Accuracy of Stress Echocardiography in Detecting Ischemic Heart Disease, Experience at the Bangkok Heart Hospital 2012

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OBJECTIVES: Stress echocardiography is a good test for detecting ischemic heart disease. The sensitivity, specificity and accuracy should be verified. This test was compared to standard coronary angiographic results. This is the first study by Bangkok Heart Hospital's echocardiography lab to verify the effectiveness of stress echocardiography.

MATERIAL AND METHODS: This study was a retrospective study that reviewed data from records. The 149 selected cases underwent stress echocardiography and a coronary angiogram (within 2 months after the stress echocardiography) between 1st January and 31st December 2012. The sensitivity, specificity and accuracy were assessed.

RESULTS: The overall sensitivity, specificity, and accuracy were 81.98%, 42.10%, and 71.81% respectively. There was a variation of sensitivity, specificity and accuracy in each day of the week. There were many factors such as number of cases, reporting physicians, technically poor studies (including poor echogenicity of subject), technician experience, abnormal wall motion at rest, atrial fibrillation and bundle branch block. The sensitivity ranged from 57.14 % to 92.3%. The specificity ranged from 16.67% to 70%. The accuracy ranged from 50.0 % to 86.67 %.

CONCLUSION: Stress echocardiography is a good test for evaluating ischemic heart disease. Our echo lab had lower sensitivity, specificity and accuracy than other previous studies. The limitation of this study was that it was a retrospective study. But it showed our routine work. We hope this will help our echo lab to improve the quality of its stress echocardiography testing.

Stress testing is the most frequent investigation to diagnose ischemic heart disease. The most common technique is electrocardiography during a treadmill stress period. Electrocardiography has limitations because there are many artifacts from movement. There are many techniques to improve the detection of ischemic heart disease, such as magnetic resonance imaging (MRI), thallium scintigraphy,[1] radionuclide ventriculography and echocardiography. The dobutamine and exercise stress echocardiography test were shown to detect coronary artery disease.[2-4]

In the Bangkok Heart Hospital, we use treadmill or dobutamine in this test depending on the patient's status. The dobutamine is used in patients who cannot exercise. We often use echocardiography as a technique to diagnose ischemia.

This study retrospectively shows the clinical use of stress echocardiography for diagnosis of coronary artery disease to detect ischemia in patients with known or suspected ischemic heart

disease. This study will show the sensitivity, specificity, and accuracy of stress echocardiography in our non-invasive department. It will help us to improve the quality of stress echocardiography in our echo lab.

Materials and Methods

Case studies: The patients underwent a stress echocardiography test in the non-invasive department of the Bangkok Heart Hospital between 1st January and 31st December 2012. There were 2,035 patients who underwent stress echocardiography. Their ages ranged from 17 to 96 years. There were 1,284 (63.1 %) men and 751 (36.9 %) women. There were 149 cases that had undergone stress echocardiography testing before undergoing a coronary angiogram (CAG) within 2 months. These patients were the subject of this study. All cases were reviewed retrospectively from data recorded.

A coronary angiogram was performed within 2 months after the stress echocardiography testing. Significant narrowing was determined as ≥ 50 % diameter stenosis of the major coronary artery or its major branch.

Stress echocardiography protocols: Sixty-six cases performed the treadmill stress echocardiography testing. The treadmill was used with Bruce protocol. Patients walked at least 85% of predicted heart rate. If they could not reach 85% of predicted heart rate (the test was labeled as an inadequate test), they were excluded. Echocardiographic images were scanned before and after the treadmill test. Electrocardiogram and blood pressure were monitored during exercise.

Eighty-three cases received dobutamine stress echocardiography. Dobutamine was step infused at the doses of 10, 20, 30, 40 μg/kg/min every 2 minutes and every 1 minute to capture echocardiography images. The test was stopped when a new wall motion presented or reached 85% of predicted heart rate. If a 40 μg/kg/min dose could not achieve the target heart rate, atropine was injected and an image was captured at 85% of predicted heart rate or higher.[5]

Echocardiography: 2D echocardiography was recorded with a parasternal short axis, apical 4 chamber 2 chamber, and 3 chamber views. The echocardiographic machines used were GE vivid 7 and vivid E9. The transducer frequency range was 1.5-2.3 MHz. Echocardiographic wall motion was graded as normal, hypokinesia, akinesia or dyskinesia. A 16-segment model (Figure 1) was used for grading wall motion.

