# Home-Based Cardiac Rehabilitation in a Young Athletic Woman Following Spontaneous Coronary Artery Dissection

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## ABSTRACT

Spontaneous coronary artery dissection is a cause of myocardial infarction in young apparently healthy individuals. While most cardiac rehabilitation programs are fully capable of caring for these individuals in a supervised setting, their young age and often very physically fit condition can necessitate a different set of issues for their care versus the care for a more traditional patient. This case study describes a young, physically fit woman diagnosed with spontaneous coronary artery dissection who underwent a home-based cardiac rehabilitation program administered by a clinical exercise physiologist. *Journal of Clinical Exercise Physiology*. 2016;5(1):6–11.


**Keywords:** women, acute coronary syndrome, myocardial infarction

## INTRODUCTION

Spontaneous coronary artery dissection (SCAD) is a cause of myocardial infarction (MI) in young (25-55 y), apparently healthy individuals. Although previously observed to be a rare occurrence, the amount of patients experiencing SCAD and cared for in cardiac rehabilitation (CR) seems to be increasing. This is possibly due to heightened awareness and improved diagnostic techniques. While most CR programs and traditional exercise prescription methods for a patient with recent MI may be appropriate for those with SCAD, a younger and more physically active population can present a challenge for clinical exercise physiologists. Challenging patients within this group include those with a recent history of vigorous physical activity or those who have jobs that require high levels of physical activity. We present a case in which the woman affected by SCAD was much more fit than a typical patient participating in CR following an MI. Thus, in this case the protocols and methods currently recommended for prescribing exercise training in older or sedentary individuals may not be applicable.

## BACKGROUND

The patient was a 39 year-old woman with no significant past medical history. She worked as a personal trainer and typically exercised most days of the week. She performed intense resistance training exercise sessions, ran on a regular basis, and participated in various types of recreational activities with no limitations or concerning symptoms. During a run in June 2014, she noticed an isolated ache in both arms that resolved after stopping. Later that same day, while working at a computer, she felt chest tightness that radiated down both arms, along with dyspnea and diaphoresis. Antacids minimally improved the pain, which resolved spontaneously after 90 min. Due to these symptoms, she presented to the hospital emergency department, at which time she was symptom free. Although her electrocardiogram (ECG) was clinically normal (ie, sinus rhythm without evidence of ischemia or infarction), her serial troponin I levels were elevated at 0.13 ng•mL$^{-1}$ and 0.92 ng•mL$^{-1}$ (normal ≤ 0.04 ng•mL$^{-1}$) at immediate hospitalization and 30 min later, respectively. She had no known medical problems, did not use tobacco or

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TABLE 1. Exercise test results.

| | July | September | December |
|---|---|---|---|
| Protocol | Submaximal treadmill-customized ramp | Submaximal treadmill-customized ramp | Maximal treadmill-customized ramp |
| Duration (min:s) | 9:29 | 10:30 | 13:35 |
| Peak work capacity | 36 mL·kg$^{-1}$·min$^{-1}$ (107% of age-predicted) | 11.4 METs | 13.3 METs |
| Peak RER | 1.04 | NA | NA |
| HR response (beats·min$^{-1}$) | Rest = 66 | Rest = 68 | Rest = 67 |
| | Peak = 151 (83% APMHR) | Peak = 162 (90% APMHR) | Peak = 181 (100% APMHR) |
| BP response (mmHg) | Rest = 120/82 | Rest = 108/70 | Rest = 92/66 |
| | Peak = 166/60 | Peak = 142/70 | Peak = 158/70 |
| Peak RPE | 6/10 Borg Scale | 8-9/10 Borg Scale | 9-10/10 Borg Scale |
| Symptoms | None | None | None |
| ST-segment changes | None | None | None |
| Arrhythmia | None | None | None |

APMHR = age-predicted maximum heart rate; BP = blood pressure; HR = heart rate; METs = metabolic equivalents of task; NA = not applicable; RER = respiratory exchange ratio; RPE = rating of perceived exertion.

over-the-counter/illicit drugs, and had no family history of heart disease. She denied recent exercise intolerance, travel, or leg swelling/pain. However, she did report recently experiencing a significant level of emotional stress.

