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Digital Supine Bicycle Stress Echocardiography: A New Technique for Evaluating Coronary Artery Disease

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Objectives. The objective of this study was to determine the accuracy of digital supine bicycle stress echocardiography, a new technique for evaluating coronary artery disease during peak exercise.

Background. Prior stress echocardiographic techniques have not utilized peak exercise imaging to determine the extent and location of coronary artery disease.

Methods. Two-hundred twenty-two patients were studied: 180 underwent both supine bicycle stress echocardiography and coronary arteriography; 42 had a <5% likelihood of disease. Forty-three patients had normal coronary arteries, 55 had single-vessel, 42 had double-vessel and 40 had triple-vessel coronary artery disease.

Results. Supine bicycle stress echocardiography was 93% sensitive, 86% specific and 92% accurate for identifying patients with coronary artery disease irrespective of prior myocardial infarction or achievement of ≥85% maximal predicted heart rate. The "normalcy" rate in the low probability group was 100%. Supine bicycle stress echocardiography was 87% sensitive, 89% specific and 88% accurate for specific vessel identification. The sensitivity was greatest for the left anterior descending compared with the right coronary artery and the left circumflex coronary artery (95% vs. 81% vs. 78%, $p < 0.01$) and for vessels in patients with double- and triple-vessel compared with single-vessel disease (90% vs. 89% vs. 78%, $p < 0.05$). The procedure was significantly more sensitive for detection of vessels with 90% to 100% compared with 50% to 70% diameter stenosis (91% vs. 81%, $p < 0.05$) and was 88% correct in the prediction of multivessel disease.

Conclusions. Supine bicycle stress echocardiography is a highly accurate tool for evaluating coronary artery disease, identifying both the patient with coronary artery disease and the location and extent of disease.

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Exercise stress echocardiography, although available for the past decade, has achieved more widespread acceptance only in the past few years (1–8) with the advent of digital acquisition and closed loop four-quadrant display, facilitating comparison of rest and post-stress images. However, it has been performed almost exclusively after maximal treadmill exercise (1–7), with data obtained while ischemia is progressively resolving. Moreover, there is a paucity of data regarding disease detection in specific coronary arteries by postexercise stress echocardiography (1,4)—an increasingly important need in the era of interventional cardiology—and no data whatsoever concerning the ability of peak exercise digital stress echocardiology to fulfill this need. Accordingly, this study was designed to evaluate a new technique, digital acquisition supine bicycle stress echocardiography, with all images acquired during peak exercise for identifying both the patient with coronary artery disease and the location and extent of coronary artery disease.

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Methods

Study patients. The study group consisted of 222 patients; 180 underwent cardiac catheterization within the 2 weeks after supine bicycle stress echocardiography and were a consecutive series of patients referred for evaluation of possible coronary artery disease who underwent both procedures. The remaining 42 patients, the "normal" group, were considered to have <5% probability of coronary artery disease on the basis of age, symptoms, risk factors and exercise electrocardiography (9) and did not undergo cardiac catheterization. All patients gave informed consent.

Supine bicycle stress echocardiography. Echocardiography was performed with a Toshiba 140A ultrasound system with 3.75- and 2.5-MHz transducers with parasternal long- and short-axis views and apical two-, three- and four-chamber views acquired in the supine position. The patient then performed bicycle exercise in the supine position on a table (Redbud Medical Systems) with the capability of left lateral tilt as needed to a maximum of 30° and head elevation to a maximum of 20° to optimize images. Depending on the patient, the work load was increased by 25 to 50 W every 2 min until a symptom-limited maximum was achieved. Images were obtained in the five views during each stage. A Freeland Cineview was used to display digitized images for

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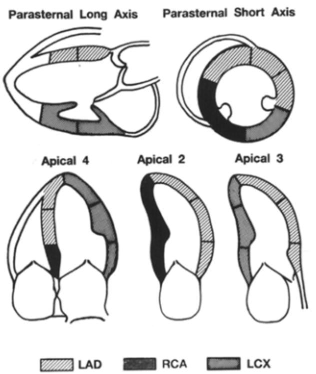

Figure 1. Division of echocardiographic views into segments and assignment to specific coronary arteries. LAD = left anterior descending, LCX = left circumflex and RCA = right coronary artery.

simultaneous comparison of rest and peak studies. Eight frames/cardiac cycle, triggered from the R wave at intervals of 67, 50 or 33 ms depending on the heart rate, were displayed. At least one early diastolic frame was included to ensure that end-systolic analysis was accomplished. Continuous three-lead electrocardiographic (ECG) monitoring was utilized with a 12-lead ECG during each stage with precordial electrodes moved to avoid encroachment on the transducer. The entire study was continually recorded on Super VHS tape. Endocardial visualization was required for analysis to proceed.

