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Characteristic body composition with high skeletal muscle mass index (SMI) and fat deposits in elderly athlete

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Abstract

The current case is a 64-year-old male athlete. He has continued playing baseball at the professional level and has always exercised physically through strength training (ST) on pitching and batting for many years. From bioelectrical impedance analyses (BIA) using InBody, weight 90kg, soft lean mass 61.2kg, fat 25.0kg, BMI 27.9 kg/m^2, and body fat 27.8%, total Extracellular water (ECW)/Total body water (TBW) 0.384, skeletal muscle mass index (SMI) revealed 8.5 kg/m^2 and whole body phase angle (PhA) 6.4 degree. Characteristic aspects showed high BMI and SMI, average ECW/TBW and PhA. These results may be from various situations in the arms, trunk and legs.

Keywords: Bioelectrical impedance analyses (BIA); Extracellular water/total body water (ECW/TBW); Simultaneous Multi-Frequency Impedance Measurement (SMFIM); Phase angle (PhA); Strength training (ST); InBody

Introduction

Aged societies have progressed in developed countries such as the United States, Japan and European countries. Then, geriatrics and anti-aging medicine have attracted attention. There is an internationally well-known best-seller book, "Brain" by Anders Hansen [1]. He presented the principle that it is only exercise that can keep the brain and body young for a long time.

Concerning exercise, sports and anti-aging medicine, we have continued medical practice and clinical research for years [2]. Especially, subjects and patients include athletes of all ages, cases of obesity, type 2 diabetes and lifestyle-related diseases, as well as cases of physical rehabilitation [3]. Furthermore, masters' sports have been more prevalent in various kinds of sports and then adequate [4].

For a decade, muscle condition and sarcopenia in the elderly have been evaluated by some evaluation methods, such as CT scans, MRIs and dual energy x-ray absorptiometry (DXA), as well as bioelectrical impedance analyses (BIA) [5]. BIA has become a reliable measure due to its convenient and useful perspectives [6]. It can calculate the ratio of total body water (TBW) to extracellular water (ECW) and phase angle (PhA) for speculating the water balance and cell function [7].

From the BIA method, the PhA value can be calculated, which may indicate cell membrane integrity, cell function and cellular health [8]. Furthermore, PhA value, physical activity and exercise habits seem to have a mutual relationship. It can be useful for evaluating muscle function and lifestyle, including sedentary behavior (SB), resistance training exercise (RT) and aerobic training (AT) [9].

During our clinical practice and research for the elderly, we have recently experienced a 64-year-old male athlete who has an impressive history associated with muscle training, obesity, type 2 diabetes and others [10]. He received a BIA examination and had a meaningful result. In this article, his general status and related perspectives will be shown.

Case and Methods

Present and sports history

The case involves a 64-year-old male athlete. As for his sports history, he started playing baseball when he was an elementary school child. His achievements were excellent for batting and pitching when he was in senior high school. At that time, he probably pitched more than 150 km/hr and then the Nippon Professional Baseball (NPB) Organization checked him for a possible draft meeting. However, he threw too much and injured his elbow, so he gave up on going to professional football.

Since his 20s, he has begun working in the hospital administration office and also playing and coaching baseball on behalf of Tokushima prefecture. He had been an excellent pitcher and batter in his 30s and 50s. However, his weight gained much in his 60s and type 2 diabetes (T2D) was diagnosed. As to glucose control, his HbA1c has been stable at 6.1- 6.4% with metformin and imeglimin (Twymeeg) for years [11]. He has continued physical training and strength training (ST). As part of the batting practice, he continued swinging a very heavy bat hundreds of times every day to train his hand, arm, back, waist and leg muscles. For promoting muscle power and muscle volume, he has also continued the training of the blood flow restriction (BFR) method during his training [12]. It

originated in Japan, and it was called KAATSU training [13]. It means Ka= make addition, and Atsu= pressure in Japanese language.