At the cardiology consultation a coronary angiography was ordered that disclosed a spontaneous left anterior coronary artery dissection without evidence of atherosclerosis. An incidental finding was a very small right to left shunt due to a patent foramen ovale. Given the absence of ongoing symptoms and the presence of normal coronary blood flow, the patient was treated with medical management. An echocardiogram performed during her hospitalization showed normal systolic function with a left ventricular ejection fraction of 55% to 65% along with akinesis of the apical septal wall. Her troponin I peaked at 2.07 ng•mL$^{-1}$ at 16 h after admission. Her medical management included 81 mg aspirin daily, 6.25 mg metoprolol tartrate twice daily, 40 mg atorvastatin daily, and avoidance of physical exertion for 30 d.

Her follow-up plan included an echocardiogram about 3 wk after discharge and a submaximal exercise test soon afterward. The echocardiogram revealed that her overall ejection fraction remained unchanged (55-65%). In the 4- and 2-chamber views, the distal septum motion was mildly improved without akinesis in the distal septum. The precautions of avoiding physical exertion and submaximal exercise testing were advised at the discretion of her cardiologist as there are no specific guidelines for a patient with SCAD after a cardiac event.

An initial exercise consultation and cardiopulmonary exercise (CPX) test were performed to determine if a traditional monitored exercise program or home-based exercise program would be best for the patient's individual needs. Submaximal testing was conducted at the request of her cardiologist. Testing was performed on all prescribed medications. She had a normal CPX test with above average submaximal exercise tolerance for her age (Table 1, July column). A home-based program was recommended. This decision was made based upon her desire, her prior consistent vigorous exercise regimen, her return to light to moderate exercise efforts on her own with no concerning symptoms, and her improved echocardiogram and favorable outcomes from the exercise test.

Subsequent exercise consultations and exercise testing in September and December 2014 were completed using ECG treadmill testing with no CPX test (Table 1). The September evaluation was again submaximal at the request of the patient's cardiologist, but the December was maximal, symptom-limited testing. She had progressed nicely over the 6 mo and had no concerning issues.

Initially, the patient was advised to exercise using any mode of aerobic exercise preferred and to incorporate longer warm-up periods than typical. The subjective exercise prescription was devised using a rating of perceived exertion (RPE) of 3-5 based on a 0- to 10-point scale. She had traditionally based her exercise intensity on heart rate and expressed a desire to continue to do so. Since her exercise test was performed while on her prescribed dose of metoprolol, an initial upper limit of 140 beats•min$^{-1}$ was advised (Table 2), which corresponded to a perceived exertion of ~5/10. This was followed by a discussion that since she was taking a beta-blocking agent her heart rate may vary depending on time of day and time since she had taken her beta-blocker medication. She was advised to increase exercise time by 5-min intervals every 1 to 2 wk as long as she was able to stay within the prescribed intensity range. She was also approved to return to light strengthening exercise but to avoid jogging/running.

Over the next several months the patient performed aerobic exercise 5 or more d•wk$^{-1}$. She progressed on the

TABLE 2. Exercise prescription.

| | July | September | December |
|---|---|---|---|
| **Aerobic** | | | |
| Frequency | 5-7 d•wk$^{-1}$ | 5-7 d•wk$^{-1}$ | 5-7 d•wk$^{-1}$ |
| Intensity | 3-5/10 Borg scale | 3-5/10 Borg scale | 6-7/10 Borg scale |
| | HR <140 beats•min$^{-1}$ | HR <150 beats•min$^{-1}$ | HR <165 beats•min$^{-1}$ |
| Duration | Up to 30 min | Up to 60 min | Not limited |
| Comments | Stop if any symptoms | Can jog 1-2 d•wk$^{-1}$ for 1 min (1:1 work:rest) for 3-4 wk; then 2:1 for 3-4 wk; then 3:1 | Avoid training/racing for marathon distances |
| **Resistance** | | | |
| Frequency | 3-7 d•wk$^{-1}$ | 3-7 d•wk$^{-1}$ | 3-7 d•wk$^{-1}$ |
| Intensity | Light effort | Moderate effort | Moderate/vigorous effort |
| Duration | 1-3 sets; 12-15 repetitions | 1-3 sets; 10 or more repetitions | Not limited; appropriate to her personal goals |
| Comments | Avoid struggling, straining, and Valsalva | Continue to avoid struggling, straining, and Valsalva; could perform daily if split routine | Continue to avoid struggling, straining, and Valsalva; could perform daily if split routine; suggested perform more comprehensive warm-ups before such activities as plyometric movements |

HR = heart rate.

elliptical trainer from 30 to 45 min and began to add time on the treadmill. Generally, her heart rate was in the 120 to 130 beats•min$^{-1}$ range and if it started to rise beyond that she slowed her pace. She also began to add active transportation by riding her bike to and from work, performing some recreational biking and hiking with her children, and horseback riding. All were performed at a moderate effort level that was below her intentional training effort.

