

# Cost Effective Modification of a Supine Exercise Bicycle for Arm Ergometry

Charles E. McCarthy, Gary J. Balady, and Allan M. Green

*Boston University Medical Center, Boston, Massachusetts*

*A quick, cost-effective modification of a supine bicycle table that enables patients to exercise with their upper extremities is described. This modification makes available thallium exercise scintigraphy to the patient population that is unable to perform conventional treadmill or bicycle exercise. Replacement of the bicycle footpedals with hand grips is both inexpensive and easily accomplished. Arm ergometry has been well received by patients, and good quality thallium images have been obtained without significant chest muscle artifact.*

Thallium exercise scintigraphy is a well established indicator of coronary artery disease (1). An analysis of our patients with chest pain in whom thallium exercise testing can be of value in the detection of coronary artery disease revealed that ~ 80% of our patient population who require diagnostic exercise testing are able to exercise using the conventional treadmill or bicycle. Combined with thallium scintigraphy this method yields consistently high sensitivity and specificity in detecting the presence of coronary artery disease. However, the remaining 20% of patients were unable to perform on the treadmill or bicycle because of lower extremity impairment. Among these were patients with:

1. Peripheral vascular disease resulting in intermittent claudication—characterized by the initiation and intensification of calf pain and leg weakness while walking.
2. Orthopedic problems—including hip, knee, and ankle joint disease, amputations, and congenital deformities.
3. Neurologic factors (e.g., chronic lower back pain, sensory impairment resulting in instability when exercising in an upright position, and paraplegia caused by previous stroke or trauma).

Arm ergometry alone is limited in its sensitivity to detect coronary artery disease (2). We have found however, that arm ergometry, when coupled with  $^{201}\text{Tl}$  scintigraphy is a valuable and reliable alternative method of detecting myocardial ischemia (3). It is easily performed and well tolerated by patients. The procedure can be closely monitored and quickly terminated if necessary. Arm ergometry approximates the important

information obtained during a conventional treadmill stress test yielding an assessment of the hemodynamic response to exercise.

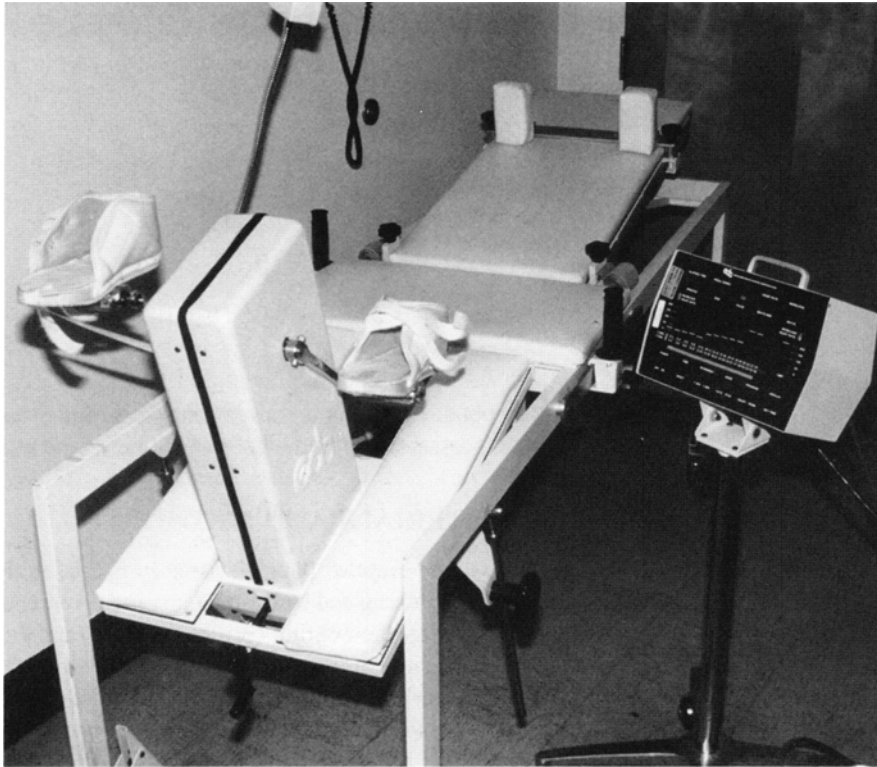
## MATERIALS AND METHODS

A supine exercise bicycle\* in our laboratory is used in the performance of exercise gated blood-pool imaging. A method was sought to modify the existing bicycle for arm ergometry without compromising this need. The supine bicycle consists of two components (Fig. 1). The electronics are contained in a stand-alone console allowing for maximum control of workload and staging with lighted displays of elapsed time, heart rate, and workload. The bicycle itself contains a series of mechanical adjustments to allow for proper positioning which will accommodate the majority of patients. The pedal assemblies incorporate standard bicycle parts which facilitate the modification.

