

Six-Year Experience With Graded Exercise Testing in a Model Family Practice Office

Dennis P. Zoller, MD, and Gerald E. Boyd, MD
Rockford, Illinois

The Office for Family Practice began in-office graded exercise testing utilizing the Bruce or Balke protocol in March of 1978. Over the past six years approximately 275 graded exercise tests have been done. The purpose of this paper is to outline the indications, results, complications, and follow-up of those patients who have had graded exercise testing done in the office over this six-year period. These results demonstrate (1) the various indications and utilization of a treadmill machine in the family practice office setting, (2) the results of graded exercise testing and complications in those graded exercise tests done in the office in comparison with those reported in the literature done by other health care providers, and (3) the usefulness and applicability of graded exercise testing in the residency training and private practice setting. In addition to the above-collected data, the results of a questionnaire sent to former residents show the benefits of having training in graded exercise testing and also the applicability of this training in their practice settings. The results support the concept that graded exercise testing should be taught in the residency program and that this can be done both safely and effectively in the model office setting.

Graded exercise testing has been utilized at least as early as 1928¹ and then further defined specifically for detection of coronary artery disease in 1941 by Master and Jaffe.² Refinements

were made in technique until the classic work of Bruce in 1956³ described the protocol that is currently most frequently used for conducting graded exercise testing.

In 1978 at the suggestion of one of the authors (G.E.B.), a treadmill machine was purchased for the residency program (1) to train residents in the office setting as to the indications and methods of graded exercise testing under family physician faculty supervision, and (2) to provide the necessary training to allow the residents to conduct their

From the Department of Family Medicine, University of Illinois College of Medicine at Rockford, Rockford, Illinois. Requests for reprints should be addressed to Dr. Dennis P. Zoller, Office for Family Practice, The University of Illinois, 1601 Parkview Ave., Rockford, IL 61107-1985.

Table 1. Profile for 275 Patients Undergoing Graded Exercise Testing

Patients	Number	Per-centage
Male	201	73.1
Female	74	26.9
Age range (years)	26-80	
Average age, male	47.8	
Average age, female	50.3	
Indications		
Chest pain		62.9
Other pain		9.0
Known coronary artery disease		9.9
Shortness of breath		6.2
Arrhythmia		4.7
Other		7.3
Positive studies	62	22.5
Negative studies	208	75.6
Equivocal results	5	1.8

own graded exercise testing after they have finished their training program in family medicine. To date 60 family practice residents have been trained in graded exercise testing.

Methods

To ascertain the number of graded exercise tests conducted from March 1, 1978, through February 29, 1984, records of all 275 patients who were tested in that period of time were reviewed. All patients were exercised on a Burdick TMS 300 (The Burdick Corporation, Madison, Wisconsin) utilizing the Blake et al⁴ or Bruce protocol.⁵ The charts were reviewed to determine the outcome of graded exercise tests and to record the variables listed in Table 1. A subset of charts of this group of 275 patients, those with positive tests, were also reviewed, and again several variables were noted and comparisons made (Table 2).

The third area evaluated in this study was negative examinations. Negative examinations ac-

counted for 208 tests (75.64 percent). The results of the false-negative tests and variables evaluated are displayed in Table 3.

The fourth area evaluated was a questionnaire that was sent out to the 60 residents who finished the program (from June 1979 to July 1983) and who had graded exercise testing available during their residency program. The purpose was to evaluate the usefulness of this training to their practice.

Results

Of the total 275 patients, the majority of patients (73.09 percent) were male with an average age of 47.8 years. The most common indication was chest pain (62.0 percent). There were 62 positive graded exercise tests (a positive test was defined as 1 mm of ST segment depression persisting greater than 0.08 seconds). Of those patients with a positive test, the average length of time of follow-up from the time the test was done until the patient left the practice or had no further follow-up visits was 2.3 years (range one month to six years). Nine patients had repeat graded exercise testing. Through the use of radionuclide exercise testing or angiography, five patients were found to have false-positive tests, which accounted for 8.0 percent (three had angiography and two had radionuclide testing).

There were a total of 12 patients who had no further cardiac evaluation after the positive test. Three of these patients had graded exercise testing as part of the State of Illinois Department of Disability Evaluation and had no follow-up after the test was performed. Of the nine patients who had no further testing or cardiology evaluation, all nine were treated with antianginal medications. The average time of follow-up for these nine patients was two years. None of these patients had had any acute ischemic events during their follow-up.

The negative studies revealed a false-negative rate of 12.5 percent, which is less than what would be predicted in review of the cardiology literature where a 30 percent false-negative rate would be expected in the presence of single-vessel disease.⁶⁻⁹ In this study, however, the lower per-

Table 2. Positive Graded Exercise Tests

	Number	Percentage
False-positive tests (confirmed)	5	8.0
Average years of follow-up	2.3	
Complications		
Myocardial infarction	2	3.0
Patients with further evaluation (including cardiology consult or radionuclide scan or angiogram)	50	83.4

centage probably represents some patients who were lost to long-term follow-up. It was interesting to note that for all 26 patients who had had false-negative studies, the test was done for evaluation of chest pain. Also, 85 percent of the patients who had false-negative studies were male and only 15 percent were female. The average years of follow-up were 2.9 years, which was similar to that for the positive results (2.3 years). All 26 patients were confirmed to have coronary artery disease either with angiography or radionuclide study.

