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EC CARDIOLOGY
Case Report

Jump from Sedentary Metabolic Syndrome to High Physical Fitness! -A Case of Good Exercise Trainability

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Abstract

Healthcare professionals should pay attention to the response to exercise of each individual to whom they recommend and teach exercise training, because everyone has the aptitude to improve aerobic and metabolic capacity by exercise. In this regard, we experienced a surprisingly good exercise "responder:" a 65-year-old man with metabolic syndrome. He showed 16 kg body weight loss, a resting heart rate of 34 beats/min, high VO_{2max} of 42.5 ml/kg/min for his age, and HDL elevation from 38 to 66 mg/dl after 4 months of self-training. We believe that it is possible for an elderly person with sedentary metabolic syndrome to endure very hard training (such as long distance uphill running) and obtain good aerobic capacity if the person demonstrates not only intention and efforts, but also potential genetic superiority.

Keywords: *Metabolic Syndrome; Physical Fitness; Elderly; Exercise; Non-Responder; Responder; Autonomic Function; Aerobic Capacity; Genetic*

Introduction

Metabolic syndrome presents a high risk for cardiovascular disease. The peak exercise capacity is the strongest predictor of the risk of death among both normal subjects as well as those with cardiovascular disease [1]. Thus, it is critical to prevent and improve metabolic syndrome in the medical and administrative fields [2]. Although exercise should be practiced by people with metabolic syndrome as a crucial task, it is not always easy to obtain positive effects on risk reduction and peak VO_2 improvement due to low adherence [3] and/or non-responders to the exercise protocol [4]. Healthcare professionals should pay attention to each individual's specific response to exercise training, because each individual has an aptitude for improving aerobic capacity through exercise. In this regard, we experienced a surprisingly good exercise "responder:" an elderly man with metabolic syndrome who also demonstrated potential genetic superiority.

Case Report

A 65-year-old man had worked in an office before retiring at the age of 60. Throughout his life he never engaged in exercise or sports, even while attending school. Although he had never suffered from any medical diseases, his body weight gradually increased to 79 kg with a body mass index (BMI) of 29.4 kg/m^2. A health check-up data 3 years ago showed liver dysfunction, hyperglycemia, HbA_1C elevation (6.4%), low HDL-c (38 mg/dL), and renal dysfunction (cre 1.41, eGFR 40.8) (Table 1). Once retired, he started walking 6 - 7 km/day three times a week for his health. He started self-training to lose body weight in June 2018. For the next 4 months, the self-training was gradually increased in three steps:

1. June (1 month): ①12.5 km running on a flat course (almost every day).
2. July (1 month): ①+②12.5 km running round trip to Sanageyama mountain (an altitude of 629m) (almost every day).
3. August-September (2 months): ①+②+③10 km running on the treadmill +strength training 6 days per week.

He could continue these protocols without any injury and lose 16 kg (79 kg→63 kg) in 4 months. Because he was unsure about his training methods and wanted to know if they were medically sound, he visited our medical fitness gym and started a recommended training plan by a health fitness programmer. A routine check-up on admission showed general improvements in HDL-c (elevated to 66 mg/

	4/27/2015	9/25/2018	1/7/2019
AST (IU/L)	53	32	
ALT (IU/L)	64	24	
γ-GTP (IU/L)	42	29	
Total Cholesterol (mg/dL)	173	153	
HDL (mg/dL)	38	66	
LDL (mg/dL)	122	83	
Triglyceride (mg/dL)	118	49	
Uric Acid (mg/dL)	7.2	8.6	
Creatinine (mg/dL)	1.41	1.18	1.19
eGFR	40.8	48.8	48.0
Glucose (mg/dL)	105	99	
HbA_1C (%)	6.4	6.0	5.9

Table 1: *Serial laboratory data.*

dL), HbA_1C (decreased to 6.0), and normal liver function (Table 1). Sinus bradycardia (34 beats per minute) (Figure 1) and hyperglycemia (8.6 mg/dl) were also recognized. Due to his recent training history, we suspected that sinus bradycardia was caused by an autonomic effect of high physical fitness rather than sick sinus syndrome. A cardiopulmonary exercise test (CPX) was performed to evaluate sinus node function, coronary ischemia, and maximal oxygen consumption (VO_{2max}). The results showed a high physical fitness level and no abnormal electrocardiographic change with peak heart rate (HR) of 171 per minutes (Table 2 and Figure 1). VO_{2max} was 42.5 mg/dL/min. Ischemic change and arrhythmia were not found during the test. Ultrasound cardiography showed normal left ventricular ejection fraction (60%) and cavity size. Figure 2 shows a heart rate trend during a representative day of exercise training.