The five images were divided into segments as shown in Figure 1 and each segment was scored independently by two observers, as follows: 1 = hyperkinesia, 2 = normal, 3 = mild hypokinesia, 4 = moderate hypokinesia, 5 = severe hypokinesia, 6 = akinesia and 7 = dyskinesia. Differences of opinion were resolved by consensus. The prediction of coronary artery disease was based on worsening of segmental wall motion during exercise by at least one grade or severe hypokinesia, akinesia or dyskinesia at rest. The prediction of the presence or absence of significant coronary artery disease in specific coronary arteries was then made on the basis of the segmental analysis, with assignment to the individual vessels illustrated in Figure 1 without knowledge of the arteriographic results.

In our laboratory, 2% of stress echocardiographic studies are considered nondiagnostic. Interobserver and intraobserver agreement on the presence or absence of disease is 90% and 92%, respectively, in vessels and 92% and 94%, respectively, in patients.

Exercise electrocardiography. The 12-lead ECG during exercise was considered positive if there was ≥1 mm of horizontal or downsloping ST segment depression for ≥0.08 s after the J point compared with the tracing recorded at rest. Five patients had left bundle branch block or baseline ST segment depression that precluded accurate analysis of further ST segment changes with exercise; these five were excluded from analysis of the ECG detection of coronary artery disease.

Coronary arteriography. All patients underwent selective coronary arteriography after supine bicycle exercise echocardiography. Selective left and right coronary arteriograms in multiple views were obtained by either the Judkins or the Sones approach. Significant coronary artery disease was defined as the presence of ≥50% diameter reduction determined by magnified electronic caliper measurements (10). The view demonstrating the most severe stenosis was utilized.

Statistical analysis. Continuous variables are expressed as mean values ± SD. Student t tests were performed to determine significant differences between mean values for the continuous variables. Analysis of variance was used to compare mean values of multilevel grouping variables. Chi-square analyses or Fisher exact tests were used to compare categoric variables. A p level of 0.05 was considered to be statistically significant. When multiple comparisons were performed, primarily when comparing sensitivity, specificity and accuracy by vessel, the Bonferroni method was used to adjust the significance level.

Results

The clinical characteristics of the study patients are presented in Table 1. Twenty-one percent of the patients had

Table 1. Clinical Characteristics of 180 Patients Undergoing Cardiac Catheterization

	No.	%
Male	155	86
Age (yr) (mean ± SD)	56 ± 11	
Prior MI	38	21
Prior PTCA	70	39
Prior CABG	18	10
Chest pain history	155	86
Diabetes	16	9
Antianginal drugs	137	76
Calcium channel blockers	128	71
Nitrates	2	18
Beta-blockers	22	12
Coronary arteriography		
Normal	43	24
Single-vessel disease	55	31
Double-vessel disease	42	23
Triple-vessel disease	40	22
LAD disease	107	59
RCA disease	79	44
LCx disease	72	40

CABG = coronary artery bypass grafting; LAD = left anterior descending coronary artery; LCx = left circumflex coronary artery; MI = myocardial infarction; PTCA = percutaneous transluminal coronary angioplasty; RCA = right coronary artery.

Table 2. Exercise Test Results

	"Normalcy"	Normal Coronary Arteries	SVD	DVD	TVD
No.	42	43	55	42	40
Age (yr)	39 ± 7*	57 ± 13†	58 ± 10†	63 ± 9	64 ± 11
Duration (min)	8 ± 2*	6 ± 2†	6 ± 2	5 ± 1	5 ± 1
Watts	176 ± 77*	123 ± 50†	114 ± 50	104 ± 40	92 ± 36
Maximal HR (beats/min)	149 ± 14*	131 ± 21	130 ± 18	123 ± 18	124 ± 19
% predicted maximal HR	83 ± 8	80 ± 12	79 ± 10	78 ± 11	79 ± 13
Maximal SBP (mm Hg)	182 ± 30	184 ± 30	181 ± 21	177 ± 22	175 ± 25
Maximal DBP (mm Hg)	96 ± 9	94 ± 12	96 ± 10	93 ± 11	99 ± 17
HR × SBP (beats/min × mm Hg/100)	276 ± 50*	242 ± 61	234 ± 46	218 ± 48	217 ± 59
Chest pain (%)	0	5	33	29	35

