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Spontaneous Coronary Artery Dissection Patients Significantly More Fit than the Average Patient Referred for Exercise Stress Testing

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Abstract

Background: Spontaneous coronary artery dissection (SCAD) patients represent a rare subgroup presenting with acute coronary syndrome (ACS) who are often younger with fewer comorbidities than the average patient with coronary artery disease (CAD). It is also a condition that disproportionately affects women who appear to be more physically fit than average, although this has never been investigated.

Objectives: The purpose of this study was to determine the functional capacity of SCAD patients as compared to the average patient referred for an exercise treadmill test (ETT) in order to better inform the development of cardiovascular rehabilitation programs and exercise recommendations for these patients.

Methods: In this retrospective, case-control study, 39 women with angiographically confirmed SCAD who had undergone pre-cardiac rehabilitation ETT were identified from the Massachusetts General Hospital registry. Cases were matched by age and gender in a 1:2 fashion to controls that had undergone ETT at our institution between 2005 and 2013. ETT results were compared between the cases and controls.

Results: Women with SCAD had a significantly longer exercise duration (9.4 ± 2.0 *vs.* 8.0 ± 2.6 minutes, p=0.001) and a better functional capacity (11.0 ± 2.2 *vs.* 9.5 ± 2.7 METs, p<0.001) as compared to age and sex matched controls. SCAD cases also had a higher Duke Treadmill Score (8.8 ± 3.2 *vs.* 6.4 ± 3.8 METs, p<0.001) as compared to controls.

Conclusions: Women presenting with SCAD as the cause of ACS have a significantly greater functional capacity as compared to the average patient referred for an ETT. Therefore, they may require modification of the routine cardiac rehabilitation program designed for the average patient with CAD to achieve maximum benefit. The development of a safe, appropriately challenging, and highly personalized exercise rehabilitation prescription is necessary for these patients to return to their baseline activity and quality of life.

Keywords: Spontaneous coronary artery dissection; Acute coronary syndrome; Exercise stress test; Cardiac rehabilitation

Abbreviations

ACS: Acute Coronary Syndrome; BMI: Body Mass Index; CAD: Coronary Artery Disease; CR: Cardiac Rehabilitation; DTS: Duke Treadmill Score; ETT: Exercise Treadmill Test; METs: Metabolic Equivalents; SCAD: Spontaneous Coronary Artery Dissection

Introduction

Spontaneous coronary artery dissection (SCAD) patients represent a rare subgroup presenting with acute coronary syndrome (ACS). Due to its predilection for young, otherwise healthy women, the diagnosis of SCAD is often delayed or even missed. Patients with SCAD are typically younger and have fewer cardiovascular risk factors and comorbidities as compared to the average coronary artery disease (CAD) patient [1-4]. Furthermore, these patients have also been observed to be more physically fit than the average female participating in cardiac rehabilitation (CR) [5]; however, this remains to be an area in need of further investigation.

Current CAD clinical practice guidelines strongly recommend CR program participation for patients after an acute myocardial infarction [6,7]. CR programs have been shown to be a cost-effective secondary prevention treatment strategy for individuals with an ACS or at a higher risk for subsequent cardiac events [8]. The benefits of CR extend to both women and men with CAD of all ages and include improved physical function, exercise capacity, quality of life, psychosocial well-being, morbidity, and mortality [9-11]. Despite the many known benefits of participating in a CR program, referral, participation, and adherence rates remain low especially amongst women [12-15]. Therefore, identifying and ultimately addressing the barriers that limit many women from participating in CR programs remains an ongoing challenge.

Based on the experience from our SCAD registry, current CR programs appear to be inadequately flexible in their approach to preparing patients to return to their functional baseline prior to their SCAD event. The purpose of this study was to determine the functional capacity of SCAD patients in order to better inform the development of CR programs and exercise recommendations targeted to meet the special needs of this unique patient population.

Methodology

All cases consented and enrolled in the Massachusetts General Hospital SCAD Registry, approved by the Partners Human Research

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Committee. The requirement for informed consent was waived for the retrospective identification of the control subjects.

Study population

The cases for this study included all female patients with angiographically confirmed SCAD who were enrolled in the Massachusetts General Hospital SCAD Registry and had also undergone pre-cardiac rehabilitation treadmill stress testing using a standard Bruce protocol. Only patients whom had undergone an exercise treadmill test (ETT) within one year of their SCAD event with available results were included in this study. Control patients were identified retrospectively from the nuclear cardiology database to identify all female patients who had undergone an ETT at the Massachusetts General Hospital between January 2005 and February 2015.

Study design

Demographics, cardiovascular risk factors, and ETT results of the cases and controls were obtained retrospectively from medical records. The 39 SCAD cases were matched in a 1:2 fashion to 78 control participants who had undergone an ETT at the Massachusetts General Hospital. Matching variables included age and sex and the controls were randomly assigned to the cases. Demographics, clinical characteristics, and ETT results of SCAD patients were compared to the control population.

