

## CASE REPORT

# Sudden cardiac death during first-time jogging

Hiromitsu Kurata<sup>1,2,3\*</sup>, Akiko Ishigami<sup>1</sup>, Itsuo Tokunaga<sup>1</sup>, Yasushi Nagasaki<sup>3</sup>, and Akiyoshi Nishimura<sup>1,3</sup>

<sup>1</sup>Department of Forensic Medicine, Institute of Biomedical Sciences, Tokushima University Graduate School, Tokushima, Japan, <sup>2</sup>Department of Rehabilitation Medicine, Nakazu-Yagi Hospital, Tokushima, Japan, <sup>3</sup>Hyogo Medical Examiner's Office, Hyogo prefectural Institute of Public Health and Consumer Science, Kobe, Japan

**Abstract :** With increased interest in fitness and health care, jogging has become more popular as an exercise to promote health. However, sudden cardiac death during sports or exercise has also been reported. Some apparently healthy elderly individuals take up sports for both recreation and health improvement based only on completion of a questionnaire, without undergoing medical evaluation. We report the case of a 66-year-old Japanese man who suddenly died of acute ischemic heart disease during first-time jogging. He collapsed an hour after starting. A trainer promptly started cardiopulmonary resuscitation. An automated external defibrillator (AED) was applied, and defibrillation was attempted once by bystanders. However, he remained in cardiopulmonary arrest until he reached the emergency department, where he was pronounced dead. The autopsy found concentric hypertrophy of the left ventricular wall without fibrosis or degeneration, atherosclerotic changes in the coronary arteries, and severe lung congestion. We diagnosed death from acute myocardial ischemia. We suspect that many healthy elderly individuals have provoked a heart attack by prematurely attempting moderate or vigorous exercise, as in this case. The elderly require comprehensive medical assessment before exercise can be started. Moreover, this case shows that an AED is not always helpful. *J. Med. Invest.* 64 : 184-186, February, 2017

**Keywords :** Sudden cardiac death, Exercise, Ischemic heart disease, Autopsy

## 1. INTRODUCTION

Moderate exercise may prolong the life span (1, 2). Jogging is a popular form of exercise performed by both the young and elderly for health improvement. However, sudden cardiac death (SCD) during exercise has been reported. Trainers usually prepare an automated external defibrillator (AED) in the event of sudden cardiac arrest, and an AED sometimes saves lives. We describe an autopsy case of acute ischemic heart disease during jogging training, with death despite early cardiopulmonary resuscitation and use of an AED. We emphasize the importance of comprehensive medical assessment for the elderly before starting an exercise program.

## 2. CASE REPORT

A 66-year-old Japanese man collapsed on the field during first-time jogging training. He had been running for an hour when he collapsed. The jogging school trainer found him unconscious, pulseless, and apneic, and started basic life support. An AED was applied and defibrillation was attempted once, but he remained pulseless. Twenty-four minutes elapsed from the start of resuscitation until arrival at the hospital by ambulance. He was in cardiopulmonary arrest on arrival, and attempts at advanced life support were futile.

He had been healthy all his life, and had no history of hypertension, diabetes mellitus, or hyperlipidemia on previous workplace medical screening, according to his wife, and used to be a long-distance bicyclist. He had no family history of including sudden death, cardiomyopathy or Brugada syndrome, and he was not a

smoker all through his life. To evaluate the cause of sudden death, an autopsy was performed the next day.

### Autopsy findings

The patient was 165.0 cm in height and 54.0 kg in weight. His heart weighed 439 g (normal weight :  $385.77 \pm 78.87$  g) (3), and contained dark red fluid blood (20 ml on the left and 160 ml on the right). The thickness of the ventricular wall was 2.2 cm on the left and 0.7 cm on the right. Both ventricles showed concentric hypertrophy, but no myocardial degeneration or scarring was found (Fig. 1). All coronary arteries were atherosclerotic, and about 50% stenosis was found in the left anterior descending and left cir-



Fig. 1  
Cross-section of the heart : both ventricles showed concentric myocardial hypertrophy. No degeneration or fibrosis was found.

Received for publication November 28, 2016 ; accepted December 31, 2016.

Address correspondence and reprint requests to Hiromitsu Kurata, Department of Forensic Medicine, Institute of Biomedical Sciences, Tokushima University Graduate School, Kuramoto-cho, Tokushima 770-8503, Japan and Fax : +81-88-633-7084.

cumflex arteries, however, no arterial occlusion or plaque rupture was found. Both lungs showed severe congestion (left 1,089 g, right 823 g). The other organs showed no obvious pathology except for congestion.

