SUNTEXT REVIEWS

SunText Review of Endocrine Care

ISSN: 2771-5469

Open Access
Case Report
Volume 3:1

Body Composition of Preserved Muscle, Water Balance and Phase Angle in 90-Year-Old Chemist with Regular Lifestyle

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Received date: 13 February 2024; **Accepted date:** 16 February 2024; **Published date:** 22 February 2024

Citation: Shimamura T, Bando H (2024). Body Composition of Preserved Muscle, Water Balance and Phase Angle in 90-Year-Old Chemist with Regular Lifestyle. SunText Rev Endocrine Care 3(1): 117.

DOI: https://doi.org/10.51737/2771-5469.2024.017

Abstract

The case is 90-year-old male patient with type 2 diabetes (T2D). Concerning his profession, he was a chemical engineer and he has been a member of New Elderly Association (NEA) established by Dr. Shigehara Hinohara. By bioelectrical impedance analyses (BIA) using InBody, body composition analysis revealed that BMI 18.9 kg/m^2, body fat 20.6%, and total extracellular water/total body water (ECW/TBW) 0.407 (normal 0.380) were found. Skeletal muscle mass index (SMI) showed 6.0 kg/m^2, whole body Phase Angle (PhA) 4.1 degree. These data showed lower function of muscle and water metabolism, but satisfactory level for 80s elderly according to regular lifestyle.

Keywords: New Elderly Association (NEA); Bioelectrical Impedance Analyses (BIA); Extracellular Water/Total Body Water (ECW/TBW); Body Composition Analysis; Phase Angle (PhA); InBody

Introduction

In lots of developed countries, super-aging societies have come, in which sarcopenia, frailty and related matters would be important and crucial problems [1]. Elderly people often suffer from various medical problems such as life style-related diseases, where they have association with sarcopenia and frailty. Sarcopenia always develops decreased muscle mass, quality and power and increased risk of falls and injury [2]. Especially, nutritional and physical approaches can lead to controlling sarcopenia. Some studies were found for detail relationships among sarcopenia, muscle mass, strength and physical performance [3]. Systematic reviews showed significant relationships among sarcopenia and muscle problems. Concerning the assessment of sarcopenia, various methods have been available such as CT, dual energy x-ray absorptiometry, and MRI. However, these measures seem to be not perfect or clinically useful [4]. In recent years, phase angle (PhA) from bioelectrical impedance analyses (BIA) is effective for novel prognostic element for reduced muscle mass and impaired muscle function. It has been estimated to be portable, non-invasive and simple. PhA means manifesting membrane integrity and cell mass [5]. It can define muscle strength and skeletal muscular tissue [6,7]. Various relationship among sarcopenia, phase angle, muscular function was studied for years [8]. In previous papers, independent influence of PhA were observed on sarcopenia [9,10]. In contrast, controversial findings were also reported, in which active female elderly showed no relation with sarcopenia [11], or PhA cannot predict muscular power, muscle mass, or functional states [12]. Authors and collaborators have so far continued clinical practice and related research for elderly patients in the light of ant-aging medicine [13-15]. Amont them, we have been managing an extremely elderly patient with type 2 diabetes (T2D) who is a chemist and has been leading a regular life style for long. He received the examination of latest apparatus of body composition, and detail data were obtained. General history and situations of the patient and also related perspectives are discussed in this report."

Case Report

Medical history: The case is 90-year-old male patient with type 2 diabetes (T2D), hypertension and coronary heart disease (CHD) for about 10 years. Concerning his profession, he was a chemical engineer, and working in research department of for long. In addition, he has been a member of New Elderly Association (NEA) that was established by Dr. Shigehara Hinohara, who was supreme doctor working in the International St. Luke hospital, Tokyo, Japan. He maintains regular lifestyle for long with ideal physical and psychological situation according to Hinohara-ism. He received cardiac operation for aortic stenosis in 2021, which was successful with satisfactory clinical course. After that, his CHD and T2D has been stable, his general clinical progress has been stationary without specific problems.