Methods

This study was conducted using the apparatus of InBody BWA, which originated and was developed in Japan [14]. The measurement principle was based on the theory of Bioelectrical Impedance Analyses (BIA) [15]. Using this, detailed body composition can be obtained, including total body extracellular water (ECW), total body water (TBW), and ECW/TBW. Furthermore, phase angle (PhA) has been known as a marker of the functional status of human cells. For analyzing the correct body water status, several electric currents ranging from 1 kHz to 3000 kHz were used. Multi-frequency measurement was conducted from five parts (bilateral arms, trunk and bilateral legs) repeatedly by alternating current at 8 frequencies [16]. By SMFIM (Simultaneous Multi-frequency Impedance Measurement), 40 impedance data points were totally obtained and calculated into the results [17].

Results

The body composition analysis showed body weight 90kg, soft lean mass 61.2kg, fat 25.0kg, BMI 27.9 kg/m^2, and body fat 27.8% (Table 1).

Table 1: *Body composition analysis.*

A) Body Composition Analysis

	測定値	体水分量	筋肉量	除脂肪量	体重
water (L)	47.7 (39.9~48.7)	47.7			
protein (kg)	12.6 (10.7~13.1)		61.2 (51.2~62.6)	65.0 (54.3~66.4)	90.0 (60.3~81.7)
mineral (kg)	4.68 (3.69~4.51)				
fat (kg)	25.0 (8.5~17.0)				

B) Soft Lean-Fat Analysis

	低	標準	高
weight (kg)	90.0		
soft lean (kg)	61.2		
fat (kg)	25.0		

C) Obesity Index Analysis

	低	標準	高
BMI (kg/m^2)	27.9		
body fat (%)	27.8		

By the segmental lean analysis for muscle, ECW/TBW showed 0.380 in the arm, 0.384 in the trunk, 0.385–0.387 in the legs, and 0.384 in the total value (Table 2). The standard value of total ECW/TBW would be around 0.38 in the general population.

Table 2: *Muscle and ECW/TBW Analysis.*

D) Segmental Lean Analysis

	低	標準	高	ECW/TBW
rt arm (kg)	3.69			0.380
(%)	102.1			
lt arm (kg)	3.49			0.380
(%)	96.5			
trunk (kg)	28.1			0.384
(%)	97.3			
rt leg (kg)	9.97			0.385
(%)	99.1			
lt leg (kg)	10.11			0.387
(%)	100.5			

E) ECW/TBW Analysis

	低	標準	やや高	高
ECW/TBW	0.384			

His skeletal muscle mass index (SMI) revealed 8.5 kg/m^2 (Table 3), which showed a higher value compared with usual male subjects in their 60s. In contrast, segmental fat analysis revealed high deposition of fat in the arms, trunk and legs, which is compatible with an elevated BMI value. The whole-body phase angle showed 6.4 degrees.

Table 3: *Analysis of SMI, Fat and PhA.*

F) Skeletal Muscle Mass Index (SMI)

	8.5 kg/m^2
8.5	
23.11.18 09:27	

G) Segmental Fat Analysis

rt. arm	(1.7kg)	260.2%
lt. arm	(1.7kg)	273.8%
trunk	(13.4kg)	298.8%
rt. leg	(3.4kg)	188.2%
lt. leg	(3.5kg)	188.7%