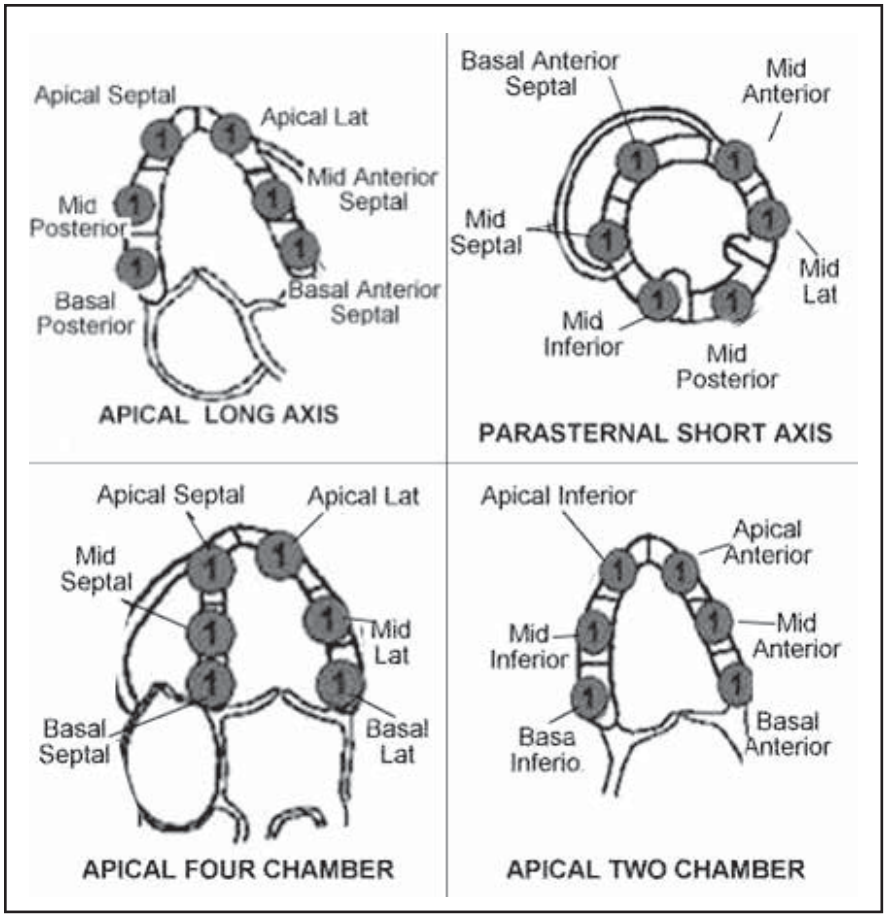

***Figure 1**: 16-segment model.*

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Results

Coronary angiogram results: the positive angiogram was defined as ≥ 50% diameter stenosis. Coronary artery disease was present in 111 patients. Thirty-eight cases were single vessel disease. There were 73 cases with multivessel disease. The left main lesion was defined as multivessel disease.

Exercise (treadmill) stress echocardiography was used in 66 cases. Dobutamine stress echocardiography was used in 83 cases. Positive stress echocardiography was found in 113 cases, 91 cases were true positive and 22 cases were false positive. There were 36 cases with negative stress echocardiography and 16 cases were true negative and 20 cases were false negative (Table 1).

$$\text{Sensitivity was calculated by} \frac{\text{(true positive)}}{\text{(true positive + false negative)}}$$

$$\text{Specificity was calculated by} \frac{\text{(true negative)}}{\text{(true negative + false positive)}}$$

$$\text{Accuracy was defined by} \frac{\text{(true positive + true negative)}}{\text{(total cases)}}$$

$$\text{Positive predictive value was} \frac{\text{(true positive)}}{\text{(true positive + false positive)}}$$

$$\text{Negative predictive value was} \frac{\text{(true negative)}}{\text{(true negative + false negative)}}$$

The calculated values shown in Table 2 detail each day of the week for a week. The sensitivity of this echo lab was 81.98%. The specificity was 42.1%. The accuracy was 71.81%. There were no cases of true negative on Day 3, so the specificity and negative predictive value was 0 (presented as NA) (Table 2).