Physical exam & data: He did not show remarkable findings in present status, symptoms or signs related to T2D, hypertension, CHD. He revealed unremarkable diabetic complications of microangiopathy. Concerning recent laboratory findings, he showed stable HbA1c and slight elevated creatinine value. The representative data of laboratory exam are summarized in (Table 1).

Table 1: *Changes in laboratory data.*

Year	2018	2019	2021	2022		2023		2024
Month	Aug	Jan	Mar	Feb	Sep	Apr	Dec	Jan
Diabetes								
HbA1c (%)	6.2	6.1	6.2	6.1	5.9	6.1	6.5	6.1
Glu-60min (mg/dL)			129	134	126	143	181	182
Renal								
BUN (mg/dL)			24	31	26	36	29.3	
Cre (mg/dL)			1.02	1.24	1.25	1.33	1.14	
eGFR (mL/min/1.73m2)			53	42	42	39	46	
Lipids								
LDL (mg/dL)			110	82	83	91	91	
HDL (mg/dL)			80	69	79	69	68	
TG (mg/dL)			84	154	110	60	63	
CBC								
Hb (g/μL)	12.0	11.5	11.2	10.3	11.9	11.1	11.7	
WBC (/μL)			6700	7200	6190	5300	5000	
Plt (x10*4/μL)			11.1	11.4	10.2	10.0	13.1	

Table 2: *Analysis of body composition.*

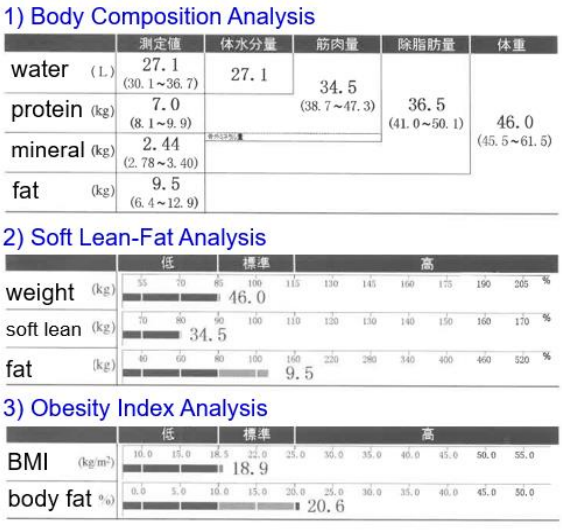

Table 3: *ECW/TBW analysis.*

4) Segmental Lean Analysis

		低	標準	高	ECW/TBW
rt arm	(kg)	1.66			0.386
	(%)	76.0			
lt arm	kg)	1.59			0.387
	%)	72.5			
trunk	kg)	15.4			0.407
	%)	88.0			
rt leg	kg)	5.64			0.417
	%)	92.7			
lt leg	kg)	5.68			0.410
	%)	93.3			

5) ECW/TBW Analysis

	低	標準	やや高	高
ECW/TBW	0.320 0.340 0.360 0.380 0.390 0.400 0.410 0.420 0.430 0.440 0.450			0.407

Table 4: *Muscle and fat analysis.*

6) Skeletal Muscle Mass Index (SMI)

6.0 kg/m²

6.0

24.01.20 10:10

7) Weight Control

Ideal Weight	53.5 kg
Weight cont.	+7.5 kg
Fat cont.	−1.5 kg
Muscle cont.	+9.0 kg

8) Segmental Fat analysis

rt. arm	0.6kg)	127.2%
lt. arm	0.6kg)	133.6%
trunk	4.0kg)	119.0%
rt. leg	1.6kg)	119.2%
lt. leg	1.7kg)	120.9%