*p < 0.001 versus all other variables. †p < 0.01 versus double-vessel disease (DVD) and triple-vessel disease (TVD). Values are expressed as number or percent of patients or mean value ± SD. DBP = diastolic blood pressure; HR = heart rate; HR × SBP = rate-pressure product; SBP = systolic blood pressure; SVD = single-vessel disease.

a prior myocardial infarction and 86% were referred because of a history of chest pain. Antianginal medications were not discontinued at the time of the imaging studies and were being taken by 76% of the patients. Coronary arteriography revealed that 43 patients had normal coronary arteries and 137 had coronary artery disease (55 with single-vessel, 42 with double-vessel and 40 with triple-vessel disease).

Table 2 displays the results of exercise testing. Analysis of variance demonstrated significant differences between the groups in age ($F = 39.5$, $p < 0.0001$), duration of exercise ($F = 10.5$, $p < 0.0001$), watts ($F = 15.7$, $p < 0.0001$), maximal heart rate ($F = 14.2$, $p < 0.0001$) and rate-pressure product ($F = 8.6$, $p < 0.0001$). Univariate group comparisons are shown in Table 2.

The sensitivity, specificity and accuracy of supine bicycle stress echocardiography in the detection of disease in any of the three major coronary arteries is compared with the results of the exercise ECG in the 180 patients undergoing cardiac catheterization in Table 3. Supine bicycle stress echocardiography was significantly more sensitive (93% vs. 52%, $p < 0.0001$) and accurate (92% vs. 60%, $p < 0.0001$) than was the exercise ECG for the entire group and for those with single-, double- and triple-vessel disease. There were no differences in specificity. It was significantly more sensitive for the detection of patients with double- and triple-vessel disease than of those with single-vessel disease (100% vs. 84%, $p < 0.01$).

There were no significant differences in the sensitivity of supine bicycle stress echocardiography for the detection of coronary disease in patients with and without prior myocardial infarction and in patients who achieved ≥85% vs. <85% of the maximal predicted heart rate (Table 4). The "normalcy" rate in the patients with <5% probability of coronary artery disease who did not undergo cardiac catheterization was 100%.

Supine bicycle stress echocardiography was 87% sensitive, 89% specific and 88% accurate for disease detection in specific coronary arteries (Table 5). The sensitivity was

Table 3. Detection of Coronary Artery Disease by Supine Bicycle Stress Echocardiography and Comparison With Exercise Electrocardiography

Patients	% Sensitivity	(95% CI)	% Specificity	(95% CI)	% Accuracy	(0% CI)
Total (n = 180)						
SBSE	93*	(89–97)	86	(76–96)	92*	(88–96)
Ex ECG	52	(43–61)	86	(76–96)	60	(53–67)
SVD (n = 55)						
SBSE	84*	(74–94)				
Ex ECG	42	(29–55)				
DVD (n = 42)						
SBSE	100*†					
Ex ECG	51	(36–66)				
TVD (n = 40)						
SBSE	100†‡					
Ex ECG	69	(54–84)				

*p < 0.0001 versus exercise electrocardiography (Ex ECG). †p < 0.01 versus single-vessel disease. ‡p < 0.001 versus exercise electrocardiography. CI = confidence interval; SBSE = supine bicycle stress echocardiography; other abbreviations as in Table 2.

Table 4. Detection of Coronary Disease by Supine Bicycle Exercise Electrocardiography in Patients With and Without Prior Myocardial Infarction and in Patients Achieving ≥85% Versus <85% Predicted Maximal Heart Rate

	No.	% Sensitivity	(95% CI)
Prior MI	37	97	(92-100)
No prior MI	100	91	(86-96)
≥85% predicted maximal HR	49	96	(91-100)
<85% predicted maximal HR	88	91	(85-97)

p = NS for all comparisons. Abbreviations as in Tables 1 and 3.

Table 6. Detection of Coronary Disease by Supine Bicycle Stress Echocardiography in Relation to Severity of Coronary Stenosis

% Stenosis	No. of Arteries	% Sensitivity	(95% CI)
50 to 70	77	81	(72-90)
71 to 89	45	85	(75-95)
90 to 100	137	91*	(86-96)

*$p < 0.05$ versus 50% to 70% stenosis. CI = confidence interval.

significantly higher for the left anterior descending artery and for vessels in patients with double- and triple-vessel disease than for vessels in those with single-vessel disease. There was a higher specificity for vessels in patients with single-vessel disease.

