricle; SBP: systolic blood pressure; VT: ventricular tachycardia. Adapted from the Guidelines for Performance, Interpretation, and Application of Stress Echocardiography in Ischemic Heart Disease: From the American Society of Echocardiography.

Figure 1 – *The patient is positioned on the semi-supine bicycle and monitored with 12-lead electrocardiogram, with appropriate skin preparation if necessary, non-invasive blood pressure, and pulse oximetry.*

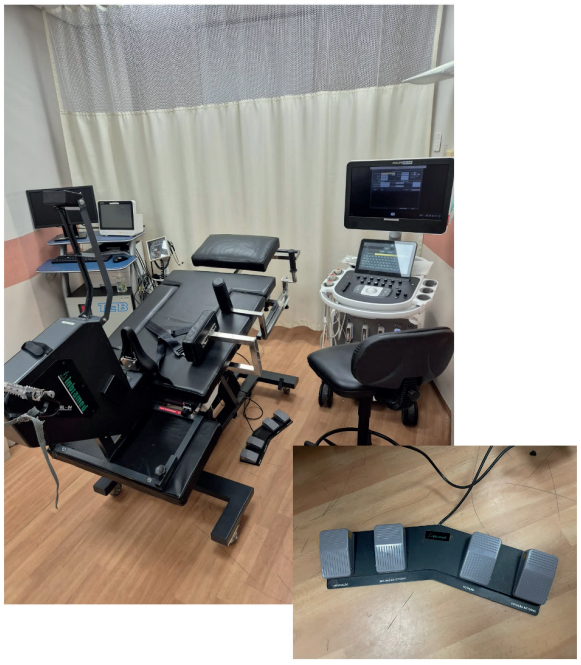

Figure 2 – *Semi-supine bicycle made by the company Inbramed allows vertical inclination of up to 40 degrees and horizontal rotation of up to 30 degrees using an electronic control.*

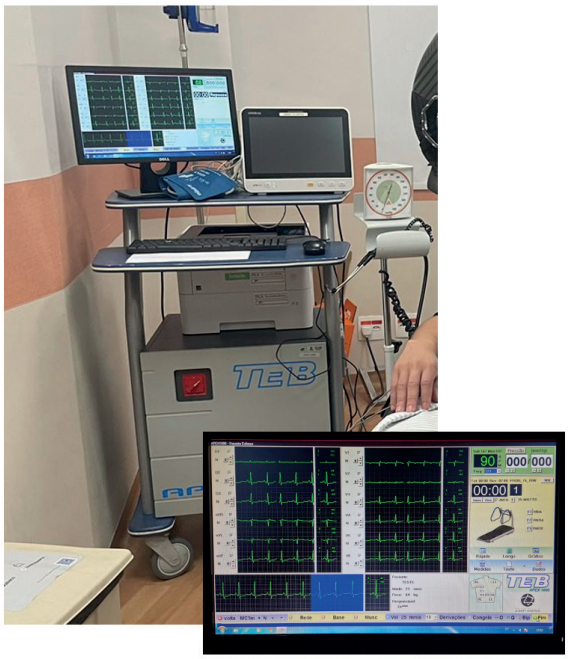

Figure 3 – *Load control and electrocardiographic recording are done using a compatible TEB APEX ergometry system.*

Video 1 – *http://abcimaging.org/supplementary-material/2024/3703/2024-0042_AR_Video_1.mp4*

which allows comparative analysis of images in different phases of exertion in quad-screen format. Physical or pharmacological stress presets can be used, depending on the examining physician's recording preference.

The ramp protocol is applied during the test, with a load increase every 2 minutes. In our service, we have chosen to use the formula recommended by Wasserman et al.[11] to calculate the load increase (Figure 4), with a 50% reduction if the patient has previous heart disease. We use the Borg scale[12] to analyze subjective perception of effort. According to the examiner's experience, the capture of peak images begins before the patient interrupts exertion due to exhaustion. Throughout the examination, a nursing professional records vital signs and the load used in the specific protocol. The test is concluded when the patient reaches physical exhaustion, when maximum heart rate is reached, when any of the diagnostic targets are obtained, or when interruption criteria occur.

Conclusion

Physical stress echocardiography provides physiological parameters, with the advantage of lower cost compared to pharmacological stress echocardiography. It is the exam of choice in patients who are physically capable. The semi-supine bicycle is a valuable alternative to the treadmill and conventional bicycle in the evaluation of patients with heart disease, and it is easily adapted in echocardiography laboratories and widely accepted by patients. It allows real-time image visualization with accuracy and quality. In addition to providing information about myocardial contractility, it makes it possible to assess gradients in native valves, prostheses, hypertrophic cardiomyopathy, measurement of pulmonary artery pressure, and diastole. It is an excellent choice for echocardiography laboratories in Brazil.

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Author Contributions

Conception and design of the research, acquisition of data, writing of the manuscript and critical revision of the manuscript for intellectual content: Stangenhaus C, Oliveira FRC, Cordovil A.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any thesis or dissertation work.

Ethics Approval and Consent to Participate

This article does not contain any studies with human participants or animals performed by any of the authors.

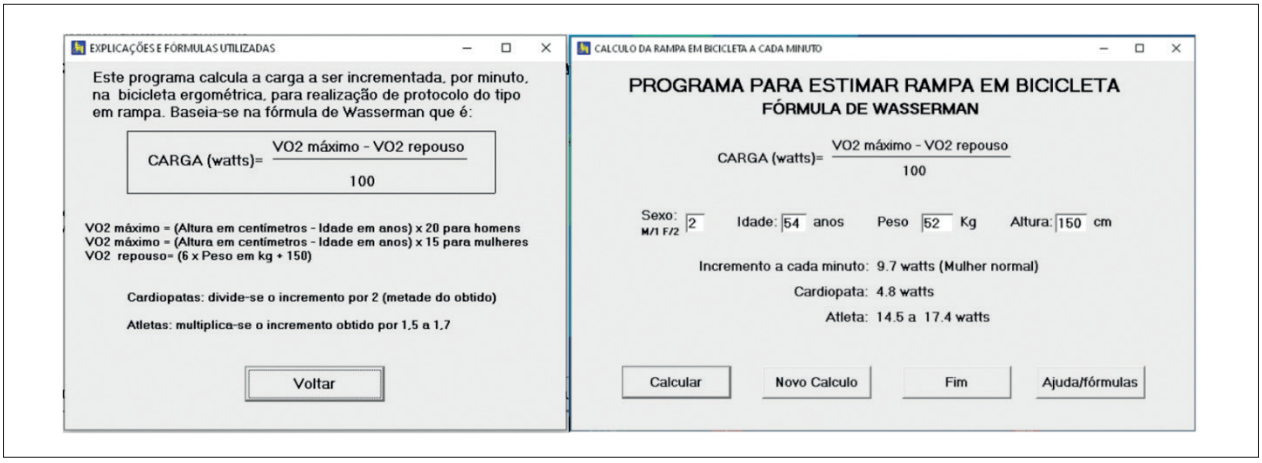

Figure 4 – *Image of the system using the formula recommended by Wasserman to calculate load increase, with a 50% reduction if the patient has previous heart disease.*

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