Table 5: *Body Phase Angle (PhA).*

9) Research Parameters

ICW	16.1 L	(18.6~22.8)
ECW	11.0 L	(11.4~14.0)
BMR	1159 kcal	

10) Whole Body Phase Angle

	proximal	
φ(°)	50 kHz	4.1°

11) Segmental Body Phase Angle

	proximal	rt arm	lt arm	trunk	rt leg	lt leg
φ(°)	5 kHz	1.9	1.7	2.5	1.2	1.4
	50 kHz	4.5	4.3	5.4	3.2	3.9
	250 kHz	4.1	4.0	6.2	3.7	4.5

Methods

Current study was performed using the instrument of InBody BWA, which was developed in Japan [16]. The principle of the measurement is based on Bioelectrical Impedance Analyses (BIA) [17]. By this measurement, body composition can be provided such as extracellular water (ECW), total body water (TBW), and also ECW/TBW. In addition, phase angle (PhA) can be provided, that is the biomarker of current function situation of human cell. For calculating body water condition, several electric current from 1kHz to 3000kHz were used. Multi-frequency measurement is conducted by five parts of the body of bilateral arms, trunk, and bilateral legs using eight frequencies [18]. For using SMFIM (Simultaneous Multi-frequency Impedance Measurement), 40 impedance data were obtained and they are calculated into the total results [19].

Results and Discussions

The body composition analysis revealed that body weight 46kg, soft lean mass 34.5kg, fat 9.5kg, BMI 18.9 kg/m^2, and body fat 20.6% (Table 2). As to the segmental lean analysis, the data of arm, trunk and leg showed 72.5%-93.3%, which were remarkably lower results (Table 3).

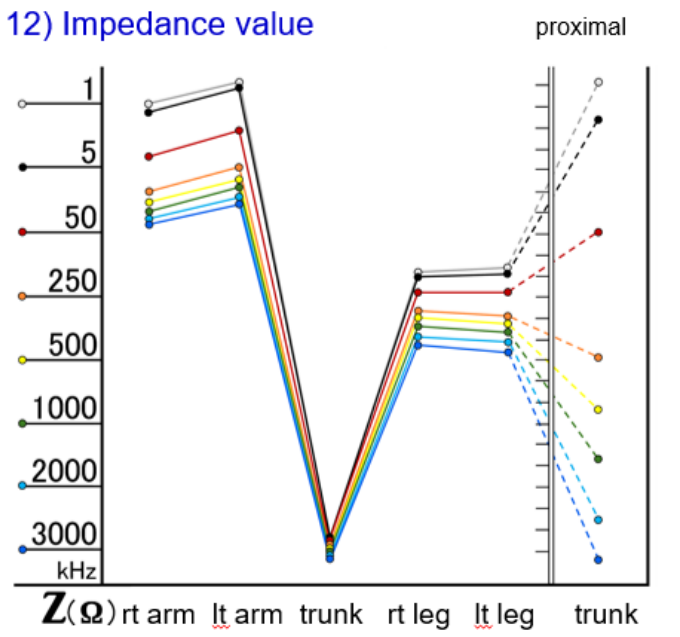

Figure 1: *Impedance analysis.*

Segmental ECW/TBW showed 0.386 – 0.417, that were higher than the standard level. Total ECW/TBW showed 0.407, which was average data from arm-trunk-leg. In general population, usual standard level of total ECW/TBW is approximately 0.38. His skeletal muscle mass index (SMI) showed 6.0 kg/m^2 (Table 4), that showed lower value in comparison with the ordinary male subjects in 60-70s. On the other hand, segmental fat analysis showed the values more than 100% for arm, trunk and leg, that is compatible to decreased BMI value. Whole Body Phase Angle was calculated to be 4.1 degree (Table 5). Related to these data, segmental body phase angle revealed wide range from arm, trunk and leg. The impedance value was calculated by different kHz (Figure 1).