There were only two complications during the six-year study period. Two patients had persistent electrocardiogram changes after the graded exercise testing, indicating injury. Both patients were hospitalized directly from the office. Both patients received angiography, one patient had emergency bypass surgery done with a good outcome, the second patient developed Q waves suggesting myocardial infarction and was treated with medication.

Of the 60 questionnaires sent to former residents, 47 were returned for a response rate of 79.6 percent. Eight of the 47 former residents were doing graded exercise testing in their office and 12 were doing graded exercise testing in the hospital for a total of 20 residents currently utilizing graded exercise testing actively in their practice (42.5 percent). Of the 27 respondents who were not doing graded exercise testing, 19 indicated that they

Table 3. False-Negative Graded Exercise Tests

	Number	Percentage
False-negative tests (confirmed)	26	12.5
Average years of follow-up	2.9	
Indications		
Chest pain	26	100
Male	22	85.0
Female	4	15.0

chose not to with no further explanation, 4 were not doing it because they had no equipment available, and 4 were unable to obtain hospital privileges. Of the 47 returned questionnaires, 45 indicated they felt training in graded exercise testing was beneficial during their residency program, and 2 indicated they found it of no benefit.

Discussion

In reviewing the literature, very little has actually been written on the role of the family physician doing graded exercise testing.^{5,10} Certainly electrocardiography is taught as part of the core curriculum in family practice residency programs, as is the care for patients with coronary artery disease. However, the diagnosis of coronary artery disease as a primary function of the family physician has not been addressed in detail. One of the purposes of this study was to look at a relatively long-term experience of one residency program utilizing graded exercise testing in an office setting under the supervision of family medicine faculty.

The actual outcome is very consistent with what has been reported in the cardiology literature. A false-positive rate of 9.3 percent was found, which compares with the 10 percent false-positive rate as predicted in the cardiology literature.⁶⁻⁹ There were no significant arrhythmias in this study.¹¹ According to Bruce, in approx-

imately one of 5,000 cases there would be a sudden death from ventricular fibrillation.¹² Two patients sustained myocardial injury during graded exercise testing, both of whom had documented severe coronary artery disease, which was recognized during the testing. Appropriate equipment, including cardiac drugs and a defibrillator, was on hand to deal with arrhythmias should patients develop acute infarction.

The false-negative results were somewhat less than the nationwide average as reported in the cardiology literature, but this lower average probably reflects the unavailability of long-term follow-up for a large percentage of the patients who had negative studies.

The results of the usefulness of graded exercise testing in the family practice office, based on questionnaires from previous residents who had been trained in its use, were encouraging in that 42 percent of those residents who answered the questionnaire were currently utilizing graded exercise testing in their private practice settings. The overwhelming positive response indicates that

the efforts to provide graded exercise testing to the residents has been beneficial.

How to continue teaching and certifying family practice residents in graded exercise testing remains questionable, as there were four residents who were not able to obtain privileges in their hospital. Currently the residency program is developing criteria to demonstrate proficiency in conducting graded exercise testing.

Conclusion

In summary, graded exercise testing is useful as a primary diagnostic tool for the family physician, graded exercise testing can be done safely and accurately by trained family physicians, and graded exercise testing appears to be beneficial to family practice residents not only for disease diagnosis but for fitness testing and precardiac rehabilitation.

References

1. Feil H, Siegel M: Electrocardiographic changes during attacks of angina pectoris. *Am J Med Sci* 1928; 175:255-260
2. Master AM, Jaffe HL: The electrocardiographic changes after exercise in angina pectoris. *J Mt Sinai Hosp* 1941; 7:629-632
3. Bruce RA: Evaluation of functional capacity and exercise tolerance of cardiac patients. *Mod Concept Cardiovasc Dis* 1956; 25:321-326
4. Blake TM, Lehan PH, Bennett KR: Exercise tests and coronary artery disease. *South Med J* 1972; 65:769-770
5. Mead WF: Maximal exercise testing—Bruce protocol. *J Fam Pract* 1979; 9:479-490
6. Frank WE: Walking the treadmill to test myocardial ischemia. *Today's Clinician* 1978; 2(9):32-33
7. Rozanski A, Diamond GA: Cardiac stress testing: Who should have it? *J Cardiovasc Med* 1984; 9:293-302
8. Goldschlager N, Selzer A, Cohn K: Treadmill stress tests as indicators of presence and severity of coronary artery disease. *Ann Intern Med* 1976; 85:277-286
9. McNeer JF, Margolis JR, Lee KL, et al: The role of the exercise test in the evaluation of patients for ischemic heart disease. *Circulation* 1978; 57:64-70
10. Eberly Jr AL: Exercise testing in family practice. *J Fla Med Assoc* 1980; 67:845-847
11. Detry JM, Abouantoun S, Wyns W: Incidence and prognostic implications of severe ventricular arrhythmias during maximal exercise testing. *Cardiology* 1981; 68 (suppl 2):35-43
12. Bruce RA: Principles of exercise testing. In Naughton J, Hellerstein HK (eds): *Exercise Testing and Exercise Training in Coronary Heart Disease*. London, Academic Press, 1973, pp 45-61