#### Histological findings

Tissue samples were fixed with phosphate-buffered formalin and embedded in paraffin; 5- $\mu$ m-thick paraffin sections were stained with hematoxylin-eosin or Berlin blue stain. Contraction bands were present in the left ventricle (Fig. 2). No interstitial fibrosis or myocardial fiber disarray was found in the myocardium. Severe congestion, hemorrhage, and siderophages were found in the lungs (Fig. 3).

We diagnosed he died from not acute myocardial infarction but acute myocardial ischemia, because of absence of myocardial degeneration or necrosis and presence of coronary atherosclerosis without coronary occlusion.

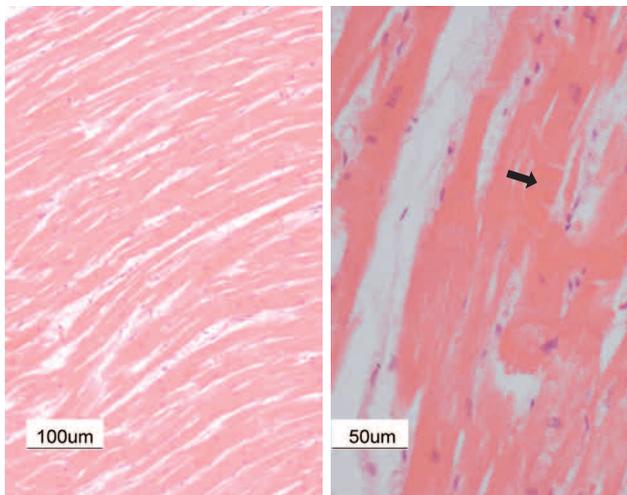


Fig. 2  
Histological findings in the left ventricle : contraction bands (black arrow) were found (hematoxylin-eosin stain). No interstitial fibrosis or myocardial fiber disarray was found in the myocardium.

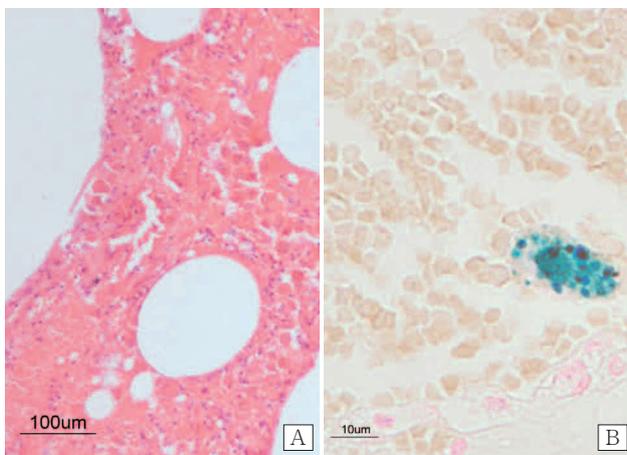


Fig. 3  
Histological findings in the lungs  
A : Severe congestion and hemorrhage into vesicles was found (hematoxylin-eosin stain).  
B : Siderophages were found (Berlin blue stain).

### 3. DISCUSSION

Since the 1970s, appropriate physical activity has been known to reduce coronary heart disease mortality (3); however, sports activity has concurrently been reported as a cause of sudden death (4, 5). In adults, the rate of acute myocardial infarction during vigorous exertion in those who did not exercise regularly was 2-10 times higher than that during sedentary activity (6). Thus, physical exercise is considered a double-edged sword.

#### Incidence of sports-related SCD

The association between intensity and frequency of exercise and cardiac events during sports activities has been reported. Habitual physical activity has been reported to reduce atherosclerotic coronary disease and risk of acute myocardial infarction (7). Individuals who practice light jogging for 1-2.4 hours per week at a slow or moderate pace have a lower mortality rate than sedentary non-joggers or moderate and vigorous joggers (8).

