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BRIEF REPORT

Impact of Adapted Sports Activities on the Progression of Carotid Atherosclerosis in Subjects With Spinal Cord Injury

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Abstract

Objective: To determine whether regular performance of adapted sports is associated with long-term changes in carotid atherosclerosis in subjects with spinal cord injury (SCI).

Design: Prospective observational study.

Setting: Academic medical center.

Participants: Men with chronic (>1y) SCI and no preserved motor function below the injury level were evaluated in 2007 and 2012 (N = 17). Nine subjects did not perform physical activity between the studied time points (control group), whereas 8 subjects entered competitive upper-body sports programs (rugby: n = 5, basketball: n = 1, jiu-jitsu: n = 1, and tennis: n = 1) after baseline and were regularly training at the time of the second evaluation (sports group).

Interventions: Not applicable.

Main Outcome Measures: Clinical, laboratory, hemodynamic, and carotid ultrasonography analysis.

Results: The studied groups showed no differences in all studied variables at baseline. After 5 years of follow-up, the control group showed increases in heart rate (87.0±3.1 vs 74.7±3.8 beats per minute; $P = .004$), but the participants had no significant changes in carotid intima-media thickness (IMT) (.65±.05 vs .67±.03mm; $P = .73$) or IMT/diameter (.118±.007 vs .136±.013; $P = .24$). In contrast, the sports group showed long-term decreases in carotid IMT (.56±.05 vs .74±.05mm; $P = .001$) and IMT/diameter (.097±.006 vs .141±.009; $P < .001$), but the participants did not show any variation in the other studied variables at follow-up.

Conclusions: Regular upper-body sports activities are associated with long-term reductions in carotid atherosclerosis in subjects with SCI and might be a potential prevention strategy aiming to reduce cardiovascular risk in this population.

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Subjects with spinal cord injury (SCI) exhibit higher prevalence of cardiovascular diseases and increased carotid intima-media thickness (IMT) than able-bodied individuals independent of variation in traditional cardiovascular risk factors.[1,2] Previous cross-sectional studies have suggested that regular adapted sports activities are associated with decreased carotid atherosclerosis in individuals with SCI,[3-5] but evidence from prospective studies in this regard is lacking. The present study investigated whether regular performance of upper-body sports is associated with long-term changes in carotid features of subjects with SCI.

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Table 1 Features of the enrolled subjects with SCI

	Control Group (n=9)		Sports Group (n=8)	
Variable	Baseline	5-y Follow-Up	Baseline	5-y Follow-Up
Clinical features				
Age, y	33.7±2.2		28.3±2.5	
Body mass index, kg/m^2	23.9±1.3	23.1±0.9	21.8±0.6	22.0±0.7
Glucose, mg/dL	84.9±3.0	87.6±5.0	80.1±1.1	82.4±2.2
LDL cholesterol, mg/dL	108.6±18.6	111.5±11.7	91.2±9.1	108.0±12.5
HDL cholesterol, mg/dL	48.5±4.5	47.9±4.0	38.0±2.9	37.3±1.8
Log triglycerides, mg/dL	1.94±0.10	1.96±0.08	1.93±0.07	1.93±0.08
Log C-reactive protein, mg/dL	−0.24±0.29	0.01±0.38	−0.89±0.20	−0.79±0.19
Injury				
Time of injury, y	7.6±1.5		5.1±1.3	
Tetraplegia, n (%)	4 (44)		5 (63)	
AIS grade A, n (%)	8 (89)		7 (88)	
AIS grade B, n (%)	1 (11)		1 (12)	
Injury level, tetraplegia/paraplegia	C4-6/T4-8		C5-7/T3-9	
Hemodynamic features				
Systolic BP, mmHg	103.1±5.0	116.7±7.3	108.1±7.2	111.1±8.1
Diastolic BP, mmHg	71.7±5.2	75.1±4.4	66.0±4.5	68.4±3.9
Heart rate, bpm	74.7±3.8	87.0±3.1*	71.4±5.4	62.0±2.2
Stroke volume, mL	78.0±6.7	64.5±5.3	71.1±4.5	72.1±5.7
Cardiac output, L/min	5.7±0.4	5.7±0.5	5.0±0.3	4.5±0.4
PVR, dyne×s×cm^{-5}	1172±80	1285±104	1301±91	1602±263
Carotid features				
CCA IMT, mm	0.67±0.03	0.65±0.05	0.74±0.05	0.56±0.05†
CCA diameter, mm	5.2±0.5	5.5±0.2	5.3±0.2	5.7±0.2
CCA IMT/diameter	0.136±0.013	0.118±0.007	0.141±0.009	0.097±0.006‡
CCA resistive index	0.81±0.01	0.79±0.02	0.82±0.02	0.81±0.02
ICA resistive index	0.71±0.02	0.79±0.04	0.75±0.04	0.75±0.05

NOTE. Values are mean ± SE or as otherwise indicated.

Abbreviations: AIS, American Spinal Injury Association Impairment Scale; BP, blood pressure; bpm, beats per minute; CCA, common carotid artery; HDL, high-density lipoprotein; ICA, internal carotid artery; IMT, intima-media thickness; LDL, low-density lipoprotein; PVR, peripheral vascular resistance.

* $P=.004$ compared with baseline values in the respective group.

† $P=.001$ compared with baseline values in the respective group.

‡ $P<.001$ compared with baseline values in the respective group.

Methods

In 2007, 17 sedentary men with chronic (>1y) SCI and no preserved motor function below the injury level were enrolled from a university hospital and were evaluated by clinical, laboratory, hemodynamic, and carotid ultrasonography analysis. In 2012, all individuals were again evaluated by the same procedures. Among the enrolled individuals, 9 of them did not perform physical activity between the studied time points (control group), whereas 8 subjects entered competitive upper-body sports programs (rugby: n=5, basketball: n=1, jiu-jitsu: n=1, and tennis: n=1) after baseline and were regularly training at the time of the second evaluation (sports group). When evaluated in 2012, this latter group was continuously participating in sports activities on average 6.3±1.1h/wk for 3.0±0.6 years. Information regarding sports activities was provided by the coaches of the training programs. Exclusion criteria included diabetes mellitus (glucose ≥126mg/dL), obesity (body mass index ≥30kg/m^2), systemic hypertension (systolic blood pressure ≥140mmHg or diastolic blood pressure ≥90mmHg), hyperlipidemia (low-density lipoprotein cholesterol ≥160mg/dL or triglycerides ≥200mg/dL),[6] smoking, cardiovascular or pulmonary disease, cancer, regular medical therapy, and active infection. None of the patients used antihypertensive, antiarrhythmic, or lipid-lowering medications throughout the study period. Written informed consent was obtained from all subjects, and the study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the Ethics Committee of the University of Campinas.

Clinical data included information on the participants' age and injury duration. Body mass index was calculated as body weight divided by height squared. Blood samples were obtained on the morning after 12 hours of fasting for analysis of glucose, lipid fractions, and C-reactive protein. Office blood pressure and heart rate were measured using a validated digital oscillometric device with the subjects in a sitting position.[a] Stroke volume was generated from Doppler interrogation of transaortic flow at the aortic annular level and aortic cross-sectional area using a Vivid 3 Pro apparatus[b] equipped with a 2.5-MHz transducer.[7] Cardiac output was calculated as stroke volume × heart rate, whereas peripheral vascular resistance was obtained by the following formula: mean

List of abbreviations:

IMT intima-media thickness
SCI spinal cord injury