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(Case Report)

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Manifestation of cardiopulmonary exercise testing in an HIV-infected patient with highly active anti-retroviral therapy: A Case Report

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Abstract

Background: Human immunodeficiency virus (HIV) is a retrovirus that causes severe immunodeficiency syndrome in most patients if left untreated. It has been a reportable disease in Taiwan since 1984, and was diagnosed in 41,679 patients until June 2020. However, there is no previous study evaluating aerobic capacity in HIV-infected patient in Taiwan.

Case report: A 50-year-old male with HIV infection visited our rehabilitation center for cardiopulmonary exercise testing (CPET) due to dyspnea on exertion sometimes. He received a highly active antiretroviral therapy (HAART) regimen since 2015. He could achieve VO_2max during CPET. The maximal aerobic ability was about 91.95% of the predicted, and functional aerobic impairment (FAI) was within normal limit. His VO_2 peak was 8.3 MET, equal to 29.05 mL/kg/min. Additionally, VO_2 AT was 4.5 MET, equal to 15.75 mL/kg/min. We make recommendations of physical exercise training program according to CPET results.

Conclusion: The difference of disease duration, HAART regimen and time of HAART will affect the cardiopulmonary fitness results. However, our HIV-infected patient showed normal aerobic fitness following the CPET, and aerobic capacity did not impair in HIV-infected patient receiving HAART due to personalized life-style modification.

Keywords: HIV; Antiretroviral therapy; Cardiopulmonary exercise test; Aerobic fitness

1. Introduction

HIV is a retrovirus that infects cells of the immune system, specifically CD4+ T cells. It could cause lifelong illness if left untreated. For patients who have access to antiretroviral therapy (ART), the overall incidence of acquired immunodeficiency syndrome (AIDS) and death related to HIV infection has decreased dramatically [1]. However, HIV and possibly ART produce myocardial dysfunction by pro-inflammation cytokine release that results in myocardial fibrosis, apoptosis, and cardiac steatosis [2]. Additionally, HIV infection has been associated with an increased risk of heart failure in the ART era [3]. In a meta-analysis of 11 studies from the ART era, including over 2000 patients with HIV, the prevalence of diastolic and systolic dysfunction by echocardiography was 43.4 and 8.3 percent, respectively [4]. The role of chronic inflammation and immune activation may be central to the increased risk of coronary artery disease in HIV patients [5]. Among these non-AIDS-defining conditions, lung disease, including chronic obstructive pulmonary disease (COPD), malignancy, pulmonary hypertension, and pulmonary fibrosis are increasing causes of morbidity and

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mortality [6]. Physical activity impairment is highly prevalent in HIV-infected patients. Increased frailty, as well as declines in lung and cardiovascular health, were observed in previous research [7]. Recent studies indicated significant aerobic and muscle strength deficits more frequently found in HIV-infected patients than in healthy people [8]. This report presents the cardiopulmonary exercise testing (CPET) results of an HIV-infected patient in Taiwan with a highly active ART (HAART) regimen who took the test after he presented with dyspnea on exertion.

2. Case Report

A 50-year-old male with HIV infection visited our rehabilitation center for cardiopulmonary exercise testing (CPET) due to dyspnea on exertion sometimes. There was no obvious blood pressure difference over the bilateral arms. The electrocardiogram showed normal sinus rhythm and there was no obvious abnormality seen in chest radiograph. Other medical history included hypertension and dyslipidemia with medication control. Furthermore, he received a HAART regimen with combivir and efavirenz (2015/1/22-1/29), which was then withheld due to diarrhea. Combivir was rechallenged first as the symptom subsided from 2015/2/10, and then efavirenz was added back in 2015/2. HAART was shifted to triumeq on 2016/11/29. During the latest laboratory monitoring of HIV infection, his CD4 count was 470 cells/mm^3 and his viral load was less than 20 copies/mL.