The incidence of sports-related SCD has been reported. In an evaluation of 188 SCD cases aged 10 to 50 years in Lausanne, Switzerland from 1995 to 2010, 22 (12%) were sports-related. Of these 22, 91% died during leisure sports (9). In another study of 8,862 autopsied SCD cases aged 9 to 69 years in Spain from 1995 to 2010, 168 (1.8%) were sports-related. The causes of death were coronary atherosclerotic disease (50.5%), arrhythmogenic cardiomyopathy (7.7%), hypertrophic cardiomyopathy (7.1%), idiopathic left ventricular hypertrophy (6.5%), congenital coronary anomalies (4.1%), myocarditis (3.5%), aortic stenosis (2.9%), other causes (6.5%), and unknown causes (11.3%). Among those who died from coronary atherosclerotic disease, 74 of 85 victims were over 35 years old (10). A prospective study in France from 2005 to 2010 among those aged 10 to 75 years reported that 4.6 persons per million general population per year died during sports-related activities (11).

Younger persons who die during sports-related activities are almost all competitive athletes, and the major causes of death are associated with a hereditary or congenital cardiomyopathy, coronary anomaly, or similar pathology (10, 12). On the other hand, non-competitive, leisure sports-related deaths almost always involve men, and the mortality rate increases with age. The majority are men possibly because they are more vigorous and play longer than women (13). The rate of atherosclerotic coronary disease increases with age as the cause of sports-related death (6-12).

#### Exercise intensity and SCD

Exercise intensity is usually described in terms of metabolic equivalents (METs). Light or moderate jogging at under 6 METs was reported to increase longevity (8). The current case usually rode a bicycle for leisure. The exercise intensity of leisure cycling at less than 10 miles per hour (16.1 kilometers per hour) is 4.0 METs. In contrast, the intensity of combined walking and jogging is 6.0 METs and that of jogging alone is as high as 7.0 METs (14). His first time jogging was vigorous exercise compared to his usual leisure cycling.

His cardiac ventricles showed concentric hypertrophy. Hypertrophic cardiomyopathy and hypertension were well-known as the cause of myocardial concentric hypertrophy. In this case histological findings showed no interstitial fibrosis and myocardial fiber disarray, so we supposed he had so-called "masked hypertension". Recently masked hypertension that shows normotension in workplace medical screening, and hypertension out of workplace, was reported to be associated with increased risk for cardiovascular disease (15). This may be the reason why this case had atherosclerotic change and stenosis in coronary arteries. There were not myocardial degeneration, fibrosis and coronary artery occlusion macroscopically. Therefore, we excluded acute myocardial infarction as his cause of death. Concentric hypertrophy

due to masked hypertension and insufficient coronary blood supply during vigorous exercise due to coronary atherosclerosis may cause acute myocardial ischemia and fatal arrhythmia such as ventricular fibrillation. He had no history of heart disease or other physical problems. However, siderophages were present in the lungs, and are known as "heart failure cells" in histological study. This finding suggested that he had pulmonary congestion. He may have had symptoms such as dyspnea and chest pain, but kept running because of overconfidence.

#### Value of the AED

The AED was used once during bystander resuscitation without benefit. The fact that the AED discharged means he had ventricular fibrillation or pulseless ventricular tachycardia during resuscitation; however, the electrocardiogram obtained by the rescue squad indicated cardiac standstill. AEDs have become widely available, and the media have reported that many lives have been saved. The value of the AED during sports events has been reported. In the USA, 1,710,052 runners participated in marathons from 1976 to 2009, and 30 had sudden cardiac arrest. An AED was used in 20; 17 survived and 3 died. On the other hand, 7 of the 10 who arrested and did not use the AED died. The risk factors for sudden cardiac arrest and failed AED use were male sex and older age. The survival rate for SCD during sports with use of the AED was significantly higher than that without use of the AED (16). However, the AED is not always helpful in sports-related sudden cardiac arrest, especially in elderly men.

#### Prevention of sports-related SCD

To prevent sports-related SCD, especially in the elderly, participation screening is very important. A medical screening trial for first-time participants over 45 years old before cross-country running was performed in Sweden in 2010 (17). The initial medical screening comprised 12-lead electrocardiography, blood pressure measurement, echocardiography, blood testing, medical history-taking, and a physical examination. Based on the reported criteria (18), those who needed further medical assessment were referred. Four of 154 participants refused to join sports events, and there were no cardiac occurrences. If the present case had undergone the same screening as above, concentric left ventricular hypertrophy would have been diagnosed with echocardiography, and participation might have been prevented by stress electrocardiography on further assessment. We emphasize that further medical screening should be provided for middle-aged or elderly individuals prior to participation in vigorous activities, to prevent unexpected sports-related SCD.

#### CONFLICT OF INTEREST

The authors declare no conflict of interest.