	At rest	At AT level	At peak level
Workload (watt)	0	142	228
Blood pressure (systolic/diastolic mmHg)	117/75	188/88	230/82
Heart rate (beats/min)	59	125	171
VO_2/kg (ml/min/kg)	5.1	26.8	42.5
ST change	None	None	None
arrhythmia	None	None	None

Table 2: *Cardiopulmonary exercise test after 4-month self-training.*

Abbreviations: AT: Anaerobic Threshold; VO_2: Oxygen Consumption.

Figure 1: *Electrocardiograph.*

a) At rest in lead II (4/25/2015) Heart rate: 52 beats/min.

b) At rest in lead II (9/25/2018) Heart rate: 34 beats/min.

c) At peak work load during cardiopulmonary exercise test (10/15/2018) Heart rate: 171 beats/min.

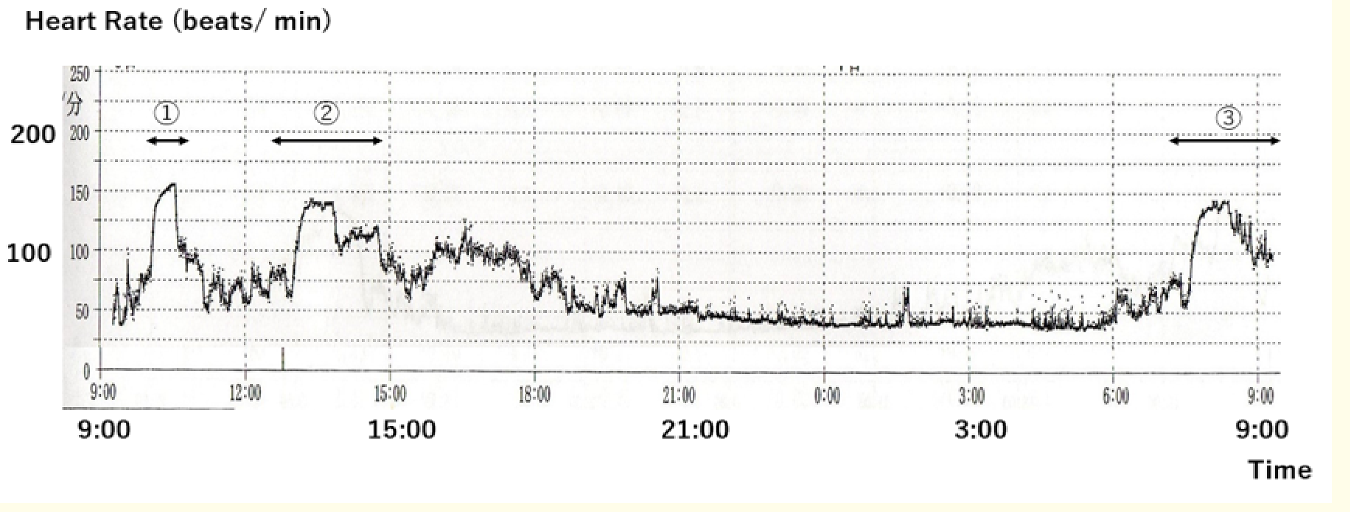

Figure 2: *Heart rate trend during Holter monitor on October, 2018.*

Trainings during 24-hour Holter monitor

① Running on the treadmill.

② Round running trip to Mt. Sanageyama (an altitude of 629 meters).

③ Same as ② in the next morning.

Discussion

This case revealed that unsupervised self-training for 4 months could achieve not only weight loss but also remarkable improvement in metabolic and aerobic capacity and autonomic function [5] even in an elderly person with a sedentary lifestyle and metabolic syndrome. His current VO_{2max} is high for his age and comparable to that of an average 40-year-old in Japan. We think that the sinus bradycardia detected at the check-up indicated the parasympathetic activation due to aerobic training but not the sick sinus syndrome, because his peak HR (171 beats/min) was more than the expected peak HR for his age (220-65 = 155) during workload. The decrease of his resting HR by exercise training was more than that reported in the previous studies (5 - 9 beats/min) [5,6]. HDL elevation was inversely proportional to autonomic function improvement. These findings indicate that this case was a "good responder" to exercise training.