The patient's strength training consisted of 2 sets of each exercise in the 12-15 repetition range and following precautions 3 or more d•wk$^{-1}$. Avoidance of the Valsalva maneuver was recommended since SCAD has been associated with extreme physical exertion. She performed a variety of free weight, body weight, and strengthening exercises. Overall, she reported feeling good without concerning symptoms with any of her exercise and physical activities.

In August 2014, she followed up with her cardiologist and remained asymptomatic and without concerns. She was instructed to continue with aspirin (81 mg) and beta blocker (metoprolol, 6.25 mg twice per day), and advised to stop taking the statin medication. She was instructed to have an echocardiogram and symptom-limited exercise test in December at 6 mo after hospitalization.

In September 2014, the patient was told that she could add intervals to her cardiovascular exercise routine that feel "hard" to her, could start some light jogging, and could continue to increase the intensity of her strength training (Table 2). She independently decided to accelerate the suggested time table for running and was able to stay within her suggested heart rate and subjective exercise intensity guidelines.

Leading up to December 2014, when her cardiologist wanted to have her perform a symptom-limited maximal effort exercise test, she was finding it more difficult to keep her heart rate under the suggested 150 beats•min$^{-1}$ upper limit. At that time she was running a few times per week along with some other aerobic exercise (elliptical or bike) and averaging 5 d•wk$^{-1}$. Indoor aerobic exercise was performed for 30-45 min per session. She ran on the treadmill most sessions at a 6 mph (9.7 kph) pace. If her HR approached 150 beats•min$^{-1}$, she would walk for 1 to 2 min. If she ran outside she would slow down or walk as needed to keep within the prescribed HR range. Her strengthening exercises consisted of 15-25 min of weight lifting (2 d•wk$^{-1}$, one day upper body, one day lower), 2 sets of 10-12 reps, still avoiding Valsalva. Recreation included 1 to 2 d•wk$^{-1}$ running with her horse on a lead rope.

As the results of the patient's December 2014 echocardiogram (normal systolic and diastolic function, ejection fraction of 55% to 65%, no wall motion abnormalities, and normal cardiac valves) and exercise testing were favorable and she had been free of any concerning symptoms, she was again encouraged to continue to increase her exercise intensity for both her cardiovascular and strength training regimens (Table 2).

The patient followed up with her cardiologist in January 2015 and continued to do well with no specific concerns. The physician reviewed all tests, lab results, and medications. It was decided that she would continue with 6.25 mg metoprolol twice daily, discontinue aspirin due to gastrointestinal upset, continue with a regular physical activity and exercise routine, and return in 1 y for continued follow-up.

In February 2015, the patient was running 3-5 miles 3 d•wk$^{-1}$ along with some other aerobic exercise, including the elliptical for 30 to 45 min and/or spin cycle for 45 min 1 d•wk$^{-1}$. When she did cycling intervals her HR was ~140 beats•min$^{-1}$ early in the workout session and increased to 150-155 beats•min$^{-1}$ by the end of the session. She performed her interval sessions about 2-3 h after she took metoprolol. During runs her HR would stay at ~155 beats•min$^{-1}$, and she would focus her running on feeling good and trying not to push hard. Her strengthening exercises consisted of any desired mode (free weights, machines, body weight, etc) for 15-20 min, 2-3 d•wk$^{-1}$, staying in the 8-12 repetition range. Recreation included riding her horse 1 or 2 d•wk$^{-1}$. She also went skiing with her family without any issues at the higher altitudes (>10,000 ft; 3,048 m) of the Colorado Rocky Mountains.

## DISCUSSION

### Epidemiology

SCAD is an uncommon and challenging cause of acute coronary syndrome (8). SCAD is defined as a sudden separation between the layers of a coronary artery wall that creates an intimal tear (or "flap") or intramural hematoma obstructing blood flow. Although coronary artery disease can serve as a potential origin for dissection (1), SCAD can occur in the absence of coronary artery disease.