Discussion

In this article, current case revealed some characteristic points. Related factors are shown as follows: i) elderly who is 90 years old, ii) he has been almost physically healthy due to his regular lifestyle, iii) he has been socially respected by people for his career of chemist researcher and behavior of Hinohara-ism, iv) he has been interested in skeletal muscle mass index (SMI) because of recognizing decreased muscle volume for years [20], v) obtained data included lower SMI, higher ECW/TBW and lower PhA values compared with younger generation, vi) however, these data seem to be excellent to average compared with elderly in more thatn 80s [21]. His general health control seems to be maintained for long due to keeping ideal life style physically and psychologically. Body composition analysis usually evaluates the following factors, which are water, protein, minerals, and body fat content. The balance of these four would be important, and problems such as water imbalance, protein deficiency, mineral deficiency, and excess body fat are observed [22]. In recent years, body water balance (ECW/TBW analysis) has been attracting attention. Water in the human body is distributed intracellularly and extracellularly, and in healthy people, the ratio of extracellular water is maintained at around 0.380. When this ratio increases, there is increase in extracellular water or decrease in intracellular water. Muscles with higher numerical numbers are evaluated to be of poor quality. This case showed BMI 18.9 kg/m^2, Skeletal Muscle Mass Index (SMI) 6.0 kg/m^2. He states that he did not feel any problems of muscle power, but muscle volume seemed to be decreased in recently years. For his segmental lean analysis, the data of ECW/TBW showed the tendency as arms (0.386-0.387) < trunk (0.407) < legs (0.410-0.417). This result suggests that muscle quality of leg may be rather worse than those of arm or trunk [23].

There seems to be a relationship between the clinical symptoms of this case and the ECW/TBW values (arm<trunk<leg) measured in this BIA. The patient is 90 years old, has gradually lost muscle mass in his lower extremities in recent years. Furthermore, he shows slight elevated serum creatinine, and has no edema in his upper extremities but slight edema in his lower extremities [24]. These situations are considered to be closely related to segmental ECW/TBW values. When some edema exists in the body, the water content in the muscles increases and the quality of the muscle decreases. In addition, nutritional status usually

deteriorates with the aging process, which may cause cells to become dehydrated and decreased quality of muscle cell [25]. In general, it is not easy to increase muscle mass, but on the other hand, body water balance by ECW/TCW measurement can be improved relatively quickly through disease treatment and lifestyle changes. Since ECW/ICW value of thigh shows inverse association with gait speed and knee extension in elderly people, elevated ECW/ICW value would be considered as decreased physical function. Using bioelectrical impedance analysis (BIA), the relationship between gait speed/handgrip strength and body ECW/ICW ratio was investigated for 71 elderly females in the community [26]. As a result, body ECW/ICW value may suggest health status in elderly females.

This patient showed the value of 4.1 degree as PhA. Clinical association has been observed between PhA and sarcopenia, in which impaired muscle function and low skeletal muscle mass have been present. The study was conducted with the following purpose [27]. They are, i) changes in PhA for different level of sarcopenia, ii) prevalence research for sarcopenia from PhA result, iii) cut-off value of phase angle for detecting sarcopenia, and iv) predictor of PhA for sarcopenia in clinical outcomes. The research was conducted and examined from 79 relevant studies. Out of them, 13 studies with 7668 subjects have met the criteria. Different cut-off points were found from 4.05 to 5.05°, that were derived from the diagnosis of sarcopenia. PhA and sarcopenia seemed to be independent predictors in geriatric hospitalized patients and in cancer patients. Some limitation is present concerning this report. Current case is only one elderly who keeps certain level of muscle function and probably due to usual regular life style with research mind. Such case is maybe rather rare, and then we will follow up his clinical and social progress from now. In summary, 90-year-old men has been presented who showed successful aging with keeping physical function of muscle power and psychological stability with Hinohara-ism. It is expected that this report will contribute for the development of anti-aging medicine in the future.

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