He received a body composition measurement and CPET. Vector bioelectric impedance analysis (VBIA) was used to measure his body composition. It was performed with the bioelectrical impedance vector analysis software using the resistance–reactance graph method. Zeus 9.9 PLUS (Jawon Medical Co. Ltd., Kungsang Bukdo, Korea) was used to analyze his body composition. Fat mass index (FMI) was calculated by dividing the fat mass (kg) by the square of the participant's height (m), and fat-free mass index (FFMI) was calculated by dividing the fat-free mass (kg) by the square of the participant's height (m). The baseline characteristics of the patient are summarized in Table 1.

Before CPET, we explained the procedures and demonstrated the equipment to him clearly. For measuring exercise capacity, the symptom-limited exercise testing consisted of a cycle ergometer, a flow module, a gas analyzer, and an electrocardiographic monitor (Metamax 3B, Cortex Biophysik GmbH Co., Leipzig, Germany). The patient peddled on an upright bicycle ergometer to assess oxygen consumption at peak exercise (peak VO_2) and at anaerobic threshold (AT VO_2). Exercise began with an intensity of 0W workload for a 1-minute warmup, followed by incremental loading using a ramp protocol (15 W/min) until exhaustion.

Table 1 Personal characteristics of the patient

Variables	
Body Height (cm)	171.6
Body Weight (kg)	85.4
Body Mass Index (kg/m^2)	29.0
Fat Mass (kg) Fat Mass Index (kg/m^2)	22.8 7.74
Fat-Free Mass (kg)	62.6
Fat-Free Mass Index (kg/m^2)	21.26

VO_2 and carbon dioxide production (VCO_2) were measured during the test by using the breath-by-breath method. Minute ventilation (VE), blood pressure (BP), and heart rate (HR) were also recorded during the test. The Borg Scale of Perceived Exhaustion was used by the patient during maximal BP and rest periods. Heart rate reserve (HRR) was calculated as the difference between HR at 1 minute after testing and maximum HR. The metabolic equivalent (MET), the amount of oxygen consumed while sitting at rest (equivalent to 3.5 mL of oxygen per kilogram of body mass per minute), was calculated after measuring VO_2. The anaerobic threshold was defined by the VE/VO_2 and VE/VCO_2 methods [9]. The following physiological criteria for reaching VO_{2max} were used: (1) respiratory exchange ratio (RER) greater than 1.10; (2) heart rate greater than 85% of age-predicted maximum.

The results are presented in Table 2. The patient reached VO_{2max} during CPET. The maximal aerobic ability was about 91.95% of the predicted, and functional aerobic impairment (FAI) was within a normal limit. His VO_2 peak was 8.3 MET, equal to 29.05 mL/kg/min. Additionally, VO_2 AT was 4.5 MET, equal to 15.75 mL/kg/min. For the aerobic exercise training, we prescribed the intensity of exercise determined by targeting VO_2 AT and the HR measured at that time. The target VO_2 AT was 4.5 MET, and the target heart rate was 113 beats/min as recorded, respectively.

This study was approved by the Institutional Review Board of Kaohsiung Veterans General Hospital (identification number: VGHKS17-CT11-11) and the patient provided informed consent for publication of the case.

Table 2 Results of cardiopulmonary exercise testing (CPET) of the patient

Variables	
SBP/DBP max (mmHg)	212/108
HR max (bpm)	152
HRR (beats)	25
VO2/WR slope (cc/min/watt)	16.3
$PETCO_2$ rest (liter)	32
$PETCO_2$ Max (liter)	44
Anaerobic threshold	
VO_2 (MET)	4.5
VE (liter)	36.9
VO_2 (ml/kg/min)	15.75
RER	0.84
HR (bpm)	113
Peak exercise	
VO_2 (MET)	8.3
VE (liter)	74.9
VO_2 (ml/kg/min)	29.05
RER	1.10
HR (bpm)	152

SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; HRR: heart rate reserve; VO_2: oxygen consumption; WR: work rate; PETCO2: end-tidal carbon dioxide; MET: metabolic equivalent of task; VE: minute ventilation; RER: respiratory exchange ratio

3. Discussion

Taiwan Centers for Disease Control (CDC) strives to make it easier for people to obtain HIV testing so that more people can learn about their health status, get diagnosed, and receive proper treatment in a timely manner, including free antiretroviral therapy (ART or HAART). However, HIV stigma and discrimination still exist due to a misunderstanding of the disease in our society, and this might be the reason no previous studies evaluated cardiopulmonary fitness by CPET in Taiwan. To our knowledge, this is the first study to evaluate cardiopulmonary fitness in an HIV-infected patient by CPET in Taiwan.