Initially, the diagnosis of SCAD was based upon autopsy alone, and the first reported case study from 1931 described coronary dissection and rupture on the autopsy of a young woman with sudden death (14). In the 1980s, advances in coronary artery angiography allowed SCAD to be diagnosed without autopsy (12), and recent innovations in intravascular imaging have improved the ability to recognize SCAD (8). Patients with SCAD are typically young women without traditional risk factors for atherosclerosis. The typical age range is 42 to 52 y, and reported cases have ranged from 14 y to well into the 7th decade. Approximately 80% of SCAD patients are female, and 18% to 25% of cases occur when the patient is in the peripartum period (8). SCAD has been found to be the cause of up to 40% of heart attacks in women under the age of 50 y (7). A retrospective single-center report by Tweet et al (21) identified 87 patients with angiographically confirmed SCAD. Incidence, clinical characteristics, treatment modalities, in-hospital outcomes, and long-term risk of SCAD recurrence or major adverse cardiac events were evaluated. Mean age of the subjects was 43 y, and 82% were female. Extreme exertion at SCAD onset was more frequent in men (7 of 16 versus 2 of 71; $P < .001$), and postpartum status was observed in 13 of 71 women (18%). Presentation was ST-elevation MI in 49%. Multivessel SCAD was noted in 23% (21).

### Patient Factors/Etiology

The etiology of SCAD remains unknown and is considered to be multifactorial. In addition to the pregnant or postpartum state, potential contributing factors to SCAD include fibromuscular dysplasia, connective tissue diseases, coronary spasm, vasculitis, and cocaine use (10,17). Rigorous exercise (eg, heavy weight-lifting session) has also been described as a potential trigger for SCAD (5), which causes concern when determining appropriate exercise recommendations in CR, particularly among previously active patients.

### Diagnosis and Clinical Manifestations

Patients with nonatherosclerotic SCAD usually present with signs and symptoms characteristic of an acute MI. Chest or shoulder pain, syncope, dyspnea, diaphoresis, and nausea are common presenting symptoms (13,21). The diagnosis of SCAD is usually made during coronary angiography. The angiographic pattern can vary from long multiple dissections to a single short dissection. A discrete flap or false lumen is not always apparent on angiography, and therefore the diagnosis may be missed. Saw et al (15) proposed an angiographic classification of SCAD describing 3 possible presentations: type 1 with arterial wall strain; type 2 with diffuse stenosis of varying severity; and type 3, which mimics atherosclerosis. Invasive coronary imaging, such as optical coherence tomography or intravascular ultrasound, can be used to diagnose SCAD when it is not apparent on angiography and can also prove valuable in determining the magnitude and type of dissection (6). The left anterior descending coronary artery represents the most frequent site of SCAD for both sexes, and the mid segment appears the most commonly involved vessel (6). Eleid et al (4) posited that features of coronary tortuosity are more frequent among SCAD patients compared with matched controls, and the presence of severe tortuosity is associated with recurrent SCAD.

### Treatment

Although long-term survival after SCAD is better than in patients with atherosclerotic acute coronary syndrome, 10-y recurrence rates are as high as 29% (8,21). Accurate recognition of acute coronary syndrome due to SCAD is crucial because the recommended approaches to management are different. Importantly, technical success rates of percutaneous coronary interventions are markedly reduced compared with success rates for acute coronary syndrome (62% versus 92%). Even in a group of young women with SCAD during pregnancy or the postpartum period, dissection propagation after a percutaneous coronary revascularization requiring additional stenting occurs in up to 50% of patients (9). The substantial rate of spontaneous vascular healing (2,21) suggests a role for conservative management in stable patients with SCAD who have preserved coronary flow (20). Therefore, current recommendations are to revascularize acute SCAD if the patient has hemodynamic instability or poor coronary blood flow and to medically treat acute SCAD if the patient is stable and has normal, or near normal, coronary blood flow (18).

Data regarding medical management are limited, so strategies are currently similar to those for patients with atherosclerotic disease. However, important distinctions are that statins may not be indicated long term for patients without hyperlipidemia, and until more is known, in the absence of percutaneous interventions baby aspirin is considered sufficient for antiplatelet therapy (19).

