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Bioelectrical impedance in the assessment of nutritional status

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Abstract

Introduction

Bioelectrical impedance analysis is based on the difference in electric conduction in the water and fat environment. Adipose tissue and extracellular water are devoid of capacitive resistance (reactance), whereas they show passive electrical resistance (resistance). The current frequencies used in the bioelectrical impedance test do not affect nerve or heart muscle irritation. The current is completely safe and practically imperceptible to the patient.

Aim

The purpose of the work is to analyze bioelectrical impedance in assessing nutritional status.

Material and method

Review of available literature on the subject.

Results

Impedance is a category of electrical resistance consisting of two elements: resistance (passive electrical resistance) and reactance (capacitive, active electrical resistance). Resistance refers to the specific resistance of individual tissues. It is proportional to the voltage and inversely proportional to the total water content in the body. Reactance is associated with the electrical capacity of cell membranes that act as capacitors.

The phase angle is a parameter that illustrates the circulation of water between the intracellular and extracellular space. Provides information on cell membrane integrity, cell health and total body mobility.

BCM changes are typical for some chronic diseases, such as AIDS or cancer. Subjective global nutrition assessment (SGA) is the gold standard for determining nutritional status.

Conclusions

The phase angle value allows you to track the nutrition of the body as well as monitor recovery and physical fitness. Keeping BCM at the right level has a positive effect on your health. Maintaining BCM is a major goal in all types of nutrition therapies. FFMI allows observation of the effects of treatment, disease or aging patients.

Key words: impedance; nutritional status.

Introduction

Bioelectrical impedance is the general resistance of a biological conductor in alternating current circuits [1]. Impedance is a category of electrical resistance consisting of two elements: resistance (passive electrical resistance) and reactance (capacitive, active electrical resistance). Resistance refers to the specific resistance of individual tissues. It is proportional to voltage and inversely proportional what the total water content in the body. Reactance is associated with the electrical capacity of cell membranes that act as capacitors. Reactance implies a phase shift of current versus voltage and accounts for about 10% of the impedance value [2].

Bioelectrical impedance analysis is based on the difference in electric conduction in the water and fat environment. Adipose tissue and extracellular water are devoid of capacitive resistance (reactance), whereas they show passive electrical resistance (resistance). Current frequencies used in the bioelectrical impedance test, they do not affect nerve or heart muscle irritation. The current is completely safe and practically imperceptible to the patient. Low frequencies are associated with the flow of current through extracellular fluids and the inability to cross the cell membrane boundary, which is an insulator. Higher frequencies exert flow through external fluids and intracellular, and make the cell membrane behave like an excellent capacitor. To sum up, passive resistance is associated with extracellular fluid and intracellular, while active resistance is determined by the electrical capacity of cell membranes. Frequency is most often used in cameras 50 kHz. In such conditions, the current flows through both the outside and outside fluid and intracellular [3, 2].

The use of selected parameters of bioelectrical impedance analysis in nutritional assessment.

Phase angle (pH)

The phase angle is a function of resistance (R) and reactance (Xc) measured by bioelectrical impedance analysis. This is a measure of the phase shift of the alternating current caused by the "delay" resulting from consolidated resistance with the electrical capacity of cell membranes. It adopts the following formula:

$$\varphi = \text{arc tangent } Xc / R$$

where: Xc - reactance,

R - resistance

and values in the range - 90 ° to 0 ° [2].

This indicator is directly proportional to body cell mass (BCM), and its higher value corresponds to better cell function. This parameter is most diagnostically relevant at a frequency of 50 kHz. Although the biological significance of the phase angle is not fully understood, it is systematically used to determine nutritional status. Provides information on cell membrane integrity, cell health and total body mobility. The phase angle value allows you to track the nutrition of the body as well as monitor recovery and physical fitness [2, 4].

The phase angle is a parameter that illustrates the circulation of water between the intracellular and extracellular space. It is associated with a low ratio of extracellular to intracellular water [2]. In the group of patients with heart failure, lower phase angle values are associated with the higher NYHA functional class [6] and in clinical conditions indicate poor prognosis among patients with additional concomitant anemia, volume overload [5] or thyroid disease [2, 7, 8].

Body Cell Mass (BCM)

The body cell mass is part of the lean body mass. Indicates all cells involved in metabolic processes that determine the basic metabolic rate. BCM consists of skeletal muscle cells, smooth muscles, myocardium, internal organs, digestive system, blood, glands and the nervous system. The individual BCM value is determined by genetic factors, age and physical condition. The BCM content in lean body mass should be about 53-59% for men and 50-56% for women [3].