Discussion

Stress echocardiography has an advantage over stress electrocardiography (ECG). This test evaluated baseline echocardiography before the stress test. Left ventricle (LV) function, regional wall motion, heart valves, chambers and other abnormalities were detected before the stress test. The indication of stress echocardiography is an evaluation of chest pain, diagnosis of coronary artery disease, detection of viable myocardium, preoperative evaluation, and evaluation of status of coronary revascularization. Sensitivity varied from 54% to 96% and specificity varied from 50% to 100% [6-8] in previous studies.

In this study, the overall sensitivity was 81.98%, and this was lower than previous studies.[6-9] The reason might be that this study was retrospective. But this might reflect real life, and routine work. The specificity was very low because there were more false positive cases than true negative cases. Perhaps there was a bias on the part of the physician wanting to recommend that the patient should have an angiogram which resulted in more false positive cases. Some cases did not have an angiogram when there was a negative stress echocardiography, especially on Day 3 (no true negative test). Because of the low true negative and high false positive, the accuracy was too low.

Table 1: Comparision of Stress Echocardiography and Coronary Angiogram.

Stress echocardiography	Coronary Angiogram	
	Positive	Negative
Positive	91 (true positive)	22 (false positive)
Negative	20 (false negative)	16 (true negative)

Table 2: The calculated values show sensitivity, specificity, and accuracy for each day of the week (Unordered).

	n	Sensitivity	Specificity	Accuracy	PPV	NPV
All	149	81.98%	42.10%	71.81%	80.53%	44.44%
Day 1	30	92.0%	60.0%	86.67%	92.0%	60.0%
Day 2	32	72.73%	70.0%	71.87%	84.2%	53.85%
Day 3	13	70.0%	NA	53.85%	70.0%	NA
Day 4	15	72.73%	50.0%	66.67%	80.0%	40.0%
Day 5	10	57.14%	33.33%	50.0%	66.67%	25.0%
Day 6	32	92.30%	16.67%	78.12%	82.76%	33.33%
Day 7	17	90.0%	28.57%	64.70%	64.28%	66.67%

NA = not available , because there was no true negative case on Wednesday.
Bold = highest, Underlined = lowest, PPV = positive predictive value, NPV = negative predictive value

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There was variation in the sensitivity, specificity and accuracy on each day of the week examined. The most sensitive day was Day 6. The most specific day was Day 2. The most accurate day was Day 1. There were many factors that influenced sensitivity, specificity and accuracy. For example, the number of cases, the reporting physician, technically poor studies (including poor echogenicity of subject), technician experience, abnormal wall motion at rest, atrial fibrillation and bundle branch block were important factors that had an effect on each day.

Limitation

This study was a retrospective study. There was some bias from the physician, these results are not randomized. There were many cases that underwent a stress echocardiography test but only selected cases had an angiogram.

There was a subjective interpretation that depends on the reporter's experience. The lack of quantitative evaluation reduced the accuracy, sensitivity, and specificity of the test. Especially in the case of abnormal wall motion at rest, atrial fibrillation, and bundle branch block. The quantitative evaluation was suggested but this is time consuming, and requires good technical studies (good images, good equipment, good views, good operators) and needs experienced reporters.

Conclusion

Stress echocardiography is a good test to evaluate ischemic heart disease but it needs good technical studies and experienced reporters. This study was a retrospective study that showed the routine work of our echo lab. This study showed low sensitivity, specificity and accuracy in our lab compared to previous studies (from another site). This study had limitations but it has shown an opportunity to improve the accuracy, sensitivity, and specificity of the test in the lab. There are many quantitative evaluations, hardware, and software to help. The accuracy, sensitivity, and specificity of stress echocardiography will continue to improve.

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