It is a gold standard method to assess aerobic exercise capacity by measuring peak VO_2. The aerobic capacity was found to be normal in our patient with HIV infection following CPET. Previous studies revealed HIV-infected patients were at an increased risk of poor physical function, exhaustion, slower walking speed, low physical activity, and muscle weakness [10,11]. Raso et al. demonstrated that poor muscle strength in some HIV/AIDS patients was associated with lower anaerobic capacity and cardiopulmonary fitness [12]. In addition, HIV infection was found to be an independent predictor of decreased physical function and an impaired pulmonary function test result and that diffusing capacity abnormalities contributed to decreased 6-MWD [13]. Furthermore, the use of HAART has been associated with mitochondrial dysfunction and motor impairment [14]. Gomes-Neto M et al. indicated reduced muscle strength and aerobic capacity of HIV-infected patients in comparison with healthy controls [8]. To our surprise, however, cardiorespiratory fitness of our patient seemed no impairment in view of his CPET results.

There are some possible reasons for the normal cardiorespiratory fitness of our patient's CPET results. Previous study indicated that the peak oxygen uptake (VO_{2peak}) of physically active individuals with HIV/AIDS does not differ from that of control subjects of similar age and with similar physical activity patterns on average [11]. A systematic review with a meta-analysis concluded that combined aerobic and resistance exercise should be considered a nonpharmacological treatment in HIV-infected patients [15,16]. High-intensity aerobic exercise increased cardiorespiratory fitness in older HIV-infected men [17]. Guidelines of exercise therapy for HIV-infected patients demonstrate that aerobic exercise could be considered, beginning with light intensity (30-39% $VO_{2resting}$ or HRR) and progressing to moderate intensity (40-59% $VO_{2resting}$ or HRR) for 3-5 days/week [18]. It can be initiated with 10 minutes and then progress to 30-60 minutes/day [18]. In terms of resistance exercise, it should begin with light intensity with a gradual progression to 60% one-repetition maximum (1-RM) [18]. Performing 8-10 repetitions from 1-2 sets initially and gradually increasing to 3 sets is recommended [18]. It is safe and effective to use machine weights even without supervision [18]. There is still little data on specially guided exercise training for HIV-infected patients. It should be adjusted accordingly based on the individual's age and current health status.

Aerobic capacity may be improved by increasing physical activity levels and by lifestyle modification, either at hospital or in home [19]. Exercise and weight reduction should be given emphasis in any preventive cardiovascular program and as part of a healthy lifestyle for all patients with HIV infection [20]. These interventions could disallow other risk factors that contribute to cardiovascular disease. In our patient, exercise was suggested since the initial diagnosis of HIV infection, and there were some records of baseline VBIA, aerobic fitness, and the change over time, even he did not regularly perform an echocardiogram or pulmonary function test examination during these years.

This case report disclosed the aerobic capacity of a single HIV-infected patient in Taiwan. Measuring the aerobic fitness through CPET of HIV- infected patients from baseline after diagnosis and following the change over time is important and could be considered in further research. By evaluating the cardiopulmonary fitness of these HIV-infected patients, we could develop a better understanding of the disease in our country and provide patients with appropriate medical treatment and exercise recommendations according to their CPET results.

4. Conclusion

Differences in disease duration, HAART regimen, and time of HAART initiation may affect the cardiopulmonary fitness results. However, our HIV-infected patient showed normal aerobic fitness following the CPET, and aerobic capacity did not impair in HIV-infected patients receiving HAART. Further research, including more cases evaluating the aerobic fitness of HIV-infected patients in Taiwan, is needed.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors report no disclosures of conflict of interest relevant to the manuscript. This report was not supported by any grants and has no financial benefits.

Statement of informed consent

Informed consent was obtained from the patient included in the study.

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