## Clinical Exercise Implications

There is little to no mention in the current SCAD literature regarding how to best approach exercise stress testing for prognostic or exercise prescription purposes. The Guidelines for Exercise Testing and Prescription from the American College of Sports Medicine suggest that clinical exercise testing can be performed submaximally either before or 4 to 6 d after discharge for an MI. Recommendations for SCAD do not exist and there is no specific definition of what is considered a submaximal effort. Symptom-limited testing is suggested as safe at 14-21 d after discharge from the hospital (3). Therefore, optimal timing for any exercise testing must rely on clinical judgment. If submaximal efforts are performed for the sake of exercise prescription, then routine ECG/exercise only or use of CPX testing to define anaerobic threshold may be appropriate.

## Cardiac Rehabilitation

CR is suggested for patients with SCAD. Silber et al (16) recently studied 9 patients with SCAD who started CR an average of 12 d after discharge. They underwent either a 6-min walk test or maximal CPX testing at the start of the program. A typical exercise prescription for patients with MI was used that also incorporated high-intensity interval training (perceived exertion = 15-17/20) along with usual aerobic and strength training routines over the course of 28 monitored CR sessions. Results demonstrated safety and effectiveness with improvements of 18% for peak $\dot{V}o_2$ and 22% in 6-min walk distance (16).

Despite the known benefit of CR among patients with a history of MI, not all patients with SCAD are initially referred to CR. This is perhaps due to such factors as female sex, youth, overall good health, or fear of recurrent SCAD (8). If recent extreme physical activity is associated with a SCAD event, some health care providers may be inclined to prohibit even minimal physical exertion, such as lifting more than 5 lb (2.3 kg). This approach has no evidence of support and has the potential to substantially increase the risk of deconditioning and associated chronic diseases (8). This recommendation can be particularly challenging for women with postpartum SCAD as most infants weigh more than 5 lb at birth.

Other reasons for lack of CR attendance may be those most common to CR, such as the distance of travel to a CR location, cost of attendance (ie, copays), and a need to return to work promptly. While most well-staffed and experienced CR programs are well equipped to work with the SCAD population, attention should be paid to ensure that they feel comfortable. Occasionally, younger participants may feel out of place in a CR environment where the average participant may be considerably older or have multiple comorbidities and risk factors. This could potentially lead to problems with adherence. The lack of attendance at CR programs can delay patients' return to normal activity and mental health. CR may be particularly important for patients with SCAD, who often have anxiety, depression, and ongoing physical symptoms (11).

Our patient was initially evaluated and deemed suitable for independent exercise under more remote guidance from a clinical exercise physiologist. This model allowed her to progress at an individual pace while receiving ongoing guidance and close follow-up evaluations to continue to individualize her exercise prescription. While this patient's exercise prescription and progression was much more aggressive than the typical CR participant, it is still significantly more conservative than the program described by Silber et al (16), who started earlier and incorporated more aggressive interval training. The original intent of her rehabilitation program was to be more in line with that of Silber et al (16), but due to multiple issues it was modified because the patient chose to not attend a more traditional, monitored setting. Because of this the decision was to progress her slowly. Our protocol for enrollment into CR also increased the time from discharge to initial evaluation, so in our environment the initial advice tends to be conservative. Another factor in the slower progression was the direction given to the CR staff by her cardiologist. Those recommendations can vary greatly from physician to physician. The choice to delay maximal exercise testing and remain submaximal until 6 mo after discharge was also at the request of her cardiologist and does not reflect any specific guidelines.

# CONCLUSIONS

Currently, there is no evidence that those who suffer from SCAD should avoid exercise if proper guidance and supervision are provided. Until further data are available, an exercise prescription for patients with SCAD can be approached in an individual manner and liberalized depending on that person's progress. This includes taking into consideration exercise history, consistency of exercise, time off from exercise (after diagnosis, procedures, etc), prior and current level of conditioning, residual disease, and any changes in risk factors or comorbidities. Although there are no specific guidelines available it may be prudent to avoid extreme exercise intensities and recreation as well as discourage long-duration endurance events or power lifting/Olympic-style lifting that involves the Valsalva maneuver. While a typical cardiac exercise prescription may work well for some patients with SCAD, those who are young and athletic should have a CR/exercise program tailored to their abilities, similar to the approach taken with the patient in this case study.

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