Comparison of reflex, resistance training, and core activities using change in blood pressure over time after spontaneous coronary artery dissection

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ABSTRACT

A 53-year-old female athlete with spontaneous coronary artery dissection, acute myocardial infarction, and infrarenal abdominal aortic dissection enrolled in a 6-week cardiovascular rehabilitation (CR) program. During CR sessions, the patient performed a combination of aerobic, resistance training, and core activities. In the final CR session, the patient performed reflex activities and the forced Valsalva maneuver. The patient's electrocardiogram, blood pressure, heart rate, and transient change in blood pressure over time were continuously monitored and recorded. The patient completed CR without negative symptoms or adverse events.

KEYWORDS Blood pressure; cardiac rehabilitation; dP/dt; rate-pressure product; resistance training; spontaneous coronary artery dissection

One year after myocardial infarction resulting from spontaneous coronary artery dissection (SCAD) involving the left anterior descending and right coronary arteries, a 53-year-old woman enrolled in an 18-session cardiac rehabilitation (CR) program at Baylor Hamilton Heart and Vascular Hospital. Her goal was to perform resistance training and core activities. She had been medically restricted from performing these activities due to the negative association between SCAD and movements involving the Valsalva maneuver (VM). Unique CR monitoring was used to reach her goal of returning to pre-event activities.

CASE REPORT

This patient had experienced prior fibromuscular dysplasia and multiple vascular dissection syndrome, including an index infrarenal aortic dissection at 42 years of age that required emergency vascular repair. During CR, the patient's medications included telmisartan (Micardis), 40 mg a day; nebivolol (Bystolic), 10 mg twice a day; low-dose aspirin; nitroglycerin (Nitrostat) sublingual spray, 0.4 mg as needed; and hydrochlorothiazide, 12.5 mg a day. In keeping with the

standard protocol of the CR program, telemetry (TeleRehab VersaCare, ScottCare Corp, Cleveland, OH) was used to monitor the patient's electrocardiogram. During each of the daily CR sessions, she performed 5 minutes of low-intensity warm-up activities before 20 to 30 minutes of aerobics using the step machine or jogging on an indoor track. She also performed two sets of 10 repetitions (moderate intensity) of one resistance training activity, either dumbbell overhead press, dumbbell chest press, or leg press, and two sets of one core activity for 30 seconds, either a crunch, sit-up, push-up, plank, or Mason twist. She was instructed to abstain from holding her breath while performing the activities. In the final CR session, she was asked to both cough forcefully and perform forced VMs three times with a 2-minute rest period between activities. Then, by inserting a diabetic monofilament in one side of her nose,¹ she was provoked to sneeze two times. Blood pressure, heart rate, and peak transient change in blood pressure over change in time (dP/dt) were continuously recorded using a Finometer blood pressure monitor (Finapres Medical Systems BV, Enschede, The Netherlands) and LabChart software (ADInstruments, Dunedin, New

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Figure 1. Performance of core activity while monitored continuously using the Finometer blood pressure monitor.

Table 1. Average peak dP/dt, systolic blood pressure and heart rate during activity

Activity	Mean (SD)		
	dP/dt (mm Hg/ms)	SBP (mm Hg)	HR (bpm)
Cough	1.160 (0.26)	165 (0.3)	105 (15)
Valsalva maneuver	1.080 (0.23)	135 (12.4)	101 (76)
Sneeze	1.078 (0.59)	130 (50.5)	156 (96)
Leg press	1.060 (0.09)	102 (5.1)	82 (10)
Plank	1.034 (0.16)	135 (12.1)	88 (20)
Push-up	1.016 (0.26)	138 (19.4)	91 (21)
Overhead press	1.011 (0.12)	112 (6.1)	70 (10)
Sit-up	1.008 (0.30)	107 (13.3)	90 (29)
Chest press	0.889 (0.14)	116 (8.8)	96 (26)
Mason twist	0.852 (0.14)	98 (8.7)	92 (20)
Crunch	0.664 (0.07)	106 (5.9)	73 (11)

dP/dt indicates transient change in blood pressure over change in time; HR, heart rate; SBP, systolic blood pressure.

Zealand) (Figure 1). The average maximum dP/dt, systolic blood pressure, and heart rate during each activity are presented in Table 1. Nonaerobic activities were grouped into three different categories (e.g., reflex, resistance training, and core) for use in comparison analyses (Figure 2). A one-way analysis of variance (NCSS 11 statistical analysis software, Kaysville, UT) was performed, which resulted in a significant difference in mean peak dP/dt between groups ($P < 0.001$).

DISCUSSION

SCAD is an underrecognized cause of acute coronary syndrome² that commonly presents in women with few or no atherosclerotic risk factors and patients diagnosed with fibromuscular dysplasia.^{3,4} SCAD is a sudden tear in the intimal blood vessel lining, which progresses to the media and allows blood flow to be diverted into the wall of the

Figure 2. Average peak transient change in blood pressure over change in time during reflex, resistance training, and core activities.

coronary artery, resulting in potential occlusion, restriction of blood flow to the myocardium, and ischemia or infarction within the affected area of the cardiac muscle.^{5,6} The etiology of the disease is unclear.⁶ In current theory, the combination of genetic predisposition, fluctuations in sex hormones, and transient elevations in blood pressure may trigger SCAD.⁶ These transient elevations in blood pressure, reflected by dP/dt, are presumably attributed to strenuous physical exertion,⁷ emotional stress, and bearing-down reflex responses,⁶ such as coughing and sneezing, that may involve the VM.

The VM, defined as the closing of the glottis and contraction of the diaphragm and abdominal musculature,⁸ naturally occurs during reflex responses such as coughing and sneezing and when performing resistance training and core activities. VM activities are perceived to increase intra-abdominal pressure, which then may result in elevated arterial blood pressure. Consequently, due to the grave consequences of SCAD, patients are commonly restricted from performing resistance training and core activities. As a result, patients become habitually inactive, which may then lead to a plethora of further health complications, including coronary artery disease, diabetes, hypertension, depression, osteoporosis, obesity, anxiety, and depression.⁹ During performance of the cough, undoubtedly a reflex that cannot be restricted, average maximum dP/dt was notably higher than in VM activities in which she was encouraged to continuously breathe.

The patient experienced no adverse events or negative symptoms during her CR program; however, this does not mean that these activities are safe for those who may have a more compromised vascular system than this previously active patient. Medical professionals should encourage SCAD patients to participate in resistance training and core activities to promote improved quality of life.

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