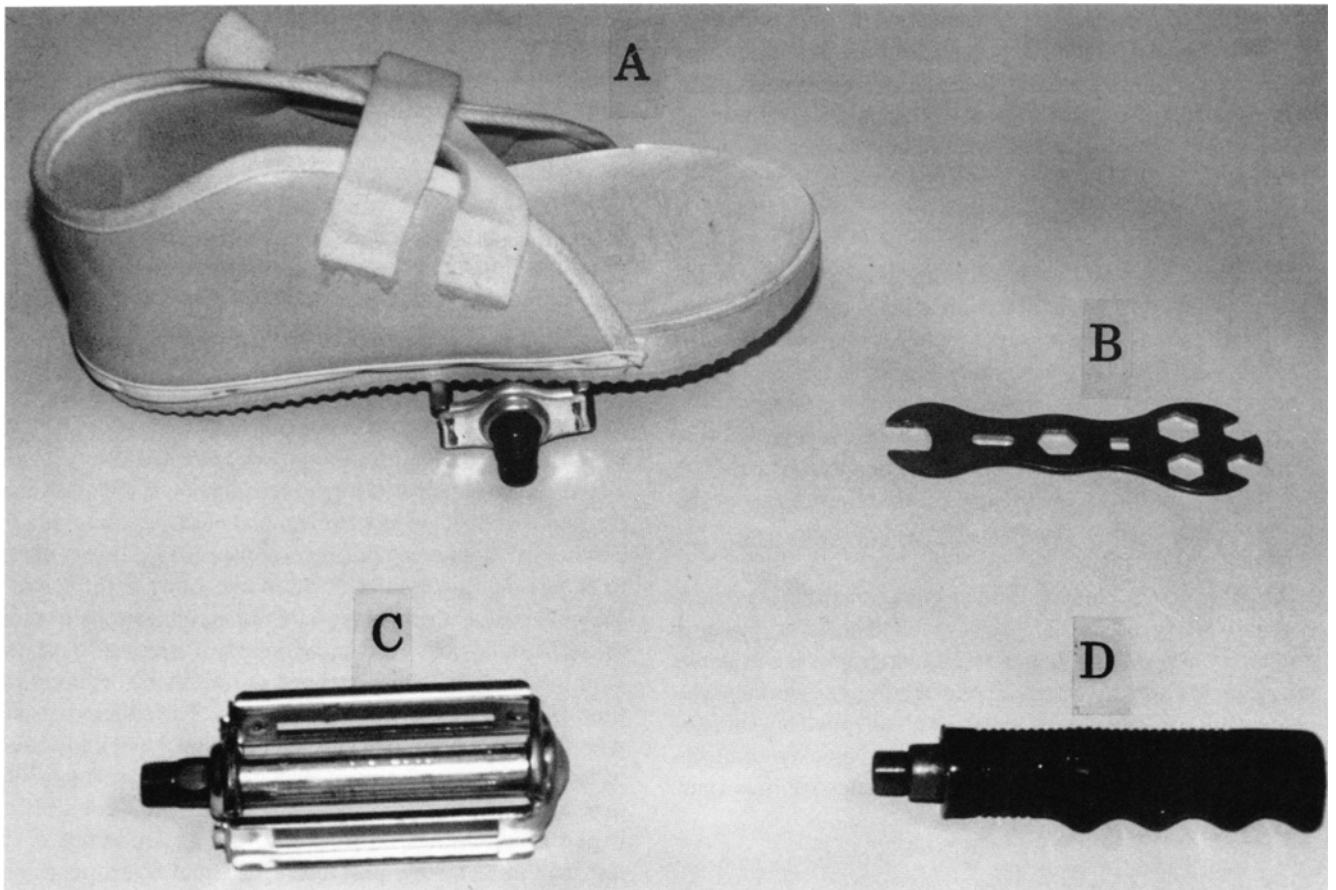
An ordinary bicycle wrench was used to remove the existing foot pedals. Identical pedals were purchased from a local bicycle shop along with a pair of rubber handgrips (Fig. 2). The total cost was less than \$15.00. The footrest sections of the pedals were removed with a hacksaw leaving only the shaft. It is important to remember to leave the inner portion of the pedal intact to allow rotation of the handgrips while exercising. The rubber handgrips were force-fit over the remaining structures to provide a comfortable and safe grip. The new handgrip units were then reattached to the bicycle with the wrench. Care must be taken to prevent stripping the threads as one of the pedals contains a reverse thread to eliminate the possibility of the unit loosening while in use.