Exercise treadmill testing

Exercise variables obtained from the ETT included exercise duration in minutes, metabolic equivalents achieved, and the Duke Treadmill Score (DTS). Exercise duration (in minutes) was defined as the duration of exercise for patients performing the standard Bruce protocol. The DTS was calculated using the following equation: exercise time (minutes) – (5 X maximum ST-deviation [mm]) - (4 x angina index) [16,17]. The treadmill angina index was coded as 0 if there was no angina, 1 if typical angina occurred during exercise, and 2 if angina was the reason for exercise termination. The DTS ranges from -25 to +15 with a score ≥ +5 classified as low risk, +4 to -10 intermediate risk, and ≤ -11 as high risk.

Data collection

Study data were collected and managed using REDCap electronic data capture (Research Electronic Data Capture) tools hosted by Partners HealthCare Research Computing, Enterprise Research Infrastructure & Services group. REDCap [18] is a secure, web-based application designed to support data capture for research studies.

Statistical analysis

Continuous variables were reported as mean ± standard deviation and categorical variables as absolute frequencies and percentages. Comparisons of the clinical and ETT variables between the SCAD cohort and the control population were analyzed using the independent t-test or Mann-Whitney U test for continuous variables and the chi-squared test or Fisher's exact test for categorical variables. Normality was defined by the Shapiro-Wilk test. All statistical tests were two-sided and p-values <0.05 were considered significant. Analyses were performed using the IBM SPSS, Version 22.0 (Armonk, NY: IBM Corp).

Results

A comparison of the prevalence of traditional cardiovascular risk factors and the functional capacity of women with SCAD and age and sex matched controls is presented in Table 1. In terms of cardiovascular risk factors, the prevalence of diabetes mellitus, family history of premature CAD, postmenopausal state, and current tobacco use was significantly higher (p=0.028, p=0.006, p=0.049, p=0.002, respectively) in the controls as compared to the SCAD cohort.

	SCAD (n=39)	Controls (n=78)	p-value
Age at ETT (years)	47.6 ± 8.8	47.7 ± 8.7	0.96
Cardiovascular risk factors			
Hypertension	10 (25.6)	23 (29.5)	0.66
Dyslipidemia	14 (35.9)	26 (33.3)	0.78
Diabetes mellitus	0	9 (11.5)	0.028
BMI ≥ 30 kg/m^2	9 (23.1)	15 (19.2)	0.63
Family history of premature CAD	7 (17.9)	34 (43.6)	0.006
Postmenopausal	14 (35.9)	15 (19.2)	0.049
Tobacco former	11 (28.2)	12 (15.4)	0.1
Tobacco current	0	16 (20.5)	0.002
ETT results			
Exercise duration, min	9.4 ± 2.0	8.0 ± 2.6	0.001
Exercise capacity, METs	11.0 ± 2.2	9.5 ± 2.7	<0.001
Duke Treadmill Score	8.8 ± 3.2	6.4 ± 3.8	<0.001

Data presented as mean ± SD or n (%); SCAD: Spontaneous Coronary Artery Dissection; ETT: Exercise Treadmill Test; BMI: Body Mass Index; CAD: Coronary Artery Disease; METs: Metabolic Equivalents

Table 1: Comparison of the prevalence of traditional cardiovascular risk factors and functional capacity of women with SCAD and age and sex matched controls.

There was no significant difference observed in the prevalence of hypertension, dyslipidemia, BMI ≥ 30 kg/m^2, and former tobacco use, between the cases and controls. In regard to the ETT results, the SCAD cohort had a significantly longer exercise duration (9.4 ± 2.0 *vs.* 8.0 ± 2.6 minutes, p=0.001) as compared to controls. The SCAD cohort also had a significantly greater functional capacity (11.0 ± 2.2 *vs.* 9.5 ± 2.7 METs, p<0.001) as well as DTS (8.8 ± 3.2 *vs.* 6.4 ± 3.8 METs, p<0.001) as compared to controls.

Discussion

Based on observations of the patient population seen at the Massachusetts General Hospital SCAD clinic, patients with SCAD are generally young, female patients, many of whom have multiple traditional cardiovascular risk factors and comorbidities. Following the diagnosis of SCAD, a relatively rare and potentially life-threatening condition, many of our patients report high levels of anxiety as well as difficulty managing their personal and professional lives, obligations, and responsibilities. Initial clinic visits are typically focused on optimizing medication regimens and providing patients with recommendations regarding lifestyle modifications including avoidance of future pregnancies, hormonal therapies, extremes of temperatures, high level aerobic activities, and heavy weight lifting. As the vast majority of our patients were highly active individuals prior to their SCAD event, many have questions specifically about the necessity of exercise limitations, as they are quite eager to return to their baseline level of physical fitness. Our staff work with patients to understand that recovery from SCAD can be best understood using a "trimester" approach. The first trimester involves immediate post-hospitalization care, determination of appropriate timing of stress testing upon resolution of any cardiac symptoms, management of stress and anxiety associated with the diagnosis of SCAD, and performance of post-SCAD stress testing. The second trimester involves initiation and completion of CR and eventual return to regular activities at work and at home. During the third trimester following successful completion of CR the patient incorporates the concepts learned during CR and is able to independently exercise. At our program, referral to CR remains

a cornerstone of the management strategy for patients with SCAD as it allows them to reinitiate an exercise regimen in a safe and controlled environment. However, currently available conventional CR programs are targeted to meet the needs of traditional cardiac patients and appear to be inadequately flexible in providing personalized rehabilitation prescriptions for patients with SCAD to return to their functional baseline status.

