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Wartości kąta fazowego mierzonego przy pomocy analizy impedancji bioelektrycznej u studentów Politechniki Lubelskiej

Streszczenie

Wstęp. Kąt fazowy (PA) ustala się na podstawie wartości rezystancji (R) i reaktancji (Xc) mierzonych przy pomocy analizy impedancji bioelektrycznej. Biologiczne znaczenie tego parametru jest niejasne, aczkolwiek coraz częściej wykorzystuje się go do oceny stanu odżywienia.

Cel. Badanie zostało przeprowadzone w celu wykrycia istotnych statystycznie różnic w rezystancji, reaktancji i kącie fazowym w grupie zdrowych kobiet i mężczyzn.

Materiał i metody. Analiza impedancji bioelektrycznej przy użyciu aparatu SFB7 BioImp v1.55 (Pinkeba Qld 4008, Australia) przeprowadzono na grupie 60 studentów Politechniki Lubelskiej (30 kobiet i 30 mężczyzn). Kąt fazowy ustalono bezpośrednio z wartości Xc i R (PA=arcus tangens Xc/R x 180 stopni/π). R i Xc zostały zmierzone przy częstotliwościach 5, 50, 100 i 200 kHz. Do wykrycia istotnych statystycznie różnic między porównywanymi grupami użyto testu t-Studenta dla grup niezależnych. Przyjęto 5% błąd wnioskowania i związany z nim poziom istotności p<0,05.

Wyniki. Przy częstotliwości 50 kHz nie zaobserwowano istotnej różnicy statystycznej w reaktancji pomiędzy grupą mężczyzn i kobiet (odpowiednio 59,63±6,46 ohm vs. 61,54±8,56 ohm; p=0,34). Stwierdzono istotnie statystyczną różnicę w grupie mężczyzn i kobiet w rezystancji (odpowiednio 595,46±62,84 ohm vs. 725,28±74,40 ohm; p<0,000001) i kącie fazowym (odpowiednio 5,75º±0,65 vs. 4,86º±0,53; p<0,000001).

Wnioski. Wartość kąta fazowego różni się w grupie mężczyzn i kobiet. Potwierdzenie istnienia różnic w wartości kąta fazowego w różnych wiekowo grupach zdrowych polskich mężczyzn i kobiet wymagają dalszych badań.

Słowa kluczowe: analiza impedancji bioelektrycznej, kąt fazowy, reaktancja, rezystancja.

Phase angle measured by bioelectrical impedance analysis in Polish College students. Preliminary observations

Abstract

Introduction. Phase angle (PA) is an indicator based on resistance (R) and reactance (Xc) received from bioelectrical impedance analysis (BIA). Although the biological significance of PA is still not clear, it appears to have an important prognostic role in nutrition state assessment.

Aim. The study aimed to investigate the differences in resistance, reactance and phase angle in the group of Polish men and women.

Material and methods. The whole-body analyses were made with ImpediMed bioimpedance analysis SFB7 BioImp v1.55 (Pinkeba Qld 4008, Australia) in the group of 30 women and 30 men – the students of Lublin University of Technology. Phase angle was calculated directly from body Xc and R (PA=arcus tangens Xc/R x 180 stopni/π). R and Xc were measured directly in ohms at 5, 50, 100 and 200 kHz. For group comparisons of metric data the t-Student test was used. The value of p<0.05 was considered statistically significant.

Results. At 50 kHz there was no statistically significant difference between the male and female university students' groups in reactance (59.63±6.46 ohm vs. 61.54±8.56 ohm, respectively; p=0.34). There was a statistically significant difference between the male and female university students' group in resistance (595.46±62.84 ohm vs. 725.28±74.40 ohm, respectively; p<0.000001) and PA (5.75º±0.65 vs. 4.86º±0.53, respectively; p<0.000001).

Conclusions. The evaluation of phase angle computed by resistance and reactance measurements by bioimpedance analysis differ in group of Polish university male and female students. Further observational research investigating these properties in larger groups would be welcomed to elucidate and/or confirm these findings.

Keywords: impedance analysis, phase angle, reactance, resistance.

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INTRODUCTION

Bioelectrical impedance analysis (BIA) is one of the methods for nutritional status assessment. BIA is noninvasive, inexpensive and portable method that has been used mainly for body-composition analysis over the years. It measures body reactance (Xc), resistance (R) and phase angle (PA). The use of these raw data has gained popularity in nutrition assessment and monitoring of nutrition status in patients [1]. BIA is based on the principle that a fixed, low-voltage, high-frequency alternating current introduced into the human body is conducted almost completely through the fluid compartment of the fat-free mass [2]. Resistance is the restriction to the flow of an electric current, primarily related to the amount of water present in the tissues. Reactance is the resistive effect produced by the tissue interfaces and cell membranes [3]. Part of the electrical current is stored by the cell membranes, which acts as capacitors, creating resistive force. It is this reactance that causes the current to lag behind the voltage ultimately creating a phase shift, which is quantified geometrically as the angular transformation of the ratio of reactance to resistance, or PA [4].