The diagnosis of coronary disease was based on severe abnormalities at rest (severe hypokinesia, akinesia or dyskinesia) alone without exercise-induced worsening of any segment in only 5% of the patients and 3% of the vessels. In the remaining patients and vessels, there was exercise-induced worsening of wall motion in some segments that were normal to moderately hypokinetic at rest even if there were areas of severe wall motion abnormality in the distribution of the same vessel. Akinetic segments did not change with exercise and were associated with normal coronary arteries in nine instances. Severely hypokinetic areas worsened with exercise in the distribution of seven arteries, all with significant disease.

Supine bicycle stress echocardiography was more sensitive for detection of coronary stenoses of 90% to 100% than for those of 50% to 70% (91% vs. 81%, $p < 0.05$), with no significant difference from the 71% to 89% stenosis range (Table 6). The technique's ability to correctly predict the exact number of diseased vessels is shown in Table 7. It was correct in 73% of patients and identified 88% of those with multivessel disease.

Discussion

This study demonstrates that supine bicycle stress echocardiography is a highly accurate technique for the evaluation of coronary artery disease, with excellent results in identifying patients with this condition and in assessing disease in specific coronary arteries.

Prior studies. Exercise stress echocardiography with digital acquisition has been performed almost exclusively after maximal treadmill exercise, with only one center publishing results obtained during upright bicycle exercise (3,8) and none utilizing supine bicycle exercise. Pharmacologic stress echocardiography has employed dobutamine (11-13), high dose dipyridamole (Persantine) (14,15) and adenosine (16). Review of the published reports (1,2,4-8,11-16) on coronary disease evaluation in groups of patients (Table 8) reveals widely varying results that undoubtedly reflect different types of patients, techniques and criteria for abnormality.

There are few data concerning the detection of disease in individual vessels by stress echocardiography (Table 9) and no data on such detection with peak exercise imaging.

Supine bicycle stress echocardiography. The present study utilizes a new technique for digital stress echocardiography with all imaging performed *during* peak exercise with use of a supine bicycle rather than imaging after treadmill exercise or obtaining some views during upright bicycle exercise. Imaging during peak ischemia would be expected to yield sensitivities better than or at least equal to those obtained while ischemia is progressively resolving after treadmill exercise. The results of this study confirm this expectation, especially for detection of disease in specific vessels. The sensitivities of 95%, 81% and 78% for the left anterior descending, the right coronary and the left circumflex coronary artery, respectively, are better than those noted with other techniques (Table 9) and are the first reported data on peak exercise evaluation of disease in specific coronary arteries. The ability of supine bicycle stress echocardiography to correctly predict 88% of patients with multivessel disease (Table 7) is directly related to its

Table 5. Detection of Disease in Specific Coronary Arteries by Supine Bicycle Stress Echocardiography

	No.	% Sensitivity	(95% CI)	% Specificity	(95% CI)	% Accuracy	(95% CI)
All vessels	540	87	(83-91)	89	(85-93)	88	(85-91)
LAD	180	95*	(91-99)	84	(76-92)	91	(87-96)
RCA	180	81	(72-90)	90	(84-96)	86	(81-91)
LCx	180	78	(68-88)	93	(88-98)	87	(82-92)
SVD	165	78	(67-89)	93†	(88-98)	88	(83-93)
DVD	126	90‡	(84-96)	77	(64-90)	86	(80-92)
TVD	120	89‡	(83-95)				

*$p < 0.001$ versus right (RCA) and left circumflex (LCx) coronary arteries. †$p < 0.001$ versus double-vessel disease (DVD). Abbreviations as in Tables 1 to 3.

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Table 7. Prediction of Number of Diseased Vessels by Supine Bicycle Stress Echocardiography

Correct Prediction	%
Total	73
Normal	86
Single-vessel disease	71
Double-vessel disease	67
Triple-vessel disease	70
Multivessel disease	88

ability to accurately identify disease in individual vessels and is higher than the 54% reported by Armstrong et al. (1) with posttreadmill imaging.

The increasing sensitivity of supine bicycle stress echocardiography with increasing degrees of coronary stenosis measured by magnified electronic calipers (10) (Table 6) extends the observations of Sheikh et al. (17) that demonstrated a relation between quantitative measurements of lesion severity and stress echocardiographic abnormalities.