At present, relatively little is known about the effects of CR on the outcomes of patients with a history of SCAD. In a small study by Silber et al. [19], the outcomes of patients with SCAD who underwent standard CR 1 to 2 weeks after myocardial infarction were described. The study revealed that CR was safe after SCAD and resulted in an improvement in aerobic capacity, body composition, depression, and stress. Similarly, in a study by Krittanawong et al. [20], the role of CR after SCAD was also explored. Amongst the cohort of 354 SCAD patients, the vast majority of these patients attended at least 1 CR session of which most reported positive physical and emotional effects. Finally, in a study by Chou et al. [21], the effect of a multidisciplinary CR program specifically designed for SCAD patients was examined. The study found that participation in the CR program resulted in an improvement in chest pain, exercise capacity, psychosocial well-being, and cardiovascular events amongst the study participants. However, given the correlation between strenuous physical activity and SCAD, the CR program utilized in this study was a modified form of the standard CR used after atherosclerotic myocardial infarction.

Although many published studies on patients with SCAD have reported a low prevalence of traditional cardiovascular risk factors, in this study we identified a significantly higher prevalence within the SCAD cohort. In this study, the SCAD cohort has found to have the same prevalence of hypertension, dyslipidemia, BMI $\geq$ 30 kg/m^2, and former tobacco use, as compared to the average female referred for an ETT. The SCAD cohort was also found to have a significantly longer duration of exercise, functional capacity, and DTS as compared to controls. Based on these findings, women with SCAD appear to be a much more active cohort as compared to the average patient referred for ETT despite having the same prevalence of many traditional cardiovascular risk factors. These findings underscore the need to direct the development of a strategically designed CR program for SCAD survivors. Current CR programs are not structured to provide the flexibility often required to meet the fitness level and time constraints of the SCAD patient population. Therefore, there is a great need for the development of a CR program to adequately prepare patients with SCAD to meet their desired athletic and lifestyle goals in a safe and carefully monitored setting. Ideally a CR program for patients with SCAD would be focused on staff development and education in terms of allowing for flexibility and an individualized approach to personalized exercise prescriptions. In addition, given the significantly elevated prevalence of cardiovascular disease risk burden observed in this SCAD cohort, a robust secondary prevention program inclusive of education, nutrition counseling, aggressive risk factor management, lifestyle modifications, and the appropriate use of cardio-protective medications is also crucial. Finally, attention will also need to be placed to ensure that CR staff members are well equipped with the knowledge and expertise to effectively provide support and counseling to individuals suffering from the many challenging psychosocial issues that arise as the result of receiving the diagnosis of SCAD. In conclusion, the widespread implementation of a carefully designed comprehensive CR program will provide patients with SCAD with the opportunity to rebuild their self-confidence and live healthy, active, and productive lives.

Study Limitations

The principal limitation of this study was the small sample size. In line with many other studies focused on relatively rare conditions, identifying a large number of patients with SCAD was a challenge. Secondly, this was a retrospective study and therefore is subject to the inherent weaknesses of such analyses. Thirdly, the study only included patients with SCAD who had undergone a pre-cardiac rehabilitation ETT for which results were available. Finally, the study did not include any male SCAD patients; however, men constitute only a small fraction of the SCAD population. Nevertheless, this study does represent the first of its kind to investigate the functional capacity of patients with SCAD as compared to the standard patient referred for an ETT. It is hoped that the results of this study will inform the development of a CR program created specifically to meet the unique needs of the SCAD population.

Conclusions

In conclusion, SCAD survivors are a unique subset of patients whom may not benefit from traditional CR programs unless the interventions take into consideration and incorporate the individual's baseline functional capacity and unique needs. The results from this study demonstrated that women presenting with SCAD as the cause of ACS have a significantly greater functional capacity than the average patient referred for ETT testing despite having the same prevalence of many traditional cardiovascular risk factors. Therefore, they may not benefit from traditional CR programs designed for the average CAD patient. The development of a safe, appropriately challenging, and highly personalized CR program that provides the flexibility to meet the individual needs of SCAD survivors is necessary in order for these patients to return to their baseline activity level and quality of life. The impact of a specifically tailored SCAD CR program on short-term and long-term cardiac outcomes and quality of life will need to be assessed in future studies.

Conflict of Interest

The authors report no conflicts of interest.

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