H) Whole Body Phase Angle

proximal

ϕ(50kHz) 6.4°

I) Impedance value

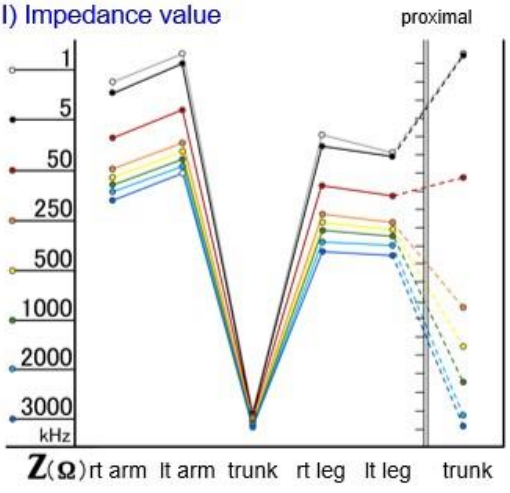

Figure 1: *Impedance analysis.*

Discussion

In the current report, the case showed some characteristic aspects. These factors are listed below: i) Sportsman for long years engaged in baseball and softball, ii) obesity and light degree of type 2 diabetes for 6 years, iii) BMI 27.9 kg/m^2 and body fat 27.8%, iv) average ECW/TBW as 0.384, v) high SMI as 8.5 kg/m^2, and vi) average PhA value as 6.4 degrees.

Concerning skeletal muscle mass index (SMI), various discussions have been found for heterogeneous methods and terminologies that are related to diagnostic criteria for consensus definitions [18]. Among them, two representative methods are dual X-ray absorptiometry (DXA) and bioelectrical impedance analysis (BIA). The reported range of cut-off values for SMI by DXA would be 5.86–7.40 kg/m^2 (male) and 4.42–5.67 kg/m^2 (female). Similarly, the cut-off values for SMI by BIA were 6.75–7.40 kg/m^2 / 5.07–5.80 kg/m^2 (M/F), respectively. Compared with these data, the SMI value was 8.5 kg/m^2, which seems to be higher than the standard situation. It may be from continuous muscle training for many years. In particular, the higher SMI values in his arms are from the usual exercise of pitching and batting in baseball.

The correlation among SMI, obesity and NAFLD was analyzed, as well as the interaction for CVD incidence over 10 years. The protocol included 3042 participants and these factors were investigated [19]. As a result, the relationship between NAFLD and CVD for 10 years was significant for normal/abnormal central obesity and low SMI. In contrast, no relationship was found between normal/abnormal central obesity and a moderate/high SMI value.

This case has shown obesity and a light degree of T2D with HbA1c 6.1-6.4% for 4 years. This situation does not influence his present and sports histories so much. The data on segmental fat analysis may indicate the necessary weight reduction for improvement of T2D and obesity. Furthermore, blood flow restriction (BFR) training has had a positive effect on muscle size and power [13]. In these circumstances, a higher SMI and lifestyle with exercise can contribute to the improvement of glucose variability in T2D.

Segmental lean analysis of ECW/TBW showed 0.380 for arms, 0.384 for trunk and 0.385/0.387 for rt/lt legs. These results are in line with the actual case situation. The case always continued physical training for arms, leading to the standard level of 0.380. Due to central obesity, visceral fat would be consistent with 0.384 in the trunk. He complained of bilateral knee pain with some edema when he received the BIA test. Thus, the high ECW/TBW of the legs can be explained. The phase angle (PhA) showed 6.4 degrees in this case. The PhA values have been studied in several kinds of sports [20]. As a result, PhA in university athletes showed 7.7/6.9 degrees (M/F) in average, respectively. In addition, PhA showed 7.6/6.8 for endurance sports, 7.7/7.0 for velocity and power sports, and 7.6/6.8 for team sports, respectively. PhA has been involved in various functions of body cell mass and water distribution. In addition, it has been associated with muscle strength, volume, and function, which can become an effective predictor of medical reports [21].

There are some limitations to this article. This case has been an athlete with obesity and T2D and has continued strength training (ST) for a long time. By BIA analysis, elevated SMI, average ECW/TBW and PhA were observed. Some positive and negative factors seem to be involved in the results, such as exercise, obesity, T2D, arthralgia, edema, water balance, aging and so on. The clinical course will be followed up with close attention.

In summary, a 64-year-old male was represented who showed some characteristic aspects of athlete, strength training, SMI, ECW/TBW and PhA. It is expected that this article will serve as a useful reference for body composition, cell function, water balance and anti-aging medicine.

Conflict of interest: The authors declare no conflict of interest.

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