There are two challenges for aerobic capacity improvement by exercise training. One is low adherence [3] to the intensity and frequency of exercise training and the other is the potential of a non-responder to exercise [4]. Research and experience indicate that many people who begin a new exercise program do not obtain the benefits in their health and fitness even after weeks of sticking with their new routine. Among fitness scientists, these people are known as non-responders. Their body simply does not respond to the exercise they are doing. And once discouraged, they often return to a sedentary lifestyle. This patient was able to overcome both of these challenges by his self-training without supervision. Finally, this case might indicate the potential genetic superiority of the responder [7-9], although he has not yet undergone genetic testing, such as SNIPS or micro RNAs. We believe that hard training (long distance uphill running) could not be sustained in a sedentary elderly person with metabolic syndrome without good trainability.

High-intensity interval training (HIIT) is a time-efficient promising protocol to improve aerobic capacity more than or at least equal to moderate-intensity continuous training. HIIT can be classified into two types. One is submaximal aerobic HIIT and the other is supramaximal anaerobic HIIT (spring interval training: SIT). Figure 3 shows 3 types of HIIT, which are evidence based so that the results can be replicated by the responders [2,10-12]. These protocols increase aerobic capacity for responders, however, there is a sizeable population of non-responders who are vulnerable to metabolic syndrome and its complications. Recent studies indicate the possibility that non-responders can "respond" if they challenge the other mode of excise [13] that is different from current one or exercise more (higher dose or more frequently) [14].

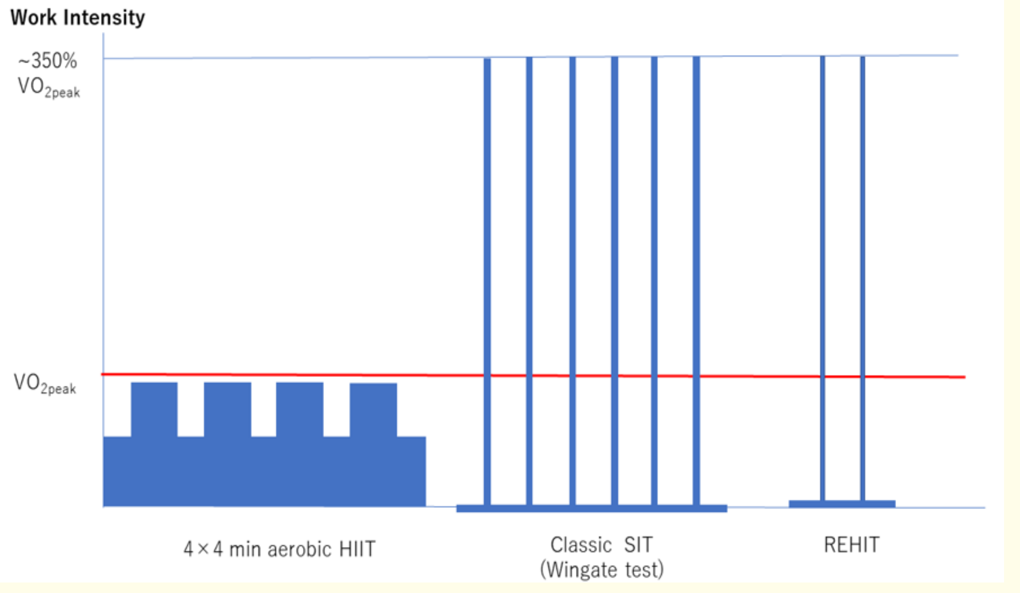

Figure 3: *Schema of high-intensity interval training protocols.*
High-intensity interval training (HIIT) is classified into two types: One is submaximal aerobic HIIT and the other is all-out anaerobic HIIT (sprint interval training: SIT). REHIT (reduced-exertion high-intensity interval training) is a low-dose and shorter SIT which is modified from SIT but still all-out anaerobic exercise.
4×4 min HIIT: Four 4-minute intervals at 90% to 95% of maximal heart rate separated by 3-minute active recovery periods of moderate intensity at 60-70% of maximal heart rate
Classic SIT: Repeated (6-8) all-out bouts at vigorous intensity ~350% of VO_{2peak} of short duration (30 sec) followed by long complete rest (2 - 5 minutes).
REHIT: 10 minutes cycling session at 25 W interspersed with 1 (first session) or 2 (all remaining sessions) Wingate-type cycle-sprints against a constant torque of 0.65 Nm·kg lean mass^{-1}. Sprints lasted 10 s in sessions 1 - 4, 15s in sessions 5 - 12 and 20s in the remaining 12 sessions.

Conclusion

We experienced a surprisingly good exercise "responder:" a 65-year-old man with metabolic syndrome, who showed the potential genetic superiority.

Disclosure

There is no conflicts of interest to declare about this case report.

Informed Consent

We obtained written informed consent from the patient regarding publishing this case.

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