The supine bicycle stress echocardiographic results for identification of patients with coronary artery disease are comparable or superior to those in posttreadmill and pharmacologic reports (Table 8) and similar to those of the only other center using peak imaging (8). With multivessel disease, there may be enough residual ischemia after exercise to allow for a high sensitivity for detection of coronary artery disease in patients even if individual vessel disease cannot be comprehensively detected. Thus, the posttreadmill sensitivities of 89% to 100% (1,4–7) for the detection of coronary artery disease in patients with multivessel disease are not substantially different from the 100% reported in this study. The posttreadmill sensitivities for detection of patients with single-vessel disease range from 58% to 92% (1,4–7). This broad range is difficult to explain; nonetheless, the 84% sensitivity in the present study is superior to that in all but one of the prior reports (5) and may represent the difference between peak and postexercise imaging. The superiority of supine bicycle stress echocardiography to the exercise ECG (Table 3) in both single and multivessel disease is consistent with prior reports (2–6) employing posttreadmill imaging.

The 86% specificity of the technique (Table 3) is comparable to that of most posttreadmill and pharmacologic results (Table 8). The expectation that artifacts induced by imaging during exercise might result in lower peak exercise specificity was not substantiated in our study.

Normalcy rates for patients with a low likelihood of coronary artery disease have frequently been substituted for specificity in reports (18–20) on myocardial perfusion imaging, which have often been plagued by poor specificity. The high specificity of supine bicycle stress echocardiography may not require the support of normalcy data, but its 100% normalcy rate is further evidence of the wide applicability of this technique and is similar to the 93% normalcy rate reported by Marwick et al. (6) with posttreadmill imaging.

Despite the generally superior sensitivity of supine bicycle stress echocardiography compared with that of postexercise imaging (Tables 8 and 9), the results of the present study do not prove the superiority of the supine bicycle technique because the same group of patients did not undergo both procedures. For the same reason, claims cannot be made for the superiority of dobutamine to postexercise stress echocardiography despite its apparently higher sensitivity (Tables 8 and 9). However, both supine bicycle and dobutamine stress echocardiography utilize imaging *during* peak ischemia, which very likely accounts for their high sensitivity. A direct comparison of peak and postexercise imaging is in progress at our laboratory.

Supine bicycle versus treadmill exercise. We (21) previously demonstrated that a higher maximal heart rate was achieved by treadmill compared with supine bicycle exercise. However, significantly higher systolic and diastolic blood pressures were achieved on the supine bicycle and the rate-pressure products were equivalent in the two approaches. In addition, the supine position is accompanied by increased venous return and consequent increased oxygen

Table 8. Digital Stress Echocardiographic Evaluation of Coronary Artery Disease in Groups of Patients

Study (first author)	Technique	No.	% Sensitivity	% Specificity
Armstrong (1)	Posttreadmill exercise	123	88	86
Ryan (2)	Posttreadmill exercise	64	78	100
Dohan (8)	Upright bicycle exercise	189	92	70
Pozzoli (4)	Postupright bicycle exercise	75	71	96
Crouse (5)	Posttreadmill exercise	228	97	64
Marwick (6)	Posttreadmill exercise	150	84	86
Quinones (7)	Posttreadmill exercise	112	74	76
Hecht (present study)	Supine bicycle exercise	220	93	86
Picano (14)	High dose dipyridamole	93	74	100
Mazeika (15)	High dose dipyridamole	55	60	93
Zoghbi (16)	Adenosine	73	85	92
Marcovitz (13)	Dobutamine	141	96	66
Mazeika (12)	Dobutamine	50	78	93
Segar (11)	Dobutamine	85	95	82

Table 9. Digital Stress Echocardiographic Evaluation of Coronary Artery Disease in Specific Coronary Arteries

		% Sensitivity			
Study (first author)	Technique	All Vessels	LAD	RCA	LCx
Armstrong (1)	Posttreadmill exercise	59	65	79	22
Pozzoli (4)	Postupright bicycle exercise	60	69	65	45
Segar (11)	Dobutamine	76	79	77	70
Zoghbi (16)	Adenosine	69	77	76	42
Hecht (present study)	Supine bicycle exercise	87	95	81	78

Abbreviations as in Table 1.

consumption. Thus, it is reasonable to conclude that supine bicycle exercise provides a physiologic stress at least equal to if not greater than that of treadmill exercise. The secondary importance of heart rate response in supine bicycle stress echocardiography is demonstrated by the similar sensitivities for detection of coronary artery disease in patients achieving ≥85% versus <85% of predicted maximal heart rate (96% vs. 91%, Table 4).