BCM is also a model indicator of energy consumption assessment, determining the body's need for calories. BCM measurement is crucial for analyzing nutritional status and assessing the level of patient malnutrition. Keeping BCM at the right level has a positive effect on your health. Maintaining BCM is a major goal in all types of nutrition therapies [3].

BCM changes are typical for some chronic diseases, such as AIDS or cancer [9].

Extracellular mass / body cell mass (ECM / BCM) indicator

The ECM / BCM indicator is a leading parameter in the assessment of nutritional status. Its value in a healthy population is below 1 due to the fact that the body cell mass is clearly greater than the extracellular mass. One of the first symptoms of malnutrition is an increase in this parameter, caused by BCM catabolism, ECM water deposition due to hyperinsulinism or water storage in the ECM for other reasons [3, 10].

Lean Body Mass Index (FFMI)

The lean body mass index is calculated according to the formula:

$$FFMI = FFM / (\text{increase})^2$$

where: FFM - lean mass.

Values lower than or equal to 15 kg / m² for women and 16 kg / m² for men indicate for lean mass deficiency [11].

FFMI allows observation of the effects of treatment, disease or aging patients. It allows to assess whether the low level of FFM achieved with age is the result of a lower height in elderly patients or changes in body structures. This indicator registers patients with excess muscle mass [12].

Impedance indicator measured at 5 and 200 kHz (Z 5/200)

The impedance indicator Z 5/200 is a parameter that determines the distribution of water.

In severe diseases, the differences between impedance measured at 5 kHz and 200 kHz are similar, indicating impaired cell function. NYHA group III - IV patients achieved higher Z_{5/200} values compared to patients in NYHA group I - II. It should be assumed that this indicator defines a greater degree of heart failure, to which companions elevated cytokine levels and reduced production of correlative anabolic factors with increased morbidity and mortality [13].

Assessment of nutritional status using a subjective global assessment of the state nutrition (SGA)

Subjective global nutrition assessment (SGA) is the gold standard for determining nutritional status. She was interviewed about: changes in body weight, number of meals consumed, physical fitness, gastrointestinal symptoms affecting nutritional status. It is also based on a physical examination capturing the loss of subcutaneous fat, muscle tissue and swelling of the ankle or lower limb. Subjective global assessment of nutritional status is a quick, effective and reliable tool for estimating nutritional status [3].

Based on these characteristics of the interview and physical examination, the SGA is determined, which indicates the patient's nutritional status. The categories of this rating are as follows:

- (A) well fed
- (B) suspected malnutrition or moderate malnutrition and
- (C) high risk of malnutrition or cachexia [3].

Tab. 1. Subjective global assessment of nutritional status (SGA) [3]

AND	Interview
Weight change	Weight loss in the last 6 months (kg) (%) Weight change in the last 2 weeks: <input type="checkbox"/> increase <input type="checkbox"/> no change <input type="checkbox"/> decrease
Changes in food intake	<input type="checkbox"/> no change <input type="checkbox"/> changes: duration (weeks) Type of diet: <input type="checkbox"/> optimal diet based on foods permanent <input type="checkbox"/> complete liquid diet <input type="checkbox"/> liquid hypocaloric diet <input type="checkbox"/> starvation
Gastrointestinal symptoms (lasting more than 2 weeks)	<input type="checkbox"/> no symptoms <input type="checkbox"/> nausea <input type="checkbox"/> vomiting <input type="checkbox"/> diarrhea <input type="checkbox"/> anorexia
Physical capacity	<input type="checkbox"/> no change <input type="checkbox"/> changes: duration (weeks) <input type="checkbox"/> type: limited work <input type="checkbox"/> it comes <input type="checkbox"/> is
Illness and nutrient requirements	increase in metabolic demand due to disease: none; small; average; big
II	Physical examination
Loss of subcutaneous fat over the triceps and on the chest	0 - unchanged, 1 - light, 2 - medium, 3 - heavy
Muscle atrophy (quadriceps, deltoid)	0 - unchanged, 1 - light, 2 - medium, 3 - heavy
Swelling above the sacrum	0 - unchanged, 1 - light, 2 - medium, 3 - heavy
Ankle swelling	0 - unchanged, 1 - light, 2 - medium, 3 - heavy
ascites	0 - unchanged, 1 - light, 2 - medium, 3 - heavy
III	Subjective global nutrition assessment (SGA)
	<input type="checkbox"/> correct nutritional status <input type="checkbox"/> suspected malnutrition or malnutrition medium grade <input type="checkbox"/> cachexia <input type="checkbox"/> high risk of malnutrition

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