AIM

The aim of our observational study was to perform bioelectrical impedance analysis to investigate whether there are any statistically significant differences in resistance, reactance and phase angle in Polish men and women.

MATERIAL AND METHODS

The participants of the study were students of the Lublin University of Technology. The group consisted of sixty healthy students: 30 men and 30 women. The median age of surveyed people was 22 years (range from 21 to 27). The study was performed in the Human Physiology Department at the Medical University of Lublin. Participation in this study was voluntary.

BIA was performed by a medical doctor using ImpediMed bioimpedance analysis SFB7 BioImp v1.55 (Pinkeba Qld 4008, Australia). Due to previously published research indication that exercise influences BIA measurements, in particular phase angle, this variable was controlled in our study. BIA was performed, after a 10-minute rest period. All patients were positioned supine on a bed, with their legs apart and their arms not touching their torso. All evaluations were conducted on the patients' right side by using the four surface standard electrode (tetra polar) techniques on the hand and foot. R and Xc were measured directly in ohms at 5, 50, 100 and 200 kHz. R and Xc values were measured three times in each patient, and the mean values were used. PA was obtained from the arc-tangent ratio Xc:R. to transform the result from radians to degrees, the result that was obtained was multiplied by 180°/π. For further analysis, values of R, Xc, and PA measures at 50 kHz were taken. Our results are expressed as mean±SD. For group comparisons of metric data the Mann-Whitney-U-test was used. A $p<0.05$ was considered statistically significant. This study was conducted according to the guidelines set forth in the Declaration of Helsinki, and all procedures involving human subjects/patients were approved by the Research Ethics Committee of the Medical University of Lublin, Poland. All college students gave their written informed consent as a precondition of participation in the study.

RESULTS

As previously stated, many research studies refer to great reproducibility of direct bioimpedance measurements (R, Xc, PA) at 50 kHz. Due to logic of this reasoning, our method refers to 50 kHz.

Polish university male and female students' characteristics with average values of protocol variables are reported in Table 1. Baseline characteristics of the Polish university male and female students are shown in Table 1. There was a statistically significant difference in phase angle in the group of Polish men and Polish women (5.75º±0.65 vs. 4.86º±0.53, respectively; $p<0.000001$) and in resistance (595.46±62.84 ohm vs. 725.28±74.40 ohm, respectively; $p<0.000001$). There was no statistically significant difference in reactance between the male and female university students' groups(59.63±6.46 ohm vs. 61.54±8.56 ohm, respectively; $p=0.34$).

DISCUSSION

The presented study shows difference in the phase angle values in group of Polish university students. Variations in phase angle values have been reported between men and women, healthy and diseased patients, and in young and older people. Variations in PA have also been noted among individuals at fixed frequency. The observed variations could be due to differences in the capacitive behavior of these groups' tissues, associated variability in cell size, membrane permeability, or intracellular composition or associated with dif-

TABLE 1. Baseline characteristics of the Polish university male and female students.

Characteristic	Value (Polish women)	±SD	Value (Polish men)	±SD	p
Age (y)	21.67	1.15	22.43	1.91	NS
BMI (kg/m2)	21.37	3.26	23.77	4.14	p=0.02
Height (cm)	167.10	4.84	180.15	8.42	p<0.000001
Weight (kg)	59.72	9.77	77.30	14.47	p=0.000001
R at 50kHz (ohm)	725.28	74.40	595.46	62.84	p<0.000001
Xc at 50kHz (ohm)	61.54	8.56	59.63	6.46	p=0.34
Phase angle at 50 kHz (°)	4.86	0.53	5.75	0.65	p<0.000001

ferences in the distribution of body fluids among individuals, which may affect the amount of shunting of the current through the interstitial spaces [5]. Phase angle has also been reported to be a prognostic tool in various clinical situations, such as HIV [6], bacteremia [7], cirrhosis of the liver [8], renal disease [9,10], pulmonary tuberculosis [11], and cancer [12].

In healthy populations, there can be considerable differences between phase angle reference values, and these values vary by population. Barbosa-Silva et al. [13] observed similar variations in PA values between gender and age groups. To our knowledge, the lowest values of PA reference values have been found in the German population, in a study by Dittmar [14]. Thus far, there are no phase angle reference values available for healthy Polish population. In light of history, there are some shared cultural values between the German and Polish populations. German population reference values are probably most closely related to the Polish population.

Phase angle appears to have an important prognostic role. The limitation of this study being a small number of participants, does not allow the presented results to be generalized for all students. This research is one of the first in this field prepared by our team and we wish to expand our next research by recruiting more participants and make the results of body-measurements more representative. Further observational research investigating these properties in larger groups would be welcomed to elucidate and/or confirm these findings.

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