Criteria for abnormality. Published studies are replete with criteria for defining an abnormal stress echocardiogram. These criteria include failure to augment wall motion (either absolutely [5,6,11–13] or in comparison with other segments [7]), the development of a new or worsening wall motion abnormality (1–8,11–16) and rest wall motion abnormalities alone (1,3).

The choice of criteria should be influenced by the nature of the stress. Although it may be reasonable to expect wall motion augmentation in normal subjects after undergoing treadmill exercise without an excessive hypertensive response or during dobutamine infusion, it is far less reasonable to demand such augmentation during supine bicycle exercise, which is accompanied by greater extremes of preload and afterload as a result of the increased venous return and hypertensive response to this form of exercise. We, therefore, required exercise-induced worsening of wall motion of segments that were either normal or mildly to moderately hypokinetic at rest or the presence of segments that were severely hypokinetic, akinetic or dyskinetic at rest in which clearly detectable worsening would be difficult if not impossible to detect or interpret because of the severity of the baseline abnormality. Segments that were normal to moderately hypokinetic at rest that did not show increased motion were not considered diagnostic of coronary artery disease so long as worsening was not detected.

The criteria should also be sufficiently versatile to encompass the widest variety of clinical situations. In recent years, the clinical situations have expanded to include a dramatically increasing number of patients who have undergone revascularization, whether by angioplasty, thrombolysis or surgery, of areas that have experienced myocardial infarction. In the era before revascularization, severe wall motion abnormalities at rest, especially if localized, were considered pathognomonic for obstructive coronary artery disease, whether they represented scar or stunned or hibernating myocardium. However, after angioplasty or thrombolysis or bypass surgery to an infarcted area, it may be impossible to predict the presence or absence of coronary stenosis by means of a logical algorithm because the same observation (that is, severe wall motion abnormality at rest and during exercise) could be recorded irrespective of coronary patency. An akinetic area would be a false positive after thrombolysis without residual stenosis and a true positive if the vessel was occluded. However, mild to moderately hypokinetic areas after revascularization pose no particular problem because they may be expected to worsen with ischemia.

Because the stress echocardiogram is interpreted independent of clinical and angiographic information, the criteria for a wall motion abnormality must be sufficiently flexible and logical to accurately evaluate patients with and without revascularization procedures. The approach adopted in this study—requiring demonstration of ischemia when possible and yet accepting severe but not mild to moderate abnormalities at rest as evidence of coronary artery disease—has inevitable limitations as discussed but nonetheless results in excellent sensitivity and specificity. In the present study, the incidence of myocardial infarction was 21%, and in all cases was associated with severe wall motion abnormalities at rest. However, the diagnosis of coronary artery disease was based on severe wall motion abnormalities alone in only 5% of the study patients and 3% of vessels. In the remaining, there was exercise-induced worsening of wall motion in some segments that were normal to moderately hypokinetic at rest. Moreover, there was no difference in the ability of supine bicycle stress echocardiography in detecting coronary disease in those patients with and without prior myocardial infarction (97% vs. 91%, Table 5).

Limitations of the study. The cardiac catheterization group was a consecutive series of patients referred for evaluation of possible coronary artery disease who underwent supine bicycle stress echocardiography and coronary arteriography. Nonetheless, selection bias may be introduced by not performing cardiac catheterization on every patient evaluated by supine bicycle stress echocardiography. It is a bias shared by all but one prior stress echocardiographic study (6).

Imaging during peak exercise may require a greater degree of expertise by the sonographer than posttreadmill imaging and may limit the application of the technique. However, the diagnostic quality rate of 98% for supine bicycle stress echocardiography is similar to that reported for the posttreadmill technique. In fact, the absolute requirement for endocardial visualization under pressured conditions may be facilitated by the additional time provided by image acquisition during exercise as opposed to the hurried patient transport and more limited time window for image acquisition after exercise before the resolution of ischemia.

Conclusions. By virtue of its imaging capability during peak ischemia, supine bicycle stress echocardiography accurately identifies patients and specific vessels with coronary artery disease and provides a sensitive assessment of the extent and location of disease. It appears to be well suited both for application to the general group of patients with coronary artery disease and to the increasing number of patients who have undergone interventional therapy.

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