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Clinical Research

Aerobic Fitness and Risk of Ventricular Arrhythmia Following Physical Exertion

Harpreet S. Chahal, BMSc,[a,b] Elizabeth Mostofsky, ScD,[b,c] Murray A. Mittleman, MD, DrPH,[b,c] Neville Suskin, MD, MSc,[a,d] Mark Speechley, PhD,[a] Allan C. Skanes, MD,[d] Peter Leong-Sit, MD, MSc,[d] Jaimie Manlucu, MD,[d] Raymond Yee, MD,[d] George J. Klein, MD,[d] and Lorne J. Gula, MD, MSc[a,d]

[a] *Department of Epidemiology and Biostatistics, Schulich Medicine and Dentistry, Western University, London, Ontario, Canada*

[b] *Cardiovascular Epidemiology Research Unit, Department of Medicine, Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA*

[c] *Department of Epidemiology, Harvard School of Public Health, Boston, Massachusetts, USA*

[d] *Division of Cardiology, Western University, London, Ontario, Canada*

ABSTRACT

Background: Brief episodes of physical exertion are associated with an immediately greater risk of cardiovascular events. Previous studies on the risk of ventricular arrhythmia (VA) shortly after exertion have not assessed if this risk differs according to the level of aerobic fitness or sedentary behaviour. Therefore, we conducted a prospective cohort study of patients with implantable cardioverter-defibrillators (ICDs) with a nested case-crossover analysis to examine the risk of VA shortly after exertion and whether this risk is modified by aerobic fitness and sedentary behaviour.

Methods: Ninety-seven consecutive patients were recruited at the time of ICD implantation and 30 confirmed events occurred among patients who completed interviews about physical exertion preceding ICD therapy. We compared the frequency of exertion within an hour of ICD discharge to each patient's usual frequency of exertion reported at the time of ICD implantation.

RÉSUMÉ

Introduction : De brèves périodes d'effort physique sont associées à une augmentation immédiate du risque d'événement cardiovasculaire. Les études précédentes sur le risque d'arythmie ventriculaire survenant peu après un effort physique n'ont pas vérifié si ce risque variait en fonction du degré de capacité aérobique ou du comportement sédentaire. Nous avons donc mené une étude de cohorte prospective auprès de patients munis d'un défibrillateur cardioverteur implantable (DCI). Une analyse croisée de cas témoins emboîtés a été effectuée afin d'évaluer le risque de survenue d'arythmie ventriculaire peu après un effort physique et de déterminer si ce risque était modifié par le degré de capacité aérobique et par le comportement sédentaire des patients.

Méthodes : Quatre-vingt-dix-sept patients ont été recrutés de manière consécutive au moment de l'implantation du DCI et 30 événements confirmés sont survenus chez des patients qui avaient répondu à un

There is consistent evidence that discrete episodes of physical exertion are associated with a transient increase in the risk of cardiovascular events, including myocardial infarction and stroke.[1,2] Previous studies have described this association with ventricular arrhythmia, but have not examined if this risk varies according to level of aerobic fitness or sedentary behaviour.

Although appropriate antitachycardia pacing (ATP) and shocks delivered by implantable cardioverter-defibrillators (ICDs) might be life-saving, ICD therapy can be associated with psychological distress and reduced quality of life.[3,4] Reducing sedentary behaviour is important for healthy aging in older adults,[5] but patients with ICDs commonly report concerns that physical exertion will elicit a shock and might therefore abstain from or engage in decreased levels of physical activity.[6]

In this study, we evaluated whether there is a greater risk of ventricular arrhythmia during and shortly after episodes of physical exertion compared with rest. We hypothesized that decreased levels of aerobic fitness, measured according to peak oxygen consumption ($\dot{V}O_2$), and sedentary behaviour would be associated with a greater risk of ventricular arrhythmia after isolated bouts of physical exertion.

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Corresponding author: Dr Lorne J. Gula, Western University, 339 Windermere Rd, c6-110, London, Ontario N6A 5A5, Canada. Tel.: +1-519-663-3746; fax: +1-519-663-3782.

E-mail: lgula@uwo.ca

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Results: Within an hour of episodes of exertion, the risk of VA was 5.3 (95% confidence interval [CI], 2.7-10.6) times greater compared with periods of rest. The association was higher among patients with aerobic fitness below the median (relative risk [RR] = 17.5; 95% CI, 5.2-58.5) than for patients with aerobic fitness above the median (RR, 1.2; 95% CI, 0.4-4.2; *P* homogeneity = 0.002) and higher among patients who were sedentary (RR, 52.8; 95% CI, 10.1-277) compared with individuals who were not sedentary (RR, 3.2; 95% CI, 1.3-7.6; *P* homogeneity = 0.0002).

Conclusions: Within 1 hour of episodes of exertion, there is an increased risk of VA, especially among individuals with lower levels of aerobic fitness and with sedentary behaviour.