The patient is prepared for the examination in the usual manner and is connected to a twelve-lead electrocardiograph for continuous monitoring during exercise. An i.v. line is started to enable the injection of  $^{201}\text{Tl}$ . While veins in the forearm are preferred as the primary site, no complications in using the antecubital vein were encountered. If necessary, the arm with the i.v. line can be dropped during the short period of time required for the thallium injection. The patient is seated with the feet flat on the floor, and the pedal assembly is adjusted to allow the fulcrum of the handles of the arm ergometer to be at shoulder height (Fig. 3). A electrocardiogram (ECG) is performed initially at rest, once during each stage of the test, and immediately post test. Heart rate is also measured at rest, at the end of each stage, and immediately after exercise. Blood pressure is recorded before and immediately after

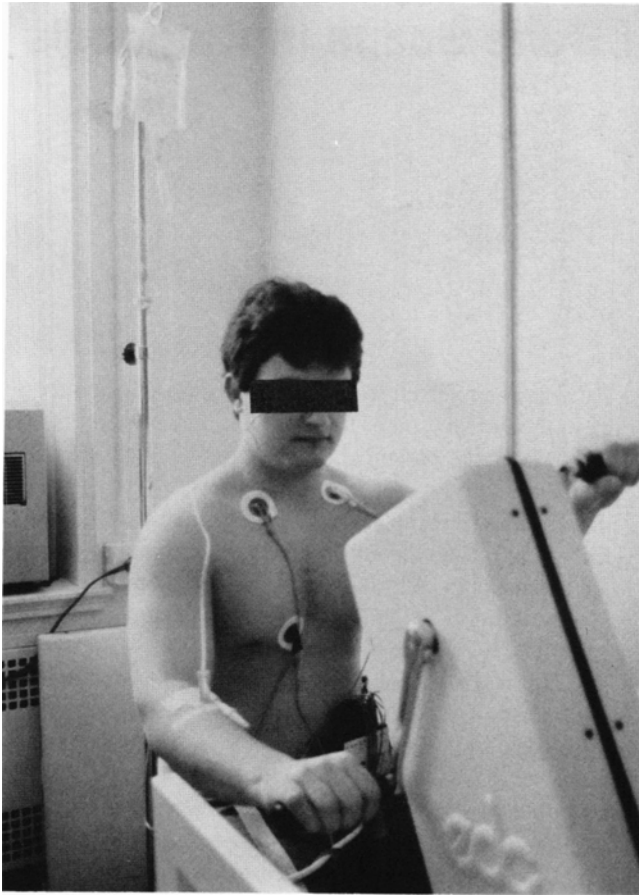
For reprints contact: Charles E. McCarthy, Nuclear Medicine Section, University Hospital, 75 East Newton St., Boston, MA 02118.



**FIG. 1.** Supine exercise bicycle system prior to modification.



**FIG. 2.** (A) existing foot pedal with patient boot; (B) bicycle wrench; (C) unmodified foot pedal; (D) modified foot pedal with handgrips attached.



**FIG. 3.** Initial patient preparation to demonstrate pedal height adjustment, ECG electrode placement, and i.v. line setup.

exercise and, while not routinely taken during exercise, is immediately available. The patient begins exercising at a workload of 10 watts and continues at increments of 10 watts every 2 min while maintaining a pedal speed of 75–80 rpm. At 1

min prior to the termination of exercise, 2 mCi of  $^{201}\text{Tl}$  is injected intravenously. The patient is monitored for ECG changes for 3 min immediately after exercise and is then placed under the scintillation camera for routine thallium scanning. Eight-minute scintiphotos are obtained in the anterior, 45° left anterior oblique (LAO), and 70° LAO projections immediately after exercise and again 3 hr later.

## RESULTS AND DISCUSSION

Good quality  $^{201}\text{Tl}$  scans have been obtained in over 50 patients performing arm ergometry using graded increments of resistance. Our images thus far have not demonstrated any significant chest muscle artifact.

The conversion of the supine bicycle to provide a method of arm ergometry for thallium stress scintigraphy is an inexpensive and easily accomplished modification. It makes available a valuable diagnostic service to a patient population who otherwise would not have been studied. In the present climate of budgetary constraints, this modification for a minimal capital outlay, can maximize the economic productivity of a specialized piece of medical equipment.

## FOOTNOTE

\*Model 8450, Engineering Dynamics Corp. (EDC), Lowell, MA 01851.

## REFERENCES

1. McGowan RL, Martin ND, Zaret BL, et al. Diagnostic accuracy of noninvasive myocardial imaging for coronary artery disease: An electrocardiographic and angiographic correlation. *Am J Cardiol* 1977;40:6–10.
2. Balady GJ, Weiner DA, McCabe C, et al. Value of arm exercise testing in detecting coronary artery disease. *Am J Cardiol* 1985;55:37–39.
3. Balady GJ, Weiner DA, Rothendler JA, et al. Arm exercise thallium testing: A reliable method for detecting coronary artery disease (abstract). *J Am Coll Cardiol* 1986;7:232.