#### REFERENCES

- Sandvik L, Erikssen J, Thaulow E, Erikssen G, Mundal R, Rodahl K : Physical fitness as a predictor of mortality among healthy, middle-aged Norwegian men. *N Engl J Med* 328 : 533-537, 1993
- Planning and Investigation Committee of the Japanese Society of Legal Medicine. Weights and sizes of internal organs measured in forensic autopsy cases from 2009 to 2013 in Japan. (in Japanese). Questionnaire research performed by the Japanese society of legal medicine. 2015, URL : <http://www.jslm.jp/problem/zouki.pdf>
- Paffenbarger RS Jr, Hale WE : Work activity and coronary heart mortality. *N Engl J Med* 292 : 545-550, 1975
- Green LH, Cohen SI, Kurland G : Fetal myocardial infarction in marathon racing. *Ann Intern Med* 84 : 704-706, 1976
- Opie LH : Sudden death and sport. *Lancet* 1 : 287-304, 1978
- Mittleman MA, Maclure M, Tofiger GH, Sherwood JB, Goldberg RJ, Muller JE : Triggering of acute myocardial infarction by heavy physical exertion. *N Engl J Med* 329 : 1677-1683, 1993
- Corrado D, Basso C, Schiavon M, Thiene G : Does sports activity enhance the risk of sudden cardiac death? *J Cardiovasc Med* 7 : 228-233, 2006
- Schnohr P, Keefe JH, Marott JL, Lange P, Jensen GB : Dose of jogging and long-term mortality. The Copenhagen city heart study. *J Am Coll Cardiol* 65 : 411-419, 2015
- Chappex N, Schlaepfer J, Fellmann F, Bhuiyan ZA, Wilhelm M, Michaud K : Sudden cardiac death among general population and sport related population in forensic experience. *J Forensic Leg Med* 35 : 62-68, 2015
- Suárez-Mier MP, Aguilera B, Mosquera RM, Sánchez-de-León MS : Pathology of sudden death during recreational sports in Spain. *Forensic Sci Int* 226 : 188-196, 2013
- Marijon E, Tafflet M, Celermajer DS, Dumas F, Perier MC, Mustafic H, Toussaint JF, Desnos M, Rieu M, Benamer N, Heuzey JYL, Empana JP, Jouven X : Sports-related sudden death in the general population. *Circulation* 124 : 672-681, 2011
- Thompson PD, Franklin BA, Balady GJ, Blair SN, Corrado D, Estes III NAM, Fulton JE, Gordon NF, Haskell WL, Link MS, Maron BJ, Mittleman MA, Pelliccia A, Wenger NK, Willich SN, Costa F : Exercise and acute cardiovascular events; placing the risks into perspective. *Circulation* 115 : 2358-2368, 2007
- Marijon E, Bougouin W, Périer MC, Celermajer DS, Jouven X : Incidence of sports-related sudden death in France by specific sports and sex. *JAMA* 310 : 642-643, 2013
- Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR Jr, Tudor-Locke C, Greer JL, Vezina J, Whitt-Glover MC, Leon AS : 2011 Compendium of Physical Activities : A Second Update of Codes and MET Values. *Med Sci Sports Exerc* 43(8) : 1575-1581, 2011
- Bromfield SG, Shimbo D, Booth JN, Correa A, Ogedegbe G, Carson AP, Muntner P : Cardiovascular risk and masked hypertension : The Jackson Heart Study. *Hypertension* 68(6) : 1475-1482, 2016
- Webner D, Duprey KM, Drezner JA, Cronholm P, Roberts WO : Sudden cardiac arrest and death in United States marathons. *Med Sci Sports Exerc* 44(10) : 1843-1845, 2012
- Aagaard P, Sahlén A, Bergfeldt L, Braunschweig F : Preparation evaluation of novice, middle-age, long-distance runners. *Med Sci Sports Exerc* 44(10) : 130-1137, 2013
- Borjesson M, Urhausen A, Kouidi E, Dugmore D, Sharma S, Halle M, Hein Heidbüche H, Björnstad HH, Gielen S, Mezzani A, Corrado D, Pelliccia A, Vanhees L : Cardiovascular evaluation of middle-aged/senior individuals engaged in leisure-time sport activities : position stand from the sections of exercise physiology and sports cardiology of the European Association of Cardiovascular Prevention and Rehabilitation. *Eur J Cardiovasc Prev Rehabil* 18(3) : 446-458, 2011