Résultats : Dans l'heure qui suivait l'effort physique, le risque d'arythmie ventriculaire était 5,3 fois supérieur (intervalle de confiance [IC] à 95 %, de 2,7 à 10,6) par rapport aux périodes de repos. Ce lien était plus important chez les patients dont la capacité aérobique était sous la médiane (risque relatif [RR] = 17,5; IC à 95 %, de 5,2 à 58,5) que chez les patients dont la capacité aérobique était supérieure à la médiane (RR = 1,2; IC à 95 %, de 0,4 à 4,2; valeur *p* d'homogénéité = 0,002), et il était supérieur chez les patients sédentaires (RR = 52,8; IC à 95 %, de 10,1 à 277) par rapport aux patients actifs physiquement (RR = 3,2; IC à 95 %, de 1,3 à 7,6; valeur *p* d'homogénéité = 0,0002).

Conclusions : Il y a accroissement du risque d'arythmie ventriculaire dans un délai d'une heure suivant un effort physique, particulièrement chez les patients sédentaires et ceux qui ont une capacité aérobique moindre.

Methods

Study population

The **M**onitoring **o**f **V**entricular Rhythm and **E**xercise-**I**CD **St**udy (MOVE-IT) study is a prospective cohort of 97 consecutive ICD patients recruited at the time of implantation at the London Health Sciences Centre in London, Ontario, Canada from May 2008 to July 2012 and followed until January 2015. Patients with ischemic or dilated cardiomyopathy received Medtronic ICDs (St Paul, MN) for primary or secondary prevention on the basis of standard criteria.[7] Patients were ineligible for the study if they met any of the following criteria: $<$ 18 years of age, comorbid noncardiac condition associated with anticipated survival $<$ 2 years, or physical limitations precluding moderate exercise. The study protocol was approved by the Health Sciences Research Ethics Board and all patients provided informed consent. Thirty therapies (ATP or shock) among 22 patients were referred for symptomatic ventricular arrhythmias, and comprise the sample for analysis.

Study design

The case-crossover design was selected to examine the transient effect of an intermittent exposure on events with acute onset.[8] Rather than comparing different people at the same time, the case-crossover design compares the same person at different times. As a result, there is no confounding by fixed or slowly varying characteristics such as sex, age, and medical history. This design involves collecting information on exposure (eg, physical exertion) immediately preceding the event (eg, ventricular arrhythmia) and comparing this with the expected frequency of exposure over a similar time period based on the basis of the study patient's habitual pattern.

Physical exertion

At the initial study visit, patients estimated their average frequency and duration of light, moderate, and vigorous exertion activities over the past 6 months using the 15-point (scores ranging from 6 to 20) visual analogue Borg scale[9] to gauge exertion intensity. Examples of exertion were provided for each category such as light gardening, brisk walking, and shoveling, which are associated with light, moderate, and vigorous exertion, respectively. Patients who reported no moderate to vigorous exertion in the past 6 months were classified as sedentary and patients who reported any moderate to vigorous exertion were deemed not sedentary. Information on timing of physical exertion and exposure to other possible behavioural precursors was also collected.

Patients who experienced symptomatic ventricular arrhythmia completed a semistructured questionnaire within 72 hours of device therapy by telephone or at the clinic. Patients reported the last time before device discharge that they had engaged in light, moderate, and vigorous exertion with the following response options: never, at the time of therapy, half an hour before, 1 hour before, 2 hours before, 3-6 hours before, 6-24 hours before, 1-2 days before, 3-4 days before, or $\geq$ 5 days before. Patients described their specific activity at the time of and immediately preceding ICD therapy, and their symptoms surrounding the event as well. Information on other potential triggers was also collected from the questionnaire and information on age, medical history, and medications was abstracted from medical records.

Cardiopulmonary exercise stress test

A modified Bruce protocol[10] was conducted 2 weeks after ICD implantation to measure peak $\dot{V}O_2$. An initial 3-minute stage of 1.7 mph and 0% gradient was followed by 3 minute stages as follows: 1.7 mph at 5% grade, 1.7 mph at 10% grade, 2.5 mph at 12% grade, 3.4 mph and 14% grade, 4.2 mph and 16% grade, and 5 mph and 18% grade. $\dot{V}O_2$ was measured continuously throughout the treadmill test using computerized online rapid gas analyzers for oxygen and carbon dioxide[11] of the Vmax Encore Metabolic Cart (CareFusion, San Diego, CA). Peak $\dot{V}O_2$ was the $\dot{V}O_2$ measured at peak exercise. The treadmill test was performed adhering to accepted standards,[12] with continuous 12-lead electrocardiogram monitoring and recordings at rest before exercise, at least every 3 minutes during exercise, peak exercise, and at 1-minute intervals for 6 